Sampling past landscapes

Methodological inquiries into the bias problems of recording archaeological surface assemblages

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CHAPTER 1

INTRODUCTION

1.1 STATUS QUAESTIONIS

For our understanding of the past, archaeological field survey is an essential fieldwork method in addition, and complement, to excavation. Compared to the latter, it allows us to gather evidence of human activity over relatively large geographical areas and can document long-term processes from prehistory up to very recent times. Field survey is a form of prospection that aims to catalogue archaeological remains in a specified research area (Attema et al. 2010: 15). After so-called antiquarian and topographic phases, most archaeological field surveys in the Mediterranean area from about 1980 onwards can be classified as systematic intensive field surveys. Such survey projects approach the landscape as presenting a continuous distribution of archaeological artifacts, i.e. the archaeological surface assemblages, also commonly labeled as the archaeological surface record. Archaeological field surveys use various techniques, depending on specific research questions, to methodically sample the surface record to allow an interpretation of past human behavior that created them (see for an overview of best practices Attema et al. 2020). In the context of this thesis, I will define intensive archaeological field survey as a method in which all archaeological material in all accessible fields in a research area are systematically sampled using a defined percentage of coverage.

An essential concept in archaeological field survey is the archaeological 'site', which conventionally refers to surface material scatters which are taken to represent locations of human occupation or use, in the form of settlement, necropoleis, sheds, field shelters, production sites, battlefields, etc. They are usually spots of higher local densities of finds, often identified in accordance with other indicators such as the presence of building materials (Fentress 2000: 48). Archaeological finds outside of these focal points or clusters have been termed 'offsite' material and may for example be interpreted as evidence of past land use (e.g. Foley 1981, Dunnell and Dancey 1983). The site concept has generated a lot of discussion among survey archaeologists, and various definitions and terms are in use, such as 'abnormal density above background' or 'places of special interest' (e.g. Gallant 1986: 408-409, Bintliff et al. 1999: 141, Bevan and Conolly 2004). It has even been suggested that the very concept of the site as a discrete sampling unit should be abandoned (Dunnell and Dancey 1983, more recently also put into practice by e.g. Pettegrew et al. 2021). However, as the archaeological site is an important unit of analysis in archaeological field survey, it is critical to properly specify what we mean with this concept. In this study, I therefore define sites as surface concentrations of artifacts that are linked to foci of human behavior related to habitation, burial practices, subsistence practices, etc., and frequently connected to buried archaeological contexts.

The end result of the majority of archaeological field surveys is a map showing distributions of finds, usually demarcating archaeological sites, which then allows for assessments of locations of past settlement systems, demographic developments, land use strategies, communication routes, etc. Many modern landscape archaeological investigations build on these datasets to be able to understand socio-economic, demographic, and political developments for specific historical periods on regional scales (Attema et al. 2020:

2). The fieldwork discipline has greatly contributed to our understanding of the diachronic development in various areas of the Mediterranean, e.g. the Southern Etruria Survey/the Tiber Valley Project (Patterson et al. 2020), the Biferno Valley Project (Barker 1995), the Metapontino Survey (Carter and Prieto 2011), the Pontine Region project (Attema 1993) and the Regional Pathways to Complexity project (Attema et al. 2010) in Italy, and the Knossos Urban Landscape Project (Whitelaw et al. 2007), the Sydney Cyprus Survey Project (Given and Knapp 2003), the Boeotia Project (Bintliff et al. 2007), the Asea Valley Survey (Forsén and Forsén 2003), the Kythera Survey (Broodbank 1998) and the Eastern Korinthia Archaeological Survey (Tartaron et al. 2006) in Greece, to name a few.

The reliability of archaeological field survey has been the subject of debate since the advent of this fieldwork technique (some key bibliography: Flannery 1976; Dunnell & Dancey 1983, Gallant 1986, Cherry et al. 1978, Bintliff 1999, Fentress 2000, Van Leusen 2002, Terrenato 2004). The main issue here is to what degree the collected samples actually result in a representative picture of the archaeological surface record, and the past human activity that led to its formation. A key concept here is indeed the act of 'sampling'; this refers to the collection of a subset of a statistical population, which itself is a group of objects or events that one wishes to gain knowledge of (Chenhall 1975: 5, Cherry et al. 1978, Drennan 2009: 80). Since it is usually unfeasible to examine a complete population, for example all archaeological artifacts present on the surface, sampling is an indispensable and often unavoidable tool for archaeologists. There are various forms of sampling in archaeology such as purposive sampling, where the sample is selected based on indications that an area, or group of objects, would provide exactly the information that one is looking for (Banning 2021: 44). However, most of the types of sampling deployed in systematic intensive field survey are at least partly based on sample theory. This means that they involve random selection at some stage, which ideally allows the resulting sample characteristics to be representative of the population characteristics (Banning 2021: 44).

In the last few decades, several debates in archaeology have provoked a critical evaluation of the validity of collected samples of archaeological distributions. For example, due to the difficult recognizability of artifacts from particular periods, traces of human activity from those periods may remain largely undetected. This notion gave rise to the issue of 'hidden landscapes' (Bintliff et al. 1999, De Neef et al. 2017), which refers to the problem that material from certain periods is present on the surface, but isn't collected or collected and not identified as such. This can effectively conceal part of the chronological range of human activity in the landscape (Caraher et al. 2006). The concept of a hidden landscape also refers to the phenomenon of past occupation phases which are buried, restructured or even destroyed by geophysical processes or anthropogenic activity (cf. Vita-Finzi 1969, Van Leusen et al. 2011, Feiken 2014). Another discourse is known as the 'missing sites' problem. This refers in general to the problem that archaeological field survey is likely to be unable to detect all archaeological sites that have ever been present as artifact remains at the surface or in the subsoil (De Neef 2016, Casarotto 2018: 30). Various survey archaeologists have recorded archaeological sites to even turn "on and off like traffic lights" (Lloyd and Barker 1981, see also García Sánchez et al. 2017). Specifically, the term has been coined for a particular problem with Roman Republican settlement history (Pelgrom 2012). According to some historians, Roman Republican farms sites are likely to have dotted the countryside of newly conquered territories in Italy (cf. Rathbone 2008). The suggested site distributions are, however, not attested by archaeological field survey, which is considered to demonstrate the shortcomings of survey and its inability to collect representative samples (Rathbone 2008). In this case, there are good reasons to believe that this conventional picture of Roman colonial landscapes is incorrect, and that the absence of sites is not a result of archaeological field survey being incapable of tracing them (Pelgrom 2012: 63-74, Casarotto et al. 2016). However, in general, these discussions have raised a lot of important questions about the reliability of archaeological field survey results.

It can therefore be argued that archaeological field survey would benefit from a better understanding of the quality of the collected samples. One of the important methodological discussions concerning the reliability of archaeological field survey revolves around a range of bias problems in the formation of the datasets (cf. Given 2004, Leusen 2002: 4.1-4.20). A bias can be defined as a nonrandom difference between the value of a sample parameter and the value of that same parameter in the population (Banning 2021: 44), for example site density. At the time of sampling, the archaeological surface record can be regarded as a distorted representation of the material correlates of human behavior in the past (Terrenato 2004:

46). These distortions, i.e. biases, are part of formation processes. These processes refer to both the formation of the archaeological surface record, as well as the formation of the archaeological datasets. For an archaeological context, including the archaeological surface record, a range of pre-, peri- and postdepositional processes will affect its composition. These refer to processes such as selective discarding of waste, the means of its deposition or distribution (e.g. ceramic objects as part of manure) as well as subsequent attrition of deposits by agricultural activity, for example ploughing. All such processes can potentially introduce systematic and nonsystematic biases.

For example, whether traces of human activity are observable in the archaeological surface record is dependent on the degree to which archaeological materials actually reach that surface, and are preserved. This is affected for example by the natural dynamics of preservation, erosion and sedimentation, or anthropomorphic factors such as land use or looting (cf. Ammerman 1985, Barton et al. 1991, Taylor 2000). In fact, not all human activity in the past may result in substantial material traces, such as the exploitation of beehives, kilns or animal stalls (De Haas 2012: 56-60). Archaeological datasets, i.e. data that is constructed through fieldwork and becomes part of the information records that we actually study, are affected by what we can call a set of 'research biases' (Van Leusen 2002: 4-1). These refer to, for example, the issue that retrieval rates may be affected by variable accessibility and visibility. Areas with e.g. heavy vegetation may be either excluded from surveys or may produce limited numbers of archaeological finds due to obfuscation by foliage (Terrenato 2000). Research design itself can also inhibit biases, such as the effects of purposive sampling techniques and the intensity of collection (Orton 2000). Other conscious choices affecting eventual databases are for example selective collection of material that is considered of high diagnostic value (Attema et al. 2010: 20). A more systematic categorization of (research) biases will be presented in the next paragraph. However, the main point here is that it may well be asked if, and to what degree, a better understanding and assessment of such biases may contribute to capturing samples of a higher quality. For this thesis, I will limit myself to dealing with these research biases.

In this respect, material which is collected through archaeological field survey and regarded as offsite data is very interesting. There is usually a common continuous scatter of archaeological finds identified during field survey that cannot directly be related to discrete 'sites', however defined. An important methodological development in this regard has been the rise of what is known as 'intensive offsite survey' (Thomas 1975, Foley 1981, Dunnell and Dancey 1983). This is a survey approach where all accessible fields are sampled by usually a registration of finds, often a full collection, in individual field walker tracts. Simultaneously, a range of variables concerning visibility circumstances, geomorphology, etc. are recorded in detail. This method allows for a detailed scrutiny of site and offsite samples and may as such contribute to the understanding of the formation of the archaeological surface record. Whereas offsite data spatially represents a huge part of the archaeological information, it is sometimes marginalized as 'background' materials or noise (cf. Gallant 1986; Mattingly 2000: 11) and often explained through general models. This is understandable, as the commonly very sparse scatters are very difficult to analyze – there is often little material in collections on individual fields, or even in total samples, to work with. Explanations for offsite data based on intensive offsite sampling approaches often involve notions of site haloes, taskscapes and manuring. Whereas these may be very valuable, at the same time they may defer attention from other potential specific local origins of the material (cf. Bintliff and Snodgrass 1988, Wilkinson 1989, Alcock et al. 1994, Bintliff et al. 2007, De Haas 2012). For example, such material can of course be the result of eroded sites, i.e. 'vestigial' sites (Bintliff 1999, De Neef et al. 2017).

Given differences in research design and research questions, the degree and intensity to which offsite data is therefore systematically collected varies, which in its turn can produce research biases. The issue of collection intensity is specifically important here, and some have critically evaluated the intensive offsite survey method itself. Objections to this approach concentrate on the one hand on its cost; the time-intensiveness of the method reduces the total geographical area that can be covered, which in turn limits the degree to which the results can contribute to answering the larger historical questions (Fentress 2000, Blanton 2001). On the other hand, doubt is cast on the degree to which the detailed data can indeed effectively reduce bias (Terrenato 2004). Another issue with the intensive survey method is that full collection of very dense material carpets, for example in case of large rural sites or the urban offsite distributions of Classical Boeotia. In such cases, full collection in individual tracts is exceptionally impractical (Attema et al. 2020: 23). Evidently, these are valid methodological considerations in the framework of sampling approaches, that must be taken into account when thinking about intensity and biases. What can be concluded is that there is a need to understand what degree of intensity and collection methods of intensive offsite survey are effective under varying circumstances, in relation to specific research aims. In addition, it is important to explore how the retrieved datasets can be analyzed on biases that may shed light on the larger questions of reliability of the method.

With this thesis, some of the major, and interrelated, research biases in the formation of datasets in archaeological field survey are assessed. The focus of this research has been on a rigorous and detailed empirical approach to the whole body of archaeological field survey data and its analysis. There is specific attention to the main methodological themes: analysis of offsite data, visibility issues, intensity of sampling techniques and the development of quantitative approaches to do this. All empirical case studies that make up this thesis are derived from a single geographical research area of Molise, Italy. However, the presented analyses are methodological inquiries with outcomes that have more general validity on the level of technical and quantitative research design. At the same time, it is recognized that the outcomes are partly dependent on the archaeology and landscape in Molise. As such, this work seeks to provide methodological perspectives for dealing with biases in archaeological field survey, that can be tailored to fit specific landscapes. To allow a more detailed assessment on the potential relevance of the outcomes for other regions, as well as further refine the methods and analyses, this study hopefully inspires replication studies of the experiments.

In addition, this research hopes to contribute to the study of legacy datasets, which are crucial to study long-term trends, such as demographic developments. Study of legacy data is becoming ever more prominent in landscape archaeological approaches, especially under the current threat of intensification of agriculture. The need for meta studies that aim to integrate, and cross-compare legacy datasets brings to attention the inherent problem of their variable origin and character (e.g. Alcock & Cherry 2004, Casarotto 2018). Different research designs, sampling methods and selection and publication strategies make legacy datasets difficult to compare. A better understanding of the consequences of different techniques and methodological choices may help in understanding what kinds of biases particular legacy datasets may suffer from. Potentially, targeted, small-scale resurveys of legacy data project areas can help calibrating them to render different datasets more comparable. The outcomes of this study may help to finetune the levels of intensity of such a targeted resurvey. A better understanding of biases and their effects is also relevant for cultural resource management. As has been noted, it is difficult to deal with the preservation and conservation of known or expected archaeological heritage that we cannot exactly locate (Leusen et al. 2007). Finally, it is expected that the outcomes of this thesis will help in fine-tuning new archaeological field survey research designs, especially concerning the strategies and types of sampling.

In the remainder of this chapter, I will first describe in more detail the process of archaeological field survey, as well as the research biases that are relevant to the various stages of that process. I will then elucidate my view on approaches to and dealing with biases, which leads to defining the research questions for this thesis. I will then expand on what I think is essential in this methodological study into biases, namely the application of statistics and the way in which they are employed as an analytical tool. Finally, I will describe the case study area that forms the context for the methodological inquiries in this thesis, and explain the structure of this thesis.

1.2 ARCHAEOLOGICAL FIELD SURVEY, RESEARCH BIAS AND THE NECESSITY FOR CRITICAL METHODOLOGICAL RESEARCH

Here, I will provide a clear context for the potential research biases by describing archaeological field survey in more methodological detail. The most common approach to systematic intensive offsite survey is the tracing of finds by line walking sample units, and counting or picking up material visible on the surface. Such units are either defined by modern day field boundaries or by some predefined spatial unit. In the lab, collected finds (if any) are counted, their material and functional category and chronology, and in case of potsherds their fabric and (part of-) vessel types, determined in as far as that is possible. This information is entered in a database along with contextual information on location, find conditions, etc. (cf. Attema et al. 2020: 46-49). Sites are recorded in the field as spatial units and often also as special collections using more targeted collection methods (cf. Attema et al. 2020: 15). Eventually, the database records are connected to the digitized sample units to create GIS maps that show the spatial spread of archaeological material. Data is projected by categorizations on the basis of variables that affect the analysis of the material distributions; relative densities of artifacts classified by type, function or chronology, as well as assemblage composition and variability on different scales. Such distribution maps are then used as a heuristic tool for understanding the archaeological material evidence, as part of a larger integrated interpretative framework together with other archaeological, ancient topographical and historical sources (Alcock et al. 1994; Barker 1995; Banning 2002; Bintliff et al. 1999; Fentress 2000, Witcher 2006). Clearly, the central role of such maps in regional explanatory models is fundamental. It is often the single archaeological source that can spatially tie all other evidence together, and ideally provides a quite complete view on the extent of archaeological remains on the surface in a specific region. These maps can provide a framework for the evaluation of hypotheses concerning human behavior in the past. For most of the mapped archaeology, the prerequisite is that the sample used for the data projection is indeed representative of the archaeological surface record, which is why the study of biases in archaeological field survey is such an important issue.

1.2.1 BIASES

The study of research biases in archaeological field survey has a long history, and a considerable range of biases affecting the formation of archaeological field survey datasets has been identified. Here, I will follow the research bias classification of Van Leusen (2002: 4-5) as that provides a clear framework for understanding their variety. Research biases can be categorized into I) conceptual biases, II) visibility biases and III) observer biases.

Conceptual biases occur as a result of a-priori data categorizations. These may lead researchers to select for example specific topographical elements for survey, document only specific site types, or limit data collection to certain ware classes or highly diagnostic artifacts. Also, the current archaeological knowledge may inform a geographical bounding box for defining a research area. For example, the choice to sample the "spatial context of Samnite/Hellenistic sanctuaries in the Tappino area" is perfectly valid for a specific research question (Sacred Landscapes Project, Stek and Pelgrom 2005). However, it is insufficient for understanding settlement patterns in the larger region, as these may be very different elsewhere. Other survey parameters that may vary as a result of this are for example the size of sample units, the spacing between the line walkers, and the basis on which fields are included or excluded from the sample. Such choices are very often an explicit result of designing an archaeological field survey strategy to answer specific historical questions. Therefore, such biases will generally not be misleading. However, they do affect the results of the survey, and the fact that they are deliberate does not necessarily preclude unintentional misuse (cf. Banning 2021: 54). Also, categorizations themselves may differ between researchers and/or may be based on unclear criteria and vague definitions. For example, how is the diagnostic value of an artifact established, or what is considered terrain with impeded ground visibility such that collection is foregone? Finally, applying such a-priori established categories to limit data collection will make regional inventories harder to compare due to very specific documentation and collection strategies.

Visibility biases are defined by Van Leusen as biases that affect the possibility that material present on the surface will actually be recorded (2002: 4-6). This definition leads to overlap with the observer biases described below, which are considered as a separate set of issues. The difference here is that visibility biases refer to physical properties of the terrain and especially the vegetation that affect detectability of artifacts, where observer biases refer to the probability that a detectable artifact is actually noticed by a field walker. Visibility biases in archaeological theory can also refer to specific depositional and postdepositional processes, but these are not implied here. Land use is an important factor, especially in the Mediterranean area (Van Leusen 2002: 4-10), and is likely to affect both accessibility as well as ground visibility. The latter refers to characteristics of soil and vegetation that determine the, often temporal, suitability of the terrain for artifact detection. For example, has the soil been ploughed, to what degree is it covered with vegetation, what are the humidity conditions, etc. (Ammerman 1985; Verhoeven 1991; Ammerman and Terrenato 1996; Terrenato 2000). The effect here is that some kinds of artifacts that are generally easier to distinguish due to their physical appearance are more probable to be detected than more obscure ones, although this is dependent on observer biases as well of course. Accessibility refers to whether an area is passable for pedestrian survey, and whether the vegetation allows surface inspection at all. For example woodland with thick bushes between the trees is usually regarded as unsuitable for archaeological field survey, because the possibility of retrieving any present material is extremely low. This means that often non-arable areas are left out of a survey, whereas a case can be made that this may cause a systematic bias as sites may purposively have been built next to farmland, not on it (e.g. Pelgrom 2012: 78).

Finally, there is a set of observer biases that apply to both temporal atmospheric conditions affecting sight, as well as the personal capabilities of the line walkers to actually observe artifacts on the ground. The former will be predominantly affected by light conditions, for example the zenith and azimuth angles of the sun with respect to the field walkers, that has been demonstrated to have a statistically significant effect on retrieval rates (Horn-Lopez 2008). Personal capabilities of field walkers refer to aspects such as expertise and interest, which may be material and/or period-specific, but also by more physical factors like length, weariness and acuity (Van Leusen 2002: 4-7).

1.2.2 CRITICAL METHODOLOGICAL RESEARCH

Some of the research biases listed above may be, at least partly, mitigated through careful consideration in research and sampling design. Imbalance in landscape types could be avoided by a well-designed stratified sampling approach making sure that all such landscape types are included (Orton 2000, Drennan 2009). Others are more complicated. For example, highly vegetated areas may be examined using alternative collection methods (e.g. Van de Velde 2001), or more invasive techniques such as shovel-testing or test-pitting (e.g. Krakker et al. 1983). More intensive collection may also counter ground visibility and/or observer biases. But how do the outcomes compare to the other field survey methods, as differences in intensity introduces again new biases? Common assessment of biases often results in hypothesizing scenarios, i.e. probability modeling, to correct for them. However, here one should be extremely careful. A common approach is to consecutively identify biases, record them in as far as possible, model them and evaluate their impact, and finally correct for them (Van Leusen 2002: 4-8–4-10). Such an approach leans on the notion that a large part of the processes resulting in biases is correctable, e.g. by applying a formula predicting artifact densities through applying data extrapolation (e.g. Martens et al. 2012: 86, cf. Attema et al. 2020: 49). A problem here is that methods used for the measurement of bias effects are often simplifications, and corrections based on them may lead to false reconstructions of 'true' material densities and spatial configurations (Caraher et al 2014: 53). Furthermore, there is hardly an independent control possible, which means that the outcomes of such an exercise cannot be validated.

As an approach to dealing with biases, I seek to apply an introspective approach; I try to identify biases, inspect them by empirical quantitative/statistical research, upon which I assess their potential impact on a case study basis, and then estimate possible consequences for the projection of our data on maps and in graphs, and their interpretations. This can be regarded as an exploration of possibilities – what scenarios are possible based on our evaluation of the data? This is a subtle shift from bias correction leading to a probabilistic data projection, i.e. visualizing a single probable outcome, towards hypothetical data projections, i.e. treating a data projection as one of several possible scenarios. What if bias A had this estimated effect, what would that imply for the larger integrated interpretation?

The central theme in this thesis then is the understanding of the mechanics of these biases, a careful design of research and sampling strategies, and wherever applied a scenario approach to data projection. I have employed such approaches in the context of finding answers to the following research questions:

I. Can we develop a more advanced analytical technique for finding traces of ephemeral sites in what is usually regarded as offsite data?
II. What is the potential for mitigating visibility and observer biases with a more intensive sampling method to identify and map archaeology, onsite and offsite, and what is the effect of quantification biases when counting or weighing batches of archaeological finds?
III. How can we apply a proportionate stratified sampling scheme in order to deal with visibility issues and research area selection biases, as well as establish an adequate sample size?

1.3 THE IMPORTANCE OF STATISTICS

As explained, analyzing and interpreting archaeological field survey data is in many ways an exercise in scenario modeling based on field samples. Many aspects of such scenario description are concepts such as relative or absolute density, sample evenness, i.e. similarity of relative proportions in samples, and richness, i.e. variability in samples, and spatial patterning such as regularity and clustering. Therefore, the data analysis of archaeological field survey is fundamentally one of quantification, sampling theory and (spatial) statistical modeling (cf. Banning 2020: 41-42). Although statistics are often hesitantly used, if at all, they actually play a fundamental role, and therefore are always implicitly there in areas of archaeological field survey research design and analysis. First, statistics are important for understanding the usefulness of our samples; are they large enough and well spread enough to allow for the hypothesis testing that we want to do? This is the field of sample theory which takes places before actual data collection as part of the research design (Banning 2020: 41-42). Fundamentally important for example is sample size, which determines the levels of confidence with which we can infer characteristics of populations from samples. Whereas its importance is recognized, it is seldom statistically tackled (cf. Attema et al. 2020: 13). Second, statistics are important in the actual analysis of the collected data. This is relevant for both the inspection of the data, as well as for the process of inference that is likely to follow. They allow specification of quantitative observation, and thereby pave the way for comparison of research outcomes (e.g. Drennan 2009).

Eventually, we need to be able to address whether the samples are adequate for the conclusions that we draw. For example, do they have sufficient statistical strength, or how significant is a difference that is perceived in e.g. the spatial spread of material concentrations between various areas? Considering the aim of understanding the mechanics of biases, such statistical specification is elementary, and an explicit assessment of the statistical properties of the research design and consequent conclusions of vital importance.

1.3.1 TRANSPARENT STATISTICS

Not only is there a need for specification of the data and its quantitative properties, but there is also, and possibly even more, a need for transparency concerning the statistical methodology itself. Statistics in archaeological academia are perceived by more than a few, sometimes anxiously, as 'black box' processes. They are perceived to be useful but impossible to understand at the level of their actual mechanics. There have been more diverging attitudes to (sampling) statistics identified by Orton (2000: 4-5), usually with the effect of not dealing explicitly with them. In the extreme case, statistics have even been explicitly rejected (Banning 2021: 48). There are many reasons for this (cf. Banning 2021: 48-52), some also very understandable, if only due to various articles disapprovingly emphasizing a series of doubtful applications (cf. Thomas 1978, Thomas 1980, Hole 1980). It is my contention that part of the problem may be due to the presentation of statistical research in archaeological literature. Whereas basic statistical principles are often not that difficult to understand, publications often stick to formal use of statistical jargon and mathematical formulae, with adverse effects on the less initiated reader. I would argue that a more transparent approach to the use of statistics, of which the approach of Drennan (2009) is an example, can provide the reader with a better sense of its mechanical principles, its role in the analysis and therefore its purpose. As such, it should allow for a more critical assessment, discussion, practice and eventually thereby bolster the scientific value of analytical outcomes. Therefore, the choice for, and mechanics of, applied statistical descriptions and inferences have been as much as possible described throughout this thesis.

1.3.2 REFLECTIVE STATISTICS

In addition to being transparent, I also believe that the application of statistics should be robust and reflective. I would describe a reflective approach as having a very critical stance towards the application of statistics, as well as always assess the interaction between data and statistical method in high detail. A good understanding of samples of data can be reached by a thorough examination of their descriptive statistics. Descriptive statistics are defined as metrics that represent a summary of any given dataset. These can be used to establish values of central tendency (i.e. averages or the most common value), variability (variation around the mean) and extreme values. This is fundamental as part of an exercise of the 'exploratory data analysis' approach developed by Tukey (1977). This method in general focuses on basic assessment of datasets with attention for simplicity, precision and accuracy, and depth of analysis. This should lead to a better understanding of samples and their characteristics as well as improved robustness of analysis and the exploration of data to suggest new hypotheses (Church 1978: 433-439). I have kept those principles in mind in order to understand to what degree samples show interesting patterns and to what degree they may be suitable for more advanced statistical procedures, i.e. formal hypothesis testing. Hypothesis testing is a form of inferential statistics where samples are assessed on estimations about sample and statistical population parameters. Where inferential statistics are applied for such testing in the presented case studies, I try to do this in a cautious way. This means that I scrutinize e.g. deviations from the trend and their explanation, effects of sample size and applicability of the tools in general. After all, archaeological research only rarely retrieves patterning that can be assessed as a clear-cut hypothesis which can be decided on using strict rules.

A key concept in hypothesis testing is statistical significance, which is a metric that denotes the probability that an observed pattern is a result of random effects, i.e. natural fluctuations of drawing a sample, also known as the vagaries of sampling (Drennan 2009: 151). This important concept is in many academic fields attributed the power to distinguish between a true and a false hypothesis (McShane et al. 2019). However, such a binary approach is too simple a representation of a very useful statistic, which has a much more subtle meaning. To be specific, significance is defined in levels ranging from 1-0, which may also be expressed in percentages. A significance level of .05 (5%) means that when the outcome of our significance test is smaller than .05, the relation is true, or that the relation is not true and our sample represents a type of event whose probability is less than 5%, i.e. 1 out of 20 (Cowgill, 1977: 360-362). Therefore, significance should not be treated as a rigid boundary separating a useful result from a useless result at all (cf. Drennan 2009: 157-160, Cowgill 1977, for a very critical view see also McShane et al. 2019). The significance metric provides us, based on mathematical approaches to probability, with a means to separate between phenomena that are likely variations that have nothing to do with the variables under scrutiny, and phenomena that seem to be affected by them and call for closer inspection. In this study, I take statistical significance into account, but always as one of the indicative values in the larger interpretative framework, and to increase understanding for what seems to be the most robust characterization of the data.

1.3.3 Statistical-empirical research

The quantitative and statistical approaches in this work are aimed on an explicit hypothetical-deductive approach, i.e. working from analytical starting points and testing their validity, using empirical-statistical analysis of datasets. When it comes to research bias identification and assessment, a plethora of approaches can be found in the archaeological field survey literature. Although there are good examples of empirical-statistical approaches (e.g. Shennan 1985, Verhoeven 1991, Van Leusen 2002), they are relatively rare. In many cases biases are treated on the basis of intuitive estimation (Van Leusen 2002: 4-15). Also more experimental methods are used, for example a lot of information regarding the effects of ploughing on displacement of surface artifacts is based on either seeding experiments and/or computer models (Odell and Cowan 1987, Yorston 1990, Boismier 1997). In order to increase the robustness of the methodological analysis of the surface record formation processes we must preferably use data that is as close as possible to the archaeological reality. We should formulate explicit methodological and archaeological hypotheses and test them as much as possible against a large dataset of actual collected field materials.

1.4 Case study and structure of the research

1.4.1 Case study

The case study providing the context for the methodological inquiries in this thesis is a series of interconnected archaeological field survey projects in the so-called Tappino Area, an area directly east of Campobasso, capital of the region of Molise, southern-central Italy. Its main research subject are the so-called Samnites, referring to the local Italic people, which played an important role in various epochs of Roman

Republican history. We only have a literary record from the Roman side, and moreover, these records date to a much later time, when Rome had long become the undisputed imperial power in the Mediterranean and beyond. From the Samnites' notable resistance to Roman expansion in the 4^{th} to 1^{st} centuries BC it can be inferred that they were able to raise a substantial military force (Livy, History of Rome: 4.8–10). At the same time, archaeologically the Samnites have proved to be quite elusive, apart from large but ill-dated hillforts and sacred places that usually take monumental form only in the late Republican period. As a result, the organizational principles of Samnite society are still to be understood, and it is clear that new archaeological research is the only way forward (Stek 2018; cf. Dench 1995; Morgan 2003). Gaining a better understanding of Samnite society, also in the context of its gradual incorporation by Rome, has been the principal motivation for a thorough examination of settlement organization, helping to establish the role of regional (hillfort) centres and sacred places in the region too.

The series of field work projects started with investigations in 2004-2006 into the so-called sacred landscape of two local sanctuaries situated on hills or hill-plateaus; that of S. Giovanni in Galdo, località Colle Rimontato, and that of Gildone, località Cupa (Stek and Pelgrom 2005; Stek 2009: 79-104; Pelgrom and Stek 2010). By means of a targeted small-scale intensive archaeological field survey project their immediate surroundings have been investigated to attest contextual settlement patterns (Pelgrom and Stek 2010). The outcomes of the Sacred Landscape Project (SLP) showed that these sanctuaries were very likely focal points in local settlement systems and suggested a rather dense pattern of variable types of Samnite domestic habitation. The apparent clustering of Samnite settlement on higher parts of the undulating landscape of the region appears also in other mapping projects (Barker 1995). This led to the hypothesis that there may be a clear pattern in settlement location preference, i.e. concentrated in elevated parts of the area. The findings could at least in part explain a conceptual bias in the traditional view of Samnite society as dispersed farmers, because the more complex clusters of settlement had not been found. This has been the starting point of a more focused research into Samnite history. Since the SLP potentially carried a research bias itself, being entirely focused on the sanctuaries, the Tappino Area Archaeological Project (TAAP) was developed to investigate with various methods the area in between the two sanctuaries (Stek 2018). The transect, which is a rectangle of 200 km^2, features a great variety of different geomorphological elements. It encompasses the Tappino riverbeds and plains, undulating hills and plateaus in various configurations, up to a small mountain, the Montagna di Gildone. It also presents a variety of land use, such as forests, horticulture, agriculture, pasture as well as fallow fields. It incorporates known archaeology such as the hillfort on Montagna di Gildone, the sanctuaries as well as the already identified Samnite farms, a Republican villa and larger rural sites. The research in the context of the TAAP has thus been focused at getting a better view of Samnite settlement patterns in a representative slice through the landscape, specifically addressing potential research biases. This refers to the aforementioned possible selection bias around the sanctuaries and/or on elevated geomorphological units in the area, but also on potential biases such as archaeological visibility. Since archaeological field survey is best suited to agricultural fields, which are likely to have been suitable for crops in the past as well, it may be that the Samnite farm as the most important site type is induced by a visibility bias. Gaining a better understanding of the diachronic developments of Samnite settlement organization in the Tappino area will also contribute to understanding the effects of the Roman incorporation and subsequent social and political events.

1.4.2 Structure of the research

In the context of the case study, the various chapters of this manuscript can now be explicitly connected to the earlier formulated research questions.

Research question I is the main theme in chapter 2, Evaluating Background Noise: assessing offsite data from field surveys around the Italic sanctuary of S. Giovanni in Galdo, località Colle Rimontato, Molise, Italy. In this chapter, a case study using the SLP dataset scrutinizes the parameters for site identification, which are usually (relative) densities, as well as general interpretative models for what remains after site-identification, i.e. offsite materials. The chapter aims to contribute by developing a new spatial quantitative approach to deal with low densities using a more focused and local analysis of offsite materials with the aim of identifying sporadic evidence of human behavior in the past.

Research question II is the main theme in chapter 3, Breakage, Bias and the Archaeological Surface Record: assessing the quantification problem in archaeological field survey, and chapter 4, Scratching the Surface: integrating low-visibility zones and large rural sites in landscape archaeology using point sampling.

In chapter 3, the most basic quantitative tool of archaeological field survey is addressed, which is that of measuring the abundance of ceramic artifacts collected during archaeological field survey. This is an elementary heuristic that archaeologists employ to compare find densities and assemblage compositions as part of the analysis of the patterning in the archaeological surface record. Based on an extensive point sampling dataset of a large rural site as documented in the TAAP, Colle San Martino, it deals with the degree to which the analysis of field survey data samples may be biased by the problem of variable breakage – potsherds break into smaller pieces due to various pre-, peri- and postdepositional processes. How do we count, and thus what do we compare, are questions that need answers to be able to make precise statements about archaeological field survey datasets. The chapter aims to provide a full synthesis of the quantification issues, presents a statistical methodological approach to assess breakage, and identifies future directions for best practice.

This investigation then serves as a basis for chapter 4, in which point sampling, an innovative hyper intensive collection method, is applied and tested. The technique is implemented to both mitigate the problem of variable visibility in the landscape, and sample areas completely unsuitable to regular field survey, which both lead to visibility biases. Furthermore, it is designed to result in samples that seek to avoid methodological problems caused by variable collection intensity, observer differences as well as problems of spatial precision. An example of the latter is that due to the spatial coarseness of the intensive offsite sample unit, finds that potentially have a different archaeological origin may be lumped together, affecting their interpretation. The chapter aims to elucidate to what degree the technique offers reliable estimations of surface assemblage composition, how it complements sample collections of regular field survey, and what are best practices for its implementation, based on extensive statistical analysis.

Research question III is then addressed in chapter 5, Sampling Samnites. A statistical approach for testing a Hellenistic/Samnite settlement pattern hypothesis in the Tappino Area, Molise, Italy. This study aligns directly with one of the main aims of the TAAP – is there a bias due to differential visibility and/or research design decisions that skew the field survey data? By a finely designed stratified statistical sampling approach, the TAAP transect is examined by placing and examining carefully selected samples areas. The chapter not only aims to answer one of the main TAAP research questions, and assess potential visibility biases based on site- and offsite data, it also aims to shed light on an essential problem in archaeological field survey; how do we determine a sufficient sample size to be able to establish the actual statistical strength of our analytical conclusions?

Finally, in chapter 6 I will conclude with a discussion on the various case studies, formulate an answer to the main research questions and reflect on the implications for future research.

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