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The Settling Systems from Images: some Case Histories

Multispectral images offer a considerable quantity of information about the presence of man in a given region, through the analysis of the environment and natural resources that man was able to exploit and through the remains and artifacts, products of his activity, he left behind: we can find them in the most superficial levels of earth's surface in all areas where there has been man. All information is to be analysed and the first step of this operation consists in finding coherence within each set of information, in order to recognize the type of occupation or land-use by man, in the quest for survival. In fact, when we talk about occupied territory, we have to refer not only to the area chosen by man for dwelling, but also to the whole region surrounding this site, where man gets the fundamental resources for his life; therefore, the anthropised territory has to be seen as a set of used natural resources, always renewable, as a site where to place or deposit built artifacts or a place where to discard them, and at the same time, as the space where to carry out every activity or cultural performance.

The first element of this analysis can be ascertained and evaluated once we have carried out image georeference, that is information we acquired from images. In this, the concept of the settling system seems essential: it refers to an organic and, at the same time, complex unit of the human presence – the "settling needs". It combines the dwelling, which is simple or more or less articulated, with the resources linked to it. This is what we have to investigate, in order to achieve a complete historical record.

The identification of each settling system in the examined territory is the first part of the methodology: it enables us to provide interpretation by geophysic detections and undisturbed core drill sampling. At the same time, each settling system is the pattern on which we can safely lay the information, on a larger scale, through aerial and low altitude views (images) and by using information already available. That is, a heritage of information about the surveyed area already acquired in the past. Perhaps, it has its limitations inherent in traditional archaeological research: it requires many interpolations, sometimes quite arbitrary, to get to the organic historical reconstruction, and, in any case, it offers only partial data of a context, not its full retrieval. But the set of the previously acquired data is the fundamental support for the historical interpretation of satellite images to explain the acquired information about man's presence and activity in the investigated area which is done by using precise geometric and topographic references especially for built artifacts in which case the indication of the orientation is fundamental.

Geophysic detections of the most superficial levels of the earth crust, the ones which testify man's activity are a precious and fundamental checking-tool on what we have already acquired from images, adding further depth and essential specifications. Thanks to the improvements of different methodologies, detections allow us to quantify the ground anomalies linked to anthropic events and structures. The intrinsic limitation of these geophysic detections, aimed at inquiring only the superficial levels of our planet, is that of being substantially pinpointed they can not be used for regular enquiries over the whole region. This limitation can, however, be overcome by applying the geophysic detections to the areas of anthropic interest, individualized in a territory by the images: in this way the analysis provides only small margins of error for the examined area.

Starting from this sequence of images detections, the contribution of the geophysic detections becomes fundamental. We have, then, a direct comparison between low altitude images and geophysic maps, electronically processed by the most common methodologies for archaeological research.

A further methodology for checking information on the ground is the undisturbed core drill sampling. This method is well-known within the earth sciences: it can supply an extremely precise soil check with the advantage of offering exact stratigraphic sequences, fundamental for the chronological distribution of the located settling systems.

Of course, the ideal check is still represented by excavation of the site derived by above explained research process, which gives richer results complementing those gleaned from above methods.

All this demonstrates that we cannot expect to achieve the completion of the study of the chosen territory, too

quickly. The data quantity and the different interpretation and procedures require considerable research and processing and later, more checking on the ground. Thus, the examples presented here cannot supply final answers as yet. Most of all, they are supposed to present some procedures and propose new questions.

The first area where the methodology for examining the settling systems was applied by 'Centro Ricerche Archeologiche e Scavi di Torino' is Selinunte, the most western Greek colony in Sicily. The first use of orbital images dates back to the end of the seventies, interpreted, at that time, through photographic prints and not through computer analysis. This interpretation started a process of methodological studies and inquiries into the territory that led, on one hand, to the use of a more effective methodology and, on the other hand, to a more and more refined historical interpretation of the territory. This latter took the longest and required the cooperation of many people for the study of all previously recorded data and of what could be noticed on the surface through the direct recognitions of the area. The result was the retrieval of settling events of the territory, acquired during a long chronological sequence.[1]

Another example is the one offered by a region of North Africa, notably the territory of the ancient Carthage. It is an innovative contribution to an interdisciplinary research which involves many scholars and that Centro Scavi is carrying out within the activities of the 'Institut Tuniso-Italien des Sciences et Techniques du Patrimoine[2]'. The interpretation of Spot XS images of the territory allowed us to clearly distinguish the well-known urban lay-out which received the first fundamental definition during the Augustan age. It also allowed us to notice the considerable extension, even beyond what was known up to now, of the Carthage territory *centuriatio*, usually attributed to the failed colony of the Gracchi. The observation of this division, highlighted by a series of slight and discontinuous lineations with an orientation different from that of the city, made us notice, in fact, that this organization occupies a considerable portion of the territory located west of the new neighbourhoods of Tunis, which today, on images, hide in part the continuity of the lay-out.

The Palmyra area in Syria was suggested by the Syrian Authorities as a priority one for the realization of an archaeological cartography of Syria and Jordan, entrusted to Centro Scavi by UNESCO.[3] The work, started in 1995 in cooperation with the 'Direction Générale des Antiquités et des Musées (D.G.A.M.)', was carried out, in a preliminary phase, on a 30 x 30 km area, with the town at the centre.

The oasis of Palmyra, mentioned in sources of the second millennium BC by the name of Tadmor, rose to an important centre of trade and cultural exchange between the Roman and the Parthian worlds in the first centuries AD and is one of the most studied sites of Syria. More than sixty years of archaeological researches, following the studies of the great expert of the antiquities of Palmyra H. Seyrig, brightly enlightened the history of this large caravan city and rest-place in the Syrian desert on the axis which connects Homs with Abu Kamal, half-way between Damascus and the Euphrates (FIG. 1).

Processing and interpretation of Landsat and Spot images of this region showed us, on one hand, all evidence of an interesting geomorphology, and, on the other hand, the evidence of settling systems sequences; these systems encourage us, indeed, to explore each context in order to historically interpret an area with natural springs which explain the sequence from the Tadmor to the Roman, Byzantine and Islamic Palmyra.

This is an area where archaeological identification on the ground ascertained a long series of presences that now, with orbital images and the increase of information due to multispectrality, will be better and better linked to a very interesting framework, to which the reconstruction of the caravan route (across the area within the more direct connections between Mesopotamia and Mediterranean) will provide solid evidence of a series of specific settling problems.

A complete georeference on the ground, carried out by the GPS receiver and a total station, allowed us to realise a significant direct control of the results of the images interpretation, with remarkable land controls. The reconnaissance on the ground and the collection of material from the surface will be integrated into the information

1. Palmyra. Panoramic view of the monumental area.

[1] The research about the architecture and the settling systems of Selinunte is a great task of the Centro Scavi di Torino. The team of scholars led by G. Gullini includes F. Colosi, M. C. Conti, C. Zoppi, and, for the image interpretation, P. Baggio and C. Zamboni.

[2] The team, led by G. Gullini and co-ordinated by M. Casini, is composed of C. A. Birocco, S. Bullo, A. Leone, C. Rossignoli, D. Sangiorgio, C. Schiavon and C. Zamboni.

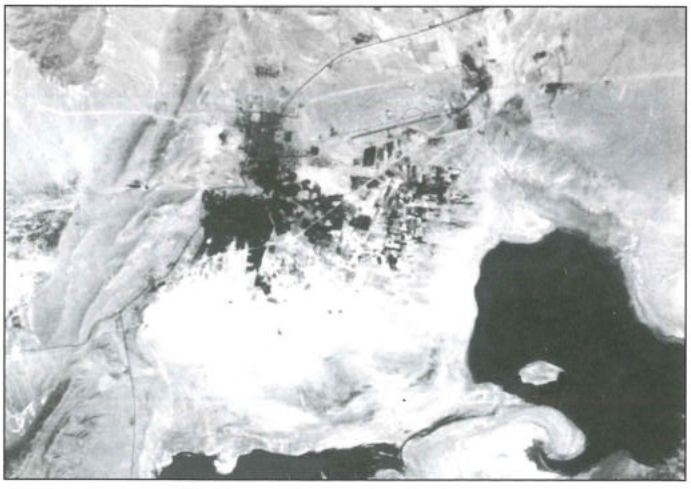
[3] The team on the field, led by G. Gullini, was composed of C. A. Birocco, P. Rossi, D. Sangiorgio and the author on the Italian side, and by N. Darrous, B. Habib, M. Rukieh, O. Sayasne, A. Sirrieh on the Syrian side.

system which is being built by data already known through archival and bibliographic documents. The interface of GIS with the georeferenced and interpreted images will enable a profounder historical reconstruction and indicate the areas to be covered by shots from low altitude. They will allow us to get detailed analytical information about the areas with more evidence and will guide eventual subsequent excavations.

A general picture of the territorial occupation in an historical age seems already well pointed out; it seems to prefer the quadrants south of Palmyra, as the ones north of Palmyra, which are hilly, give back most of all prehistoric lithic material and that often not in primary contest.

The southern sector extends around an ancient lake which at present is eutrophic (sabka) (FIG. 2); it has settlements which seem to be generally over low hills or talls emerging from the steppe. Their constant characteristic seems to be a remarkably large occupation, in the diachronic sense, often characterised by a prehistoric phase (from Middle Palaeolithic inwards) up until the Islamic period.

Some of these sites, as the mighty Umayyad fortress of al-Bakhra, situated about 18 km south of Palmyra, present building techniques and clay materials which certify also a phase dating back to the Roman period (Bounni; Al-As'ad 1989: 122). The aforementioned case concerns a walled-in citadel with a regular plan, of about 300 x 250 m, which lies over a settlement of the Roman Imperial age and reuses the remains of it (FIG. 3). The fortification, made of limestone blocks, presents two opposite entrances, the whole north-east side consisting of a doubled wall, and fourteen semicircular towers which stress the structure of the walls. Inside, it is possible to make out the remains of constructions, even if the rooms, with entrances indicated by large monolithic thresholds, are not clearly definable. Outside the fortified area, the traces of dwelling and service quarters are impressive with regard to their extension; furthermore, on the west side, there is an Islamic cemetry area, also situated on a hill. A large reservoir, fed by the natural water-table, represented one of the attractions of this inhabited area.

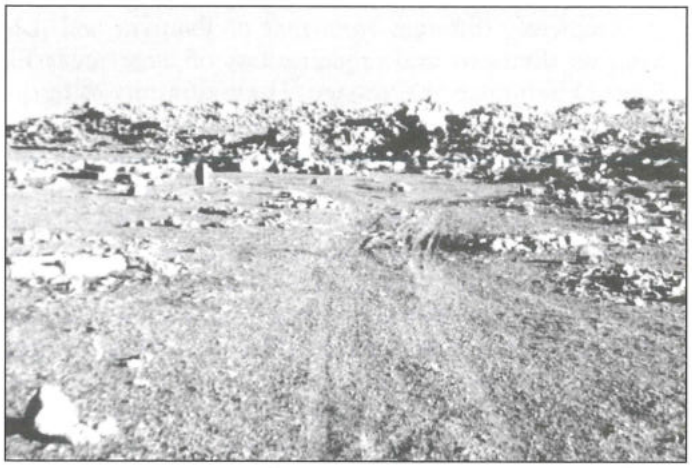


2. SPOT Pancromatic Image, 29.05.1993. Palmyra area, Syria.

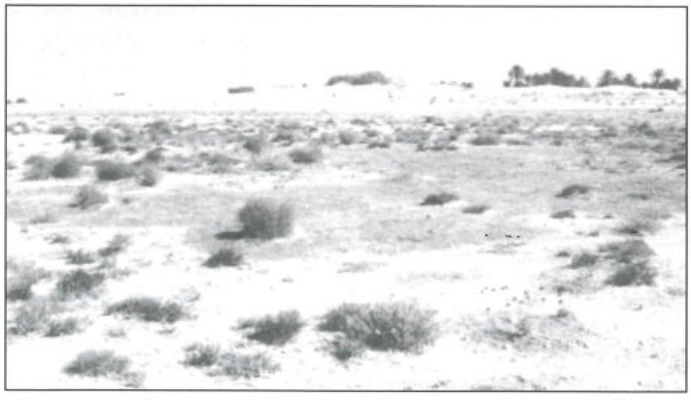
The fortified aspect and the spatial relations, which seem to connect most of these settlements, make us suppose a logic settling system planned with full knowledge of the ancient crossroads, like those towards Damascus and the Mediterranean, in the investigated south-west sector, and those towards the Euphrates, in the south-east sector.

Tall Schéjara also appears interesting: it is situated 12 km south-east of Palmyra and, at present, it is still exploited for crops, with orchards and palmgroves (FIG. 4). It does not present visible ancient structures, but it yields prehistoric lithic tools and Islamic clay materials, while, on the satellite images, the presence of four road-axes is clearly legible: they branch off as rays of a structure which encloses the perimeter of the hill (FIG. 5).

At the moment, we only provide a few explicative hints of an extremely variegated situation, in which every element can find its exact historical setting only in a more advanced phase of the research. An example can be



3. Al-Bakhra. A general view from south-east angle.



4. Tall Schéjara. A general view from south angle.

[4] The team on the fields, leaded by G. Gullini, was composed by C. A. Birocco, L. Ferraresi, M. Musso, D. Sangiorgio and the author.

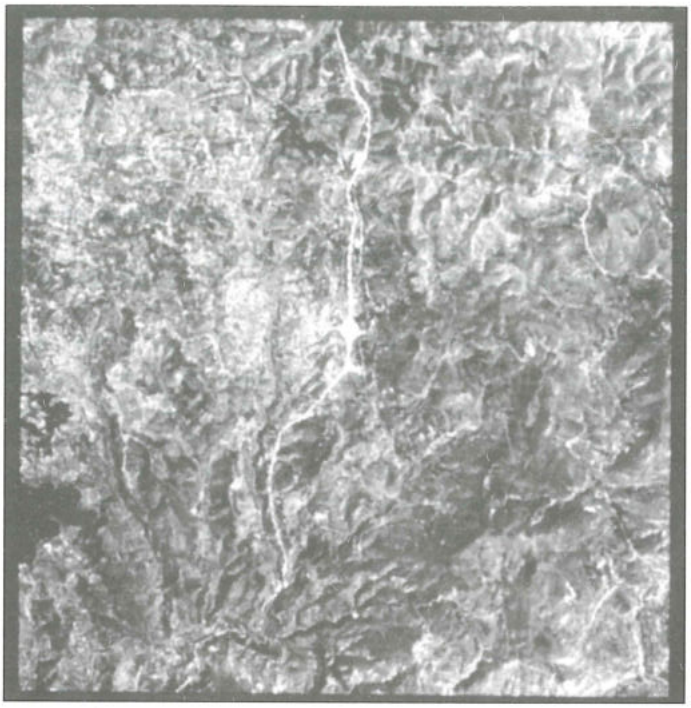
5. SPOT Pancromatic Image, 29.05.1993. Area south-east of Palmyra (Tall Schéjara).

offered by the possibility to reconstruct the whole lay-out of the *Strata Diocletiana,* suggested by the images and controlled on the ground through the more evident structures and the numerous blocks and columns, likely to be interpreted as shrines and milestones.

The Jarash territory, in Jordan, is the first site of study east of the Jordan river, chosen, here too, as priority by the Jordan Authorities.[4] In this case the natural morphology is completely different from that of Palmyra and there exist no divisions and organizations of large areas like those of Selinunte or Carthage. The conformity of territory offers easy use, thanks to the flat valleys that open out into others and are protected by hills. The presence of a territorial occupation becomes clear which we may define as "leopard patch" with several small agricultural settlements that probably survived over long periods. The first series of checking "truth-ground" and the more and more advanced details offered by integrating the interpretation of Landsat and Spot images (FIG. 6) and aerial photographs made it possible to find confirmation of all information read on the images and to reveal the extreme exposure of these 'marks' of territorial use due to the realization of new infrastructures and land reforms.

One example is the site of Khirbat Katla (FIG. 7), situated about 5 km north-east of Jarash, where we arrived through a series of patterns shown on the satellite image, corresponding on the ground to a 'natural amphitheatre' with many natural occupied caves on its edges. Still *in situ* there are structures (FIGS. 8-9) that, according to the ceramics collected in the survey, date from Late Antiquity to the Mamluk period.

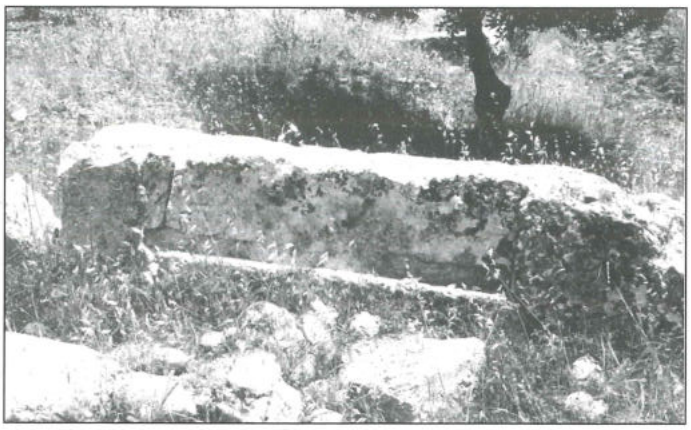
As we said, we propose questions which require a number of specific studies that have to be carried out in two directions. On one side, the exact transcription on a topographic map on a large scale of all data acquired, both through intentional recording and through the systematic organization of casual or emergency finds, as already done by JADIS. On the other side, the exact georeference and plotting of the images, in order to superimpose with absolute certainty the information of the latter with the



6. Landsat 5 TM Image, 4.04.1994. Jarash area, Jordan.

7. Khirbat Katla. A general view.

8. Khirbat Katla. A column base.



9. Khirbat Katla. Threshold block.

direct recognition and the previously acquired data.

We still need to work for a long time to complete our project; this will be possible with aerial shots at a very low altitude so as to obtain the highest resolution in the most specifically researched areas. In this way it will really be possible to record those settling systems in the various occupation periods and, as a consequence, to acquire a solid and systematic knowledge of this area of Jordan, one of the most interesting for the history of the civilization.

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