Space, Functions and Human Behavioural Strategies: The "Analisi Funzionale Tattica" as Tool for the Understanding and Explanation of the Ancient and Medieval Fortifications

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Abstract

We can doubtless count fortifications among the both qualitatively and quantitatively most widespread archaeological-monumental evidences within ancient human landscapes. In a field of more general functionalist studies applied to structured landscapes, we are developing what we defined *analisi funzionale tattica*: an approach moving from our knowledge of how, within pre-firearms military tactics, could a defender choose and "co-opt" some of the natural features of the landscape in order to make use of them in defence, and how, whereby and to what degree, should they then structurally integrate it to effective fortified systems. This allows us to establish an *effectiveness level* for the whole defensive fortification, taken on as a reference value to analyze and explain the detailed running of defence for every single structural item, concerning every way to assault fortification. The main result will be a factorization of any fortified context into its natural and artificial elements, and thus the explanation of the function of each and every one.

GIS, actually ESRI ArcGIS 9.2 Spatial Analyst and 3D Analyst modules are the tools for this kind of analysis. After a detailed analysis of natural morphology and known defence structures through 3d processing, we proceed by applying algebraic procedures and GRID reclassification formulas to the model map, expressly developed in order to evaluate the spatial behaviour of each single portion according to its resistance to different assault techniques. Thus we achieve in a contour GRID map a good estimate of the mental image a fortification expert could create through evaluating the presented defensive items. Hence this kind of analysis simulates a targeted cultural cognition of defensive points embodying their inner and outer connections.

This process can be employed both for explanatory purposes – when applied to a structurally and topologically known fortification – and for diagnostic and predicting purposes – when wishing to make a plausible hypothesis about a somehow unknown typology and entity of the defence, and even for quantifying the fortification builders' skills in terms of their utilizing best what the surrounding environment provided them.

Keywords

space, functions, exaptation, behavioural strategies

Among the different strategic directions undertaken by humans, two can be defined as strongly functionalist. These two are what Tim Ingold defined as the "building perspective" and the "dwelling perspective" (Ingold 2001, 111–139): in the former case the starting environmental features are essentially ignored, and the strategy aims to build new features, more suitable to the purpose. In the latter case modifications are the slightest, and a careful choice and co-optation among existing features is pursued. We may also say that the dwelling perspective consists of getting the best from what the surrounding environment provides, and reducing changes to the utmost. Starting from an analysis of human settlement and its environmental context, my approach is based on two points: first I examine to what extent and depending on which skill either a co-optation or building strategy was chosen; then using this extent and skill I explain the features of the analyzed sites, in some cases filling the missing parts (Monti 2006).

My studies on fortifications are part of a major field of study, concerning behavioural strategies adopted by human groups in connection with their living and acting environment. In other words, this research focuses on identifying and analysing strategies by which – in different periods and contexts – individuals and human groups interact with the surrounding environment to achieve their goals. This perspective is perfectly applicable to ancient and medieval fortifications: for example, Francesco Orlogi, the builder of the Turin and

Anversa fortifications, wrote the following on how to build good fortifications: "First of all, on designing the fortress one must, with attention, consider all the advantages that might be useful to exploit in order to improve the defence. And also foresee those that may be useful to the enemy to decrease it, in so that they won't (will not) draw some advantages from it"

Fig. 1. Queribus Castle in the French Pyrenees, a clear evidence of the principles expressed by Orlogi.

(quoted in Cassi Ramelli, 364) *Fig. 1*.

The background of the approach consists of three different kinds of knowledge: knowledge of topography, to register spatial and structural data, such as the use of total station, DGPS, and other techniques that allow us to represent space, structures and artefacts. Knowledge of GIS techniques, like the use of tree-dimensional data and spatial analysis applications for data elaboration. But first at all – the knowledge of ancient and medieval combat and siege techniques is necessary to collect, manipulate and, especially, interpret information.

When we start the analysis of a site we must consider two different families of data: spatial characteristics such as the sub-regional location of the site, site specific location, and the location of any single archaeological and structural evidence that constitute the same site. Also we need to consider the evidence for the characteristics, particularly the qualitative and quantitative characteristics of any single defensive natural element (morphology), the qualitative and quantitative characteristics of any single structural element, and the relationship and interrelations between any element with the other.

In the following, some definitions are provided in order to better describe some elements of analysis:

When we speak about **defensive function** we mean the capacity a structural or spatial element has to decrease or to cooperate to decrease the efficacy of an armed attack and to improve active defence.

Attack way is the localized scenario in which the attack occurs, characterized by specific properties that influence local attack conditions.

A functional tactical unit (Unità Funzionale Tattica, UFT) is any artificial, natural or composite entity characterized by independent, homogeneous and meaningful defensive capacity.

Functional Tactical Unit is the main classification entity useful to interpret fortifications, but we have defined three other similar entities that differ from this in two parameters: complexity and autonomy.

Functional tactical element (Elemento Funzionale Tattico, EFT): an artificial, natural or composite entity characterized by simple and non-independent defensive capacity.

Functional tactical complex (Complesso funzionale tattico, CFT): a group of artificial, natural or composite entities characterized by non-independent defensive capacity

Functional tactical system (Sistema Funzionale Tattico, SFT): a group of artificial, natural or composite entities characterized by independent defensive capacity.

An example: here you see a site constituted of a particular morphology and a particular structure. The structure is composed of four linear structural elements. Meaningful are also the position and the interrelations between the structure and the landscape morphology (*Fig. 2a*). In standard archaeological classification, based on the unit of structural stratigraphy, we can identify four stratigraphic units, one for each structure segment (*Fig. 2b*). However, in functional-tactical analysis, any segment may be identified with a functional tactical element, because its presence modifies the tactical situation in its position. Moreover, three of the four elements constitute a complex, whose function is not the same as that of each of its elements when treated individually. So we may identify these three structures as a functional complex. Empirically, this interpretation would have already been done, if we had identified this type of complex with a tower and the fourth element with a wall. But with functional-tactical analysis we can be sure that these three wall segments operate as a complex, since the defence in

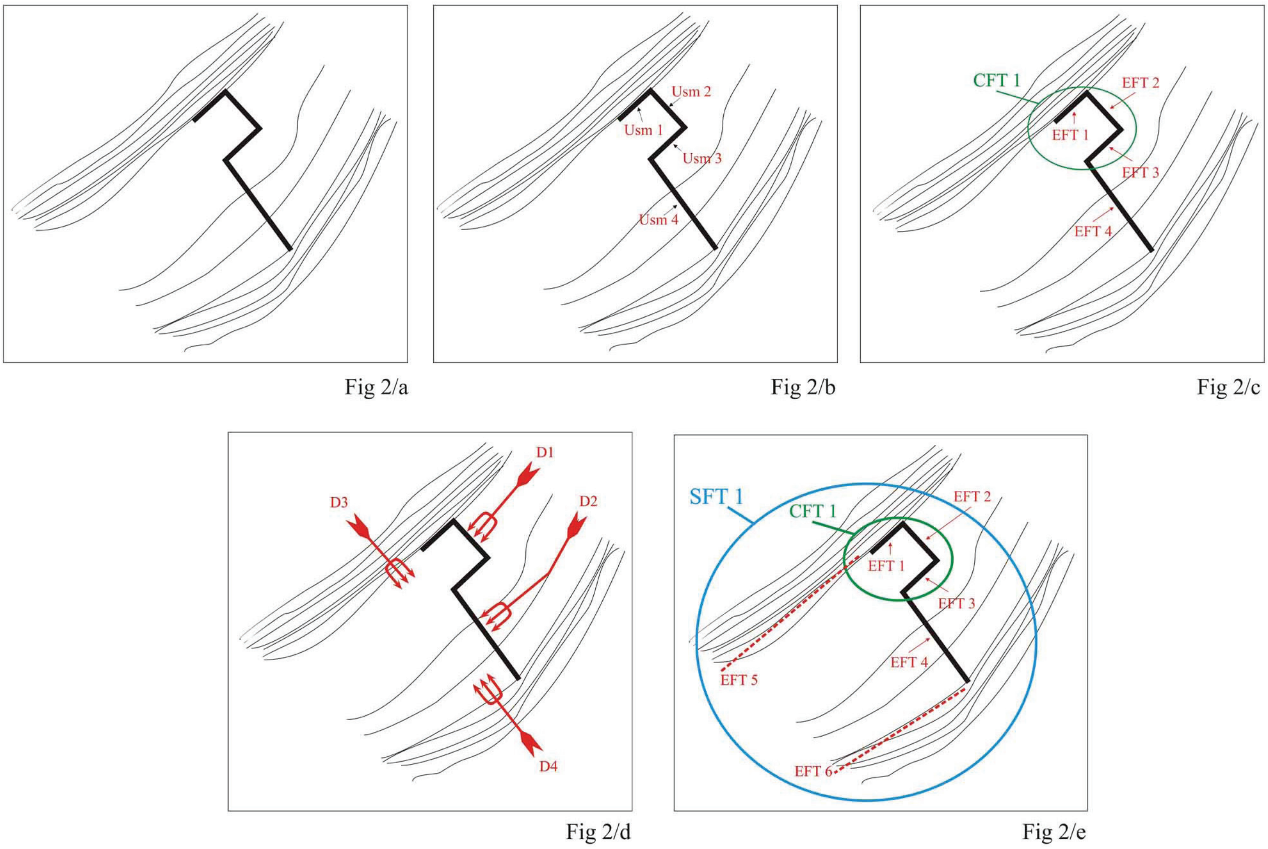

Fig. 2. The application of functional-tactical analysis on a hypothetical site, with the identification of several functional entities.

this particular position of the terrain morphology and the tactical situation make it necessary. This is the difference between the stratigraphic and the functional-tactical approach: the first considers mainly the morphology of the stratigraphic uniton the other hand, in the functional-tactical approach stated that the first element we have to consider is the function of an item in correlation with all the others and its their morphology. The ancient designer(s) of the fortress knew this, and placed the tower and the wall just in the position where it was possible to exploit this advantageous morphological condition (*Fig. 2c*). In fact, there are four possible main attack-lines to the fortification: it is evident that D1 and D2 are stopped by a structure, and D3 and D4 are stopped by the terrain morphology (*Fig. 2d*). We will not understand the operation of the fortress if we do not consider the joint functionality of structural ad morphological elements. These operate in a symbiosis and create a functionally autonomous defensive system. Therefore, we may suggest the following interpretation: there are four functional-tactical elements, three of which form a functional tactical complex, and are not autonomous without the landscape morphology. However, through the integration of the two natural elements it becomes an autonomous tactical system (*Fig. 2e*).

What I am trying to achieve by means of GIS analysis is turning an objective landscape into a subjective mindscape, considered within its chronological and cultural context. Thus, it is not an unspecific mindscape, but instead it is strongly directed to a specific function – defence – responding to strict control mechanisms – in terms of distance, energies, and probabilities. A landscape as it might have been seen by those who had chosen it for defence and were acting to fortify it, or by those who wished to assault and overcome it as soon as possible: the defenders in the former and the attackers in the latter case. As we have already seen, this conceptual structure produces measurements from a spatial model, a functionalized space in which natural features, modified elements and structurally integrated items actually follow the same principles. GIS, as I have explained before, is the tool that allows us to depict and estimate its defensive effectiveness.

As we are drawing near the subject of our main interest, that is computer applications, it is important to remember that the key of the defence before the diffusion of guns was the height difference between the location of the defender and the aggressor! The

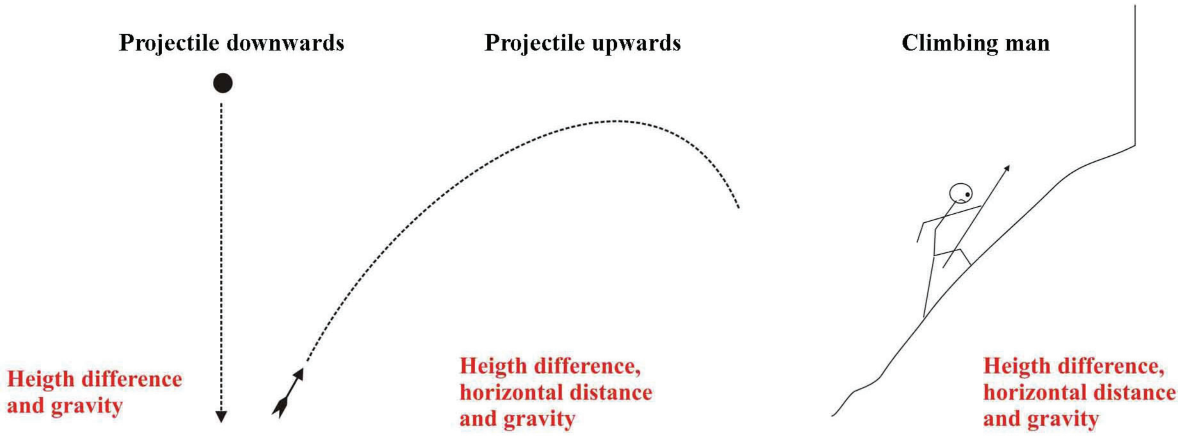

Fig. 3. Schemes of how distance and relative relief affect the assault on a fortification.

defenders must be located higher than aggressors to be able to counterattack and to defend their fortifications. Consequently, to carry out the analysis we "only" need a detailed three-dimensional model of the morphology and the structures. The significant factors that affect pouncing defence are primarily horizontal distance and height difference *Fig. 3*. With GIS technology we may represent and calculate these parameters with tree-dimensional and spatial analysis. We may consider the following as an energy balance: projectiles from top to bottom gain energy proportionally with height difference. Projectiles from bottom to top require additional energy, in proportion to the height difference and horizontal distance. Aggressors that climb a slope spend energy in proportion to height difference and horizontal distance. Another factor which must be considered is the risk to be stricken: the risk increases with the diminution of distance, while the energy of the defenders' projectiles increases with height difference.

I tested the methodology for the first time on a small castle on the Appennino Modenese named Medola: this case is interesting because it provided a chance to test the proposed methodology. In fact, we know that this castle was defended from a tower on the top of a near hill, but we attempted to apply the analysis as if we did not know about its existence. At first, the analysis procedure consisted of creating a three-dimensional model of the site, which would show both natural morphologies and the man-made defences of the castle's perimeter, but not the tower known to be defending it from the top of the spur (*Fig. 4*). Then TIN is converted to GRID format. At the same time, a multi-ring buffering spreading out from the castle's area to cover the range of all the weapons allegedly used in battle (in this case, about 300 metres), is created; this level is also converted to GRID format.

At this point, the calculation based on the inverted proportion between vertical and horizontal distance can be worked out. In outline, a Vd/Hd formula may create a map with a highly realistic factor at an empirical level (*Fig. 5*): the blue areas are actually the least dangerous, as both the way and the aggressors' shots are more inclined, while the defenders' shots downwards are more efficient thanks to favourable relative relief and shorter distance. It is even simpler to verify the dangers for the castle in the red area, which corresponds to the top of the rocky spur. The evidence for danger is the existence of a

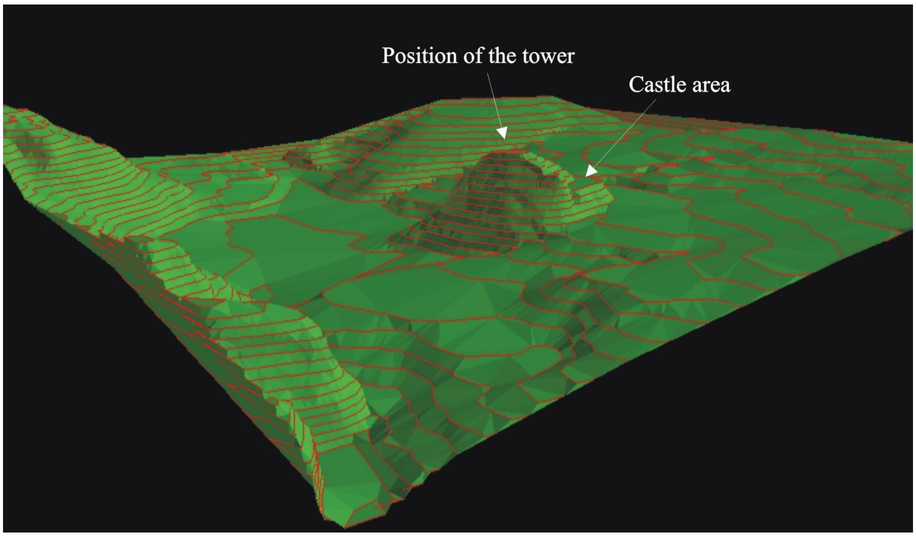

Fig. 4. The three-dimensional TIN model used to analyze the site of Medola.

tower located right there, probably built by the defenders in order to prevent the aggressors from taking over such an advantageous spot.

Thus, the map generated using GIS represents the mindscape of those who must prevent an attack or design a reinforcement of the fortification.

With regard to the formula, I would like to emphasize that we have no other possibility to verify its correspondence to reality but through a comparison of the result of the analysis with real cases. Because of the possible variations to be obtained in the maps, changing some part of the formula is especially meaningful: as the two contemplated factors must be the same, any variation will just refer to incidental multiplication factors affecting each of them (ex. [Vd x Vd]/Hd). Such adjustments, on which we are working to achieve a higher correspondence between reality and our analysis, are functional to conform the analysis to some particular form of attack, such as infantry, where relative relief has more impact than in the case of lances, which are much more affected by range and horizontal distance (*Fig. 6*).

The final step is applying the four rules to the map in order to interpret it. In practice, this map defines homogeneous sectors of defence on the basis of each defence at a local level. These sectors correspond to functional tactical elements, each of them typically defined by a specific defence level.

We may use this map in two ways: if we want to design a fortress (the mindscape of an architect or soldier), or if we want to hypothesize the presence of structural elements in each sector (archaeological mindscape). We measure on the map the value of the

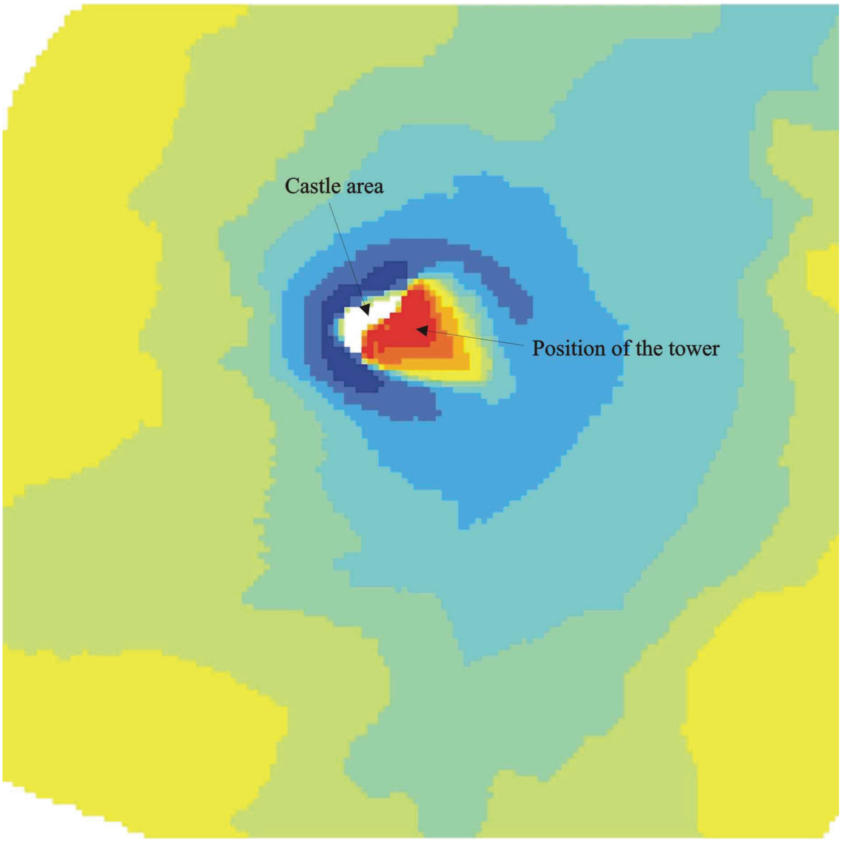

Fig. 5. The results of the analysis: the colours from blue to red represent the various "levels of danger", expressing the aggressors' level of threat due to their position facing the defence.

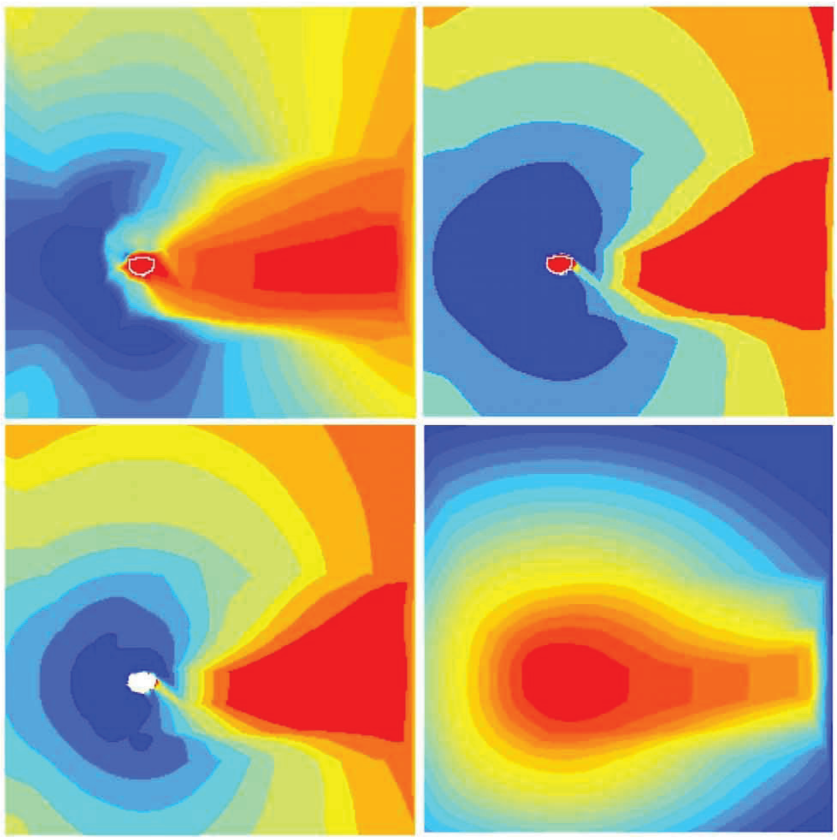

Fig. 6. Various analytical maps simply obtained either by modifying the multiplication coefficient of one of the two factors, or by changing ArcGIS Spatial analysis classification.

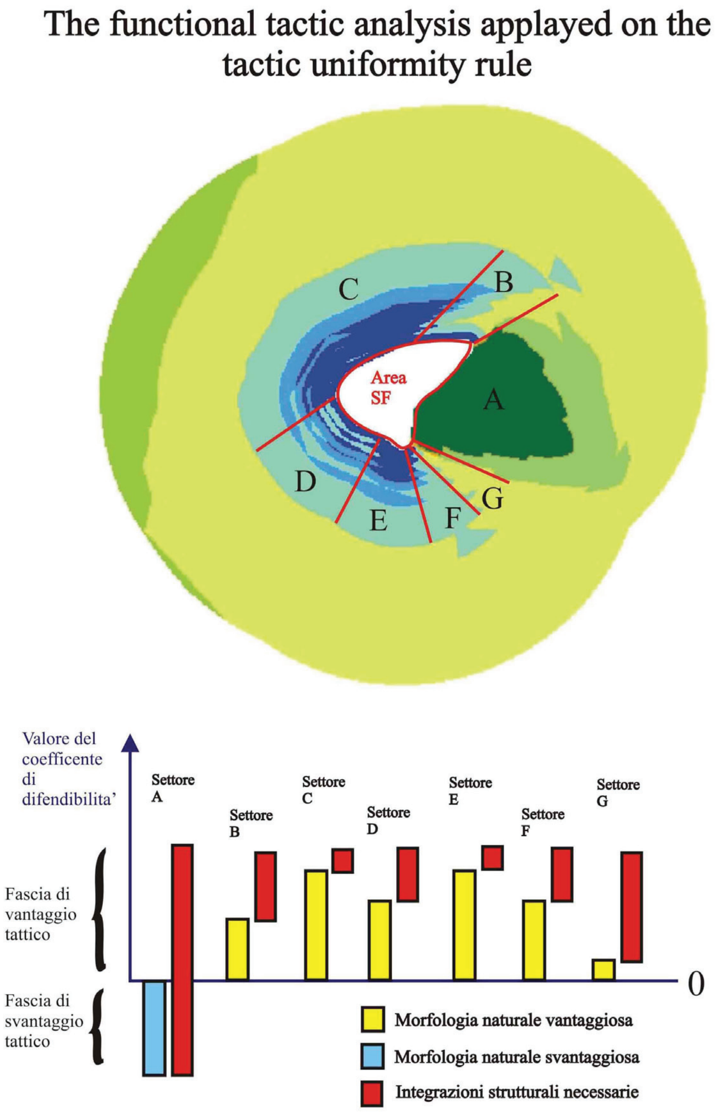

Fig. 7. Predictive use of the analytical map: since according to the tactical complementary rule the defences on each guiding line are composed of integrated natural and man-made elements and according to the tactical uniformity rule the defence level on each guiding line must be uniform with the others, we can assess the defensive level on all guiding lines by assessing only one of them, thus hypothesizing also the type and dimension of those structural defences that no longer exist.

functional tactical element that we may consider in reference, based on archaeological remains or other information, and then, on the basis of the four tactical rules and using a mathematical proportion, we may calculate the amount of the defence increment that we must obtain in all other sectors, one by one. Based on this value we will also design only adequate types of structures, fitted for each sector *Fig. 7*.

As we have seen, the procedures of modelling and measuring space are not complex, nonetheless as a specialist in environment and fortifications I think their results are consistent with reality with regard to the analyzed phenomena. The main developing field I am working on is the improvement of GIS computation. Is it possible to improve formulas and computations in order to get an even more realistic analysis? I think so. Above all, it is likely to further differentiate computation procedures, so that each can fit better a singular assault technique, thus building more realistic and well-defined landscapes to be tested singularly or in combinations.

Conclusions

Why is functional tactical analysis so relevant? Mainly because it targets a widespread strategic domain, namely the "dwelling perspective", one of the most frequently adopted behavioural models. Second, because it is remarkably broad-based, since its field of application, ancient and medieval fortifications, is one of the most common types of site or structure in case studies in historical and archaeological heritage. Third, and this is being checked for household dwelling and routes, it is likely to be applicable even more widely, to every human phenomenon with a spatial element. Therefore, assessing the analysis means achieving a key to a broad field of study covering at least one or maybe more of the most important functions ever accomplished by humans: surviving the attack from their fellow humans. These are the main reasons urging us to proceed in the research path I have showed here.

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