Scientific realism and antirealism in geography

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Abstract: The relationship between (philosophical) scientific (anti)realism and geography is still largely in need of being explored. On one side, the debate on scientific (anti)realism in philosophy of science has led to discussions in and on many scientific disciplines, the list of which rarely includes geographical sciences. On the other side, the geographical debate has outlined its own version of scientific (anti)realism, paying little attention to the literature in philosophy of science. This paper focuses on the geographical literature, with the aim of: 1) showing whether and how the geographical debate is committed to one of the main topics of philosophical scientific (anti)realism, that is: the existence of unobservable theoretical entities; 2) examining the reason(s) why philosophical scientific (anti)realism has been theoretically neglected by geographers. Sect. 2 provides the philosophical framework of our investigation, a framework that, in Sects. 3-6, is used to examine prominent examples from the geographical debate that are explicitly related to ontological analysis. Sect. 7 shows four different reasons why philosophical scientific (anti)realism remains little discussed in geography. Sect. 8, finally, provides some guidelines to enhance communication between geography and philosophy of science on the topic of scientific (anti)realism.

Keywords: philosophy of geography, philosophy of science, scientific antirealism, scientific realism, unobservable entities.

1. *Introduction*

The relationship between (philosophical) scientific (anti)realism and geography is still largely in need of being explored. On one side, the debate on scientific (anti)realism in philosophy of science has led to discussions in and on many scientific disciplines, the list of which rarely includes geographical sciences (see Okasha 2002; Agazzi 2017; Chakravartty 2017; Beebe *et al.* 2020). On the other side, the geographical debate has outlined its own version of scientific (anti)realism, paying little attention to the literature in philosophy of science (Mäki *et al.* 2004). This paper focuses on the geographical literature, with the aim of:

A1. showing whether and how the geographical debate is committed to one of the main topics of philosophical scientific (anti)realism, that is:

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the existence of unobservable theoretical entities (Sects. 3-6);

A2. examining the reason(s) why philosophical scientific (anti)realism has been theoretically neglected by geographers (Sects. 7-8).

Concerning A1, Sect. 2 provides the philosophical framework of our investigation. The framework follows the thesis of Corti (2020), holding that the dichotomy between scientific realism [SR] and antirealism [SaR] is independent from the one between metaphysical realism [MR] and antirealism [MaR]. The choice of focusing on Corti's thesis is not random:

1. firstly, it helps to clarify some of the main (philosophical) assumptions behind the dichotomies (see in particular [3] and [4] in Sect. 2), which sometimes are used interchangeably by geographers;
2. secondly, it builds the distinction between SR and SaR on the existence of (un)observable theoretical entities – an existence that this paper aims to discuss within the geographical literature.[1]

In Sects. 3-6, the framework is used to examine prominent examples from the geographical debate that are explicitly related to ontological analysis. More precisely, Sects. 3-4 consider how the nature of geographical entities and the ontological joints of geographical investigation have been discussed. Sect. 5 concerns geographical theories, within which the locution "scientific realism" is mainly associated to Roy Bhaskar's tri-partition of the ontological domains stratifying the world. Sect. 6 discusses the possibility of different SRs and SaRs that are functional to accommodate the peculiarity of the various geographical sub-branches. All those debates are presented by means of numbered lists aimed to reconstruct and isolate the main positions, assumptions, and disciplinary contexts, and to clarify the commitments of geography to (philosophical) SR and SaR. As regards A2, Sect. 7 shows four different reasons why SR and SaR remain little discussed in geography. Sect. 8, finally, provides some guidelines to enhance communication between geography and philosophy of science on SR and SaR. The purpose is thus twofold: reconstructive and speculative. As for reconstruction, this paper offers the first introduction and systematization of philosophical SR and SaR in geography. As for speculation, we think that discussing whether the geographical debate is committed to the existence of unobservable theoretical entities might help geographers to specify the kind(s) of entities they focus on and to clarify some of the theoretical assumptions of geography as a discipline. More generally, the idea is that, since geographers conduct geographical investigations under the guidance of

[1] This does not mean that T2 represents the only way to distinguish SR from SaR. Alai 2017, 2020, for example, claims that the current debate in philosophy of science on SR and SaR is much more focused on the notions of knowledge and justification than on the question of existence of (un) observable theoretical entities.

some theoretical assumptions, for the sake of methodological accuracy, such assumptions should be subject to critical analysis rather than remaining implicit and unexamined.

2. *Between scientific (anti)realism and metaphysical (anti)realism*

In philosophy of science, the question of the existence of unobservable theoretical entities – that is, entities posited by our best scientific theories *and* that human beings cannot observe directly[2] – splits the debate into two main, heterogeneous positions, which do not exclude the chance of views at the boundary between and/or external to them (see Chakravartty 2017; Corti 2020).

[1] SR, in general, claims that (at least some) unobservable entities exist in the same sense in which observable entities such as table, chairs, and so forth do.

[2] SaR, which traditionally includes some forms of empiricism and instrumentalism, does not make any commitment to the existence of unobservable entities.

This means: for sciences that, like paleontology, deal exclusively with observable entities, there is no disagreement between SR and SaR; for sciences that, such as physics or chemistry, make claims about unobservable entities, SR and SaR disagree on the existence of such entities. The disagreement also extends to the general aim of science. While SR argues that science aims to truly describe the world, SaR maintains that providing a true description applies only to the observable part of the world[3] (Okasha 2002).

Now, according to Corti (2020), the dichotomy between SR and SaR should not be, but sometimes is, confused with the one between metaphysical realism [MR] and antirealism [MaR].[4]

[3] MR, in general, claims that:

- [3.1] (a) there exists a mind-independent world, (b) a word that ultimately contains different (kinds of) entities (see Khlentzos 2021);
- [3.2] such a world has a mind-independent structure;
- [3.3] we can know/have access, at least partially, to [3.1(a)], or [3.2], or both.

[4] MaR usually endorses the negation of:

[2] On the distinction between observable and unobservable entities, see Muller 2005; Dicken and Lipton 2006; Turner 2007.

[3] Alternatively, by following van Fraassen 1980, SaR can be taken to hold that science ought to give empirically adequate (in opposition as true, or approximately true) descriptions of the world.

[4] The distinction between MR and MaR does not exclude the chance of positions that consider such a debate as meaningless, unsubstantial and/or unsettled; see for example McDowell 1994; Rosen 1994; Khlentzos 2021.

[4.1] [3.1(a)] and/or [3.2], by considering the world (as well as the entities it contains) as mind-dependent, or dependent on natural languages, human beings' epistemic status, and so forth;

[4.2] (at least) one epistemic claim of [3.3].[5]

In commenting such a metaphysical distinction, Corti (2020: 2) remarks that:

[5] as MR and MaR are umbrella terms covering a wide range of views, they can be divided into different sorts depending on which claims, among [3.1(a)], [3.2], and [3.3] are accepted or rejected. Meaning, each metaphysical (anti) realist should also specify which claims are part of their thesis. Moreover, we cannot fail to emphasize that, because these views may regard different kinds of entities (see [3.1(b)]), it should not be surprising to find out that (anti)realist positions might be independent of each other;

[6] (the independence shown by [5] does not entail that different) (anti)realisms *can(not)* share some connections with other forms of (anti)realism. And this is the case of MR and MaR and of SR and SaR. In other words, it is possible, though not necessary, to hold any combination of scientific and metaphysical realism and antirealism, as Fig. 1 displays.

	MR	**MaR**
SR	[1] + [3]	[2] + [3]
SaR	[2] + [3]	[2] + [4]

Fig. 1. Connections among scientific and metaphysical realism and antirealism.

However, further clarifications are needed to address the question of SR and SaR in the geographical debate, a question that constitutes the main topic of this paper.

First, following Okasha (2002*:* 58-59) and Corti (2020: 3-6), we maintain that the dichotomies between SR and SaR and between MR and MaR should be conceived as logically independent. Claiming the opposite would mean, for example, to exclude the possibility of being scientific realist about unobservable entities without any commitment to a mind-independent external world: a possibility which seems difficult to reject.[6]

Second, following Corti (2020), assuming SR and SaR come in many versions,

[5] For a deeper investigation on the varieties of MR and MaR, see Corti 2020. For an alternative way to present such a dichotomy, see Chalmers 2009; Khlentzos 2021.

[6] For rebuttals to this logical independence, see Psillos 2005; Chakravartty 2017; Massimi 2018; Ladyman 2019, who generally consider SR committed to MR.

[1] and [2] intend to represent only SR's and SaR's minimal assumptions on the existence of observable/unobservable entities.[7] Extending SR and SaR to other assumptions coming from both philosophical and geographical debates might still be possible, although the task is beyond the scope of this paper.

Third, on the basis of [5] and [6], it is not excluded that SR and SaR can have connections with (anti)realist positions other than MR and MaR – and *vice versa*. Fig. 1 should be thus interpreted as insuring their differences as well as their ways of interacting.

3. *Scientific (anti)realism and the philosophical debate on geographical entities*

Before analyzing how (philosophical) SR and MaR have been conceived by geographers, let us spend a few words on the philosophical debate on geographical entities (see Montuschi 2003; Smith 2019; Tambassi 2021), a debate that aims to clarify the nature of entities geographers deal with, and that has so far shown no explicit references to SR and SaR.

In such a debate, the taxonomy of Casati, Smith and Varzi (1998*:* 78-79) represents the only attempt to systematize the different positions at stake. According to the taxonomy, geographical entities are divided into two different sorts, corresponding to the (traditional) dichotomy between physical and human geography. On one side, there are entities such as mountains, rivers, and deserts, whereas, on the other side, there are socio-economic units like nations, cities, and real-estate subdivisions. Starting from this dichotomy, the authors identify three main positions on the existence of geographical entities.

[7] Strong methodological individualism holds that there are no units on the geographic scale, but only people and the tables and chairs they interact with on the mesoscopic level.

[8] Weak methodological individualism claims that, if geographic units exist, they depend or are supervenient upon individuals.

[9] Geographic realism maintains that socio-economic units and other geographic entities have the same ontological standing as the individuals that they appear to be related to.

Establishing whether the distinction among [7-9] has specifically to do with SR or SaR is not that simple. Indeed, from a metaphysical perspective, we can easily argue that conceiving socio-economic units as existing over and above the individuals means that geographical realism assumes MR claiming, in this context, the mind-independence of the geographical reality. Conversely, weak

[7] For an alternative way to present the dichotomy, see Alai 2017, 2020; Massimi 2018.

methodological individualism could represent a position within MaR: in fact, weak methodological individualism does not exclude that (at least part of) geographic reality can be (mind-)dependent upon individuals. (Thomasson 2019: 173), however, would disagree with that: if it is true that MR claims that there are some existing entities which are mind-independent (see [3.1(b)]), there is no reason to think that MR cannot accept that, in addition to those entities, there are also mind-dependent entities in the social world studied, for example, by human geography. Accordingly, weak methodological individualism could be a sort of MR too.) But the distinction among [7-9] makes no explicit reference to unobservable entities. The only thing that we might infer from [7-9] is that, if according to [7] there are only people and the tables and chairs they interact with on the mesoscopic level, then strong methodological individualism does not seem to make any claim about unobservable entities. Thus, strong methodological individualism is not committed to SR. Anything else, from the inclusion of strong methodological individualism within SaR to the inclusion of both geographical realism and weak methodological individualism among SR or SaR, would be, on the basis of [7-9], indeterminate.

4. *Scientific (anti)realism in the geographical debate on ontology*

Sect. 3 has shown that the lack of explicit references to "scientific (anti) realism" in the philosophical debate on geographical entities makes it hard to establish whether the various positions at stake are committed to SR and SaR. The same can be said for the geographical debate on ontology (see Vallega (1995); Berque (2000); Raffestin (2012); Boria (2013)), within which the taxonomy of Tanca (2018) helps to clarify the different views. Such views are categorized according to the "joints that characterize the geographical investigation", namely *things*, *representations*, and *practices*. Those joints, Tanca holds, are independent of each other and correspond to three different lists of ontological claims. The set of all claims in each list outlines one of the different and mutually exclusive ways through which geographers investigate, approach, and interpret the geographical reality.

The ontological claims of the first joint, *things*, are reconstructed as follows.

[10] Geographical reality (and its structure) is mind-independent.

[11] Our knowledge of the geographic reality corresponds to the reality itself.

[12] Sight is the primary and, according to some authors, the *only* means of access to the geographical reality.

[13] Whenever sight alone is not enough, maps and other visual geographical tools can help us in knowing new entities on/of the geographical reality.

As regards the second joint, *representations*, Tanca seems to presume the

following claims.

[14] Geographical reality (and its structure) is mind-dependent, i.e., dependent on our cognitive schemas (that can differ from one another).

[15] Our knowledge of the geographical reality is mediated by language and representation, which, in turn, reflect the social and cultural context within which they are used and have been created.

[16] Languages and representations do not represent mimetically the geographical reality; they shape and create references within and for such a reality.

Finally, the third joint, *practices*, makes the following claims.

[17] Subjects and (geographical) reality affect each other and are (contextually) inseparable.

[18] The geographical reality has a dynamic and processual character that can be explained only be means of the integration of *things*, *representations*, and practices – conceived (the latter) as performances, thought-in-action, and action-in-context. (Practices do not produce entities but constitute subjects' sense of the real).

[19] Subject's knowledge of geographical reality is not exhausted by means of sight, language, and representation, but can be enriched by non-cognitive, expressive, and emotional components of subjects' experience.

Now, if metaphysically speaking, *things* assume MR (see [10] and [11]), *representations* accept MaR (see [14] and [15]), and *practices* seem to deny neither MR nor MaR (see [17]), as regards the dichotomy between SR and SaR, [12] and [13] make the location of the joint *things* difficult. Indeed, on one side, [12] would allow

[20] the inclusion of *things* among SaR because, if sight is the *only* means of access to the geographical reality, then there are no geographical entities that sight cannot see, and therefore *things* do not assume the existence of unobservable entities;

[21] to consider *things* as not committed to SR and SaR: maintaining sight as the only means of access to the geographical reality excludes, in principle, the existence of unobservable entities, and therefore the dichotomy between SR and SaR is not applicable to *things*.

On the other side, [13] seems to enrich the geographical reality with entities that are on maps but cannot be seen with our eyes. Consequently, *things* might be regarded

[22] as a sort of SR, to the extent that [13] does not exclude, at least in principle, unobservable entities: being (observable) on a map, for example, does not mean being observable *per se* (see, for instance, Sandy Island);

[23] as not committed to SR and SaR, insofar as [13] does not specify whether unobservable entities exist in the same sense in which observable entities do.

But the same argument can also be extended to *representations* and *practices*, by replacing, in [22] and [23], [13] respectively with [16] and [19].

5. *"Scientific (anti)realism" in the geographical debate*

The lack of references to the locution "scientific (anti)realism" in the debates of Sects. 3-4 does not imply, however, that the locution has never been mentioned in the whole geographical investigation. However, as Mäki and Oinas (2004) remark, such a locution appears rarely in geography, and when it does, little attention is given to the literature on SR and SaR in philosophy of science. Moreover, unlike the philosophical debate, within which the dichotomy between SR and SaR questions the existence of unobservable entities (see Sect. 2), the geographical investigation often connects "scientific (anti) realism" to:

[24] the notion of observation, without references to the debate on unobservable entities (Yeung 1997; Brown 2004);

[25] the question of causality *and* the notion of observation (Lawson and Staeheli 1990);

[26] the existence of mind-independent and/or mind-dependent reality in physical and human geography, both from a metaphysical and epistemological perspective (see [3] and [4]) (Harrison and Livingstone 1979; Mäki and Oinas 2004).

Few exceptions occur which generally refer to the question of unobservable entities within Bhaskar's scientific realism (1975a, 1975b, 1979, 2009),[8] with emphasis on social research (Sarre 1987), international relations theory (Wendt 1987), different kinds of realism in geography (Rose 1990), social construction of the notion of nature (Proctor 1998), physical geography (Tucker 2009), and middle power scholarships (Jeong 2019). About how the question of unobservable entities fits into Bhaskar's scientific realism, Jeong (2019: 248-249) makes the point clear, maintaining that, for Bhaskar's scientific realism, the world is stratified in three different ontological domains:

[27] the real, which includes the things that exist, and their structure and power, known as mechanisms;

[28] the actual that comprehends observable or unobservable events generated by those mechanisms when activated;

[8] Bhaskar's scientific realism has been proposed in two different versions: transcendental realism for natural sciences and critical realism for social sciences (Yeung 1997). Other authors of references for scientific (anti)realism in geography are Keat and Urry 1975 and Sayer 1982a, 1984, 1985a, 1985b, 1992, 2000, who, just as Bhaskar, are rarely mentioned in the debate on SR and SaR in philosophy of science.

[29] the empirical, that is, events we experience/observe directly or indirectly.

On this basis, Jeong (2019) further specifies that:

the fundamental assumption [of this kind of scientific realism] *is that there is a world independent of human thought*, and to understand such a world requires two different dimensions of science: the "transitive" and "intransitive". The intransitive dimension holds the relatively unchanging things of the world, "the object of science [...] in the sense of the things we study – physical processes or social phenomena". The transitive dimension is formed through theories and methods concerning the objects of study in the intransitive dimension. So, while different theories and methods seek to explain the objects in the intransitive dimension, those very objects of study remain the same. Theories and methods may change or be replaced over time, but that does not necessarily mean the objects also change. [...] *The investigation of that intransitive social world can reveal* [...] *features unobservable in the domain of the empirical*» (Jeong 2019: 249, emphasis added).

This means, according to [28] and to the quotation, Bhaskar's scientific realism assumes [1] (but also [3]), to the extent that unobservable events and features are explicitly not rejected.[9] About the assumptions, Montuschi adds more details:

according to [Bhaskar's] model, *scientific objects are* ontologically "intransitive" (existing independently of our knowledge/methods of inquiry) and *unobservable* (*conceived in terms of generative mechanisms or structures, of which empirical, observable phenomena are only a manifestation*). The difference between natural and social objects [...] consists of the type of independence they have from knowledge/inquiry: it is total independence, in the case of the former; partial, in the case of the latter. [...] *Social objects, unlike natural ones, do not exist independently of the activities they govern (and also they cannot be identified independently of them empirically).* [...] Social objects – unlike natural ones – do not exist independently of the agents' conceptions of what they are doing in their activities. [...] This also means that social objects are 'conceptualized in the experience of the agents concerned' and since people's conceptualizations have a history, these objects are not immutable (marriage, like any other institution, can change over time). Finally, and more generally, it has to be acknowledged that the social sciences, unlike the natural sciences, are part of their own field of inquiry, in the sense that they are 'internal' with respect to their subject matter. This makes social scientific categorizations self-referential, and the referents of social scientific inquiry

[9] See Sarre 1987; Rose 1990. Moreover, according to Bhaskar 1975a, [29] should be considered as committed to unobservable entities. In Bhaskar 1979, it is also pointed out that science seeks causal laws to explain observed events, and that these causal laws deal with tendencies in objects, some of which may be unobservable.

themselves dependent on the processes which produce the knowledge of those very referents. Nonetheless, *partial independence is only taken to demonstrate that the objects of social science are of a specific nature* (i.e. social nature), *not that they do not constitute a category of scientific objects – and even less, that they cannot be treated scientifically* (Montuschi 2003: 14-15, emphasis added).

In a nutshell, both natural and social entities, which Montuschi links to physical and human geography respectively, are unobservable. And if it is true that social entities depend on and cannot be *empirically* identified independently to the activities they govern, it should also be emphasized that the "empirical" in question refers to [29], that is, one of the three ontological domains stratifying the world. According to Rose (1990: 166, 169), such domains exhibit, for Bhaskar's scientific realism, the following relationship, [27] > [28] > [29],[10] and altogether postulate the existence of entities that are unobservable in character.

While, in the geographical debate, the importance of Bhaskar's scientific realism has been highlighted by authors such as Gregory (1978, 1982), Sayer (1982b, 1987) and Cooke (1987), there has been also criticism, especially as regards the postulation of unobservable entities. Sack (1982), for example, asks whether those entities really exist or are product of our own theorizing. Allen (1987), instead, affirms that unobservable entities are just conjectured and if they existed, they would have accounted for certain types of events. But since there is no guarantee that such entities do exist, Bhaskar's scientific realism remains wholly hypothetical and dependent on the a priori transcendental argument (Rose 1990: 169).

6. *Scientific (anti)realisms and geographical sub-branches*

Sala (2009) splits the whole geographical domain in three different areas of research, namely: human, physical, and technical geography. Going back in time, Pattinson (1963) distinguishes four historical traditions within the geographical investigation: spatial, area studies, man-land, and earth science. More recently, Agnew and Livingston (2011) and Johnston and Sidaway (2016) map the disciplinary space of geography as a set of movements, flows, and channels, by identifying over a dozen geographical schools. None of these classifications excludes the possibility of including, among its ramifications, the multiplicity of sub-branches characterizing the geographical investigation – i.e., economic, social, tourism, coastal, bio-, hydro, transportation geography, and so forth.

[10] Where [27] is meant to include [28] that, in turn, includes [29].

The heterogeneity of the geographical investigation, including the fact that geographical sub-branches have particular lists of entities (see Sect. 3 and Tambassi 2021) and that (anti)realist positions may be independent of each other (see [5]), pushes Mäki and Oinas (2004: 1772) towards a general skepticism about a global (anti)realism capable of accommodating all geographical sub-branches in a suitable and profitable way (see also Mäki 1996). Instead, they propose a series of local (anti)realisms, each tailored to grasp the view of a certain discipline (such as realism about geography, realism about biochemistry, realism about archaeology, and so forth) or even smaller units such as specific research fields and theories, like cultural geographies, coastal geography, and so on. As for SR and SaR, Mäki and Oinas maintain that any local (scientific anti)realisms should meet two main constraints:

[30] the specific contents of any (anti)realism, that is, for SR and SaR, the question of the existence of unobservable theoretical entities (see [1] and [2]);

[31] the peculiar features of the local discipline.

It is on the basis of such constraints that Rhoads and Thorn (1994) have focused on the *potential* contribution of (philosophical) SR and SaR, as they are conceived in Sect. 2, to geomorphology (but also to others sub-fields of the physical geography). On one side, they argue that the challenge is to show how many theoretical constructs embodied in geomorphology, including references to unobservables, have been preserved in contemporary geomorphic theories (see [30]). On the other side, by following [31], they contend that

> there is no reason to presuppose that a philosophical framework for geomorphology will be merely a restatement of the philosophy of another discipline. Because geomorphology is concerned with distinctive types of natural systems that include synergistic physical and biological elements and employs characteristic investigative methods, it cannot be reduced to the underpinning disciplines (Rhoads and Thorn 1994: 98).

7. *Four reasons for a theoretical marginality*

The theses presented so far are isolated cases in the geographical debate, within which the question of the existence of unobservable theoretical entities generally remains marginal. The reasons for this, geographers suggest, are essentially four: the first two, [R1] and [R2], concern the reception of philosophical scientific (anti)realism(s) in geography, the last two, [R3] and [R4], explicitly question the issue of unobservable entities.

R1 can be tracked in the words of the majority of geographers above and refers to the relationship between geography and philosophical scientific (anti)

realism. While Brown (2004: 369) affirms that SR (and SaR) should not be confused with any particular philosophy, Yeung (1997: 51) emphasizes that SR (and SaR) is a philosophy intrinsically, and Sack (1982: 504) adds that geography should not make its questions (and methods) adhere to philosophy, but rather use philosophy to help focus on geographical questions. Accordingly, the question of the existence of unobservable theoretical entities rarely appears in the geographical debate because it is just a philosophical question and not a geographical one.

R2 specifically refers to the thesis of Yeung (1997), according to which the marginality of such a question stems from the multiplicity of realisms populating the geographical investigation – a multiplicity that has confined the question of unobservable entities into the background, lost among the various questions emerging from different realisms (in geography).

> [T]he crux of most recent debates in [...] geography rests upon a misreading of different moments of [scientific] realism. There seems a lack of proper understanding of [scientific] realism in its own terms. Critics of realism and realist research in human geography rely largely upon cursory readings of different versions of 'realism' presented in the geographic literature. It is not surprising that many of them are confused between treating [scientific] realism as a philosophy, an epistemology, a method, a dogma or just another '-ism' (Yeung 1997: 54).

R3, instead, connects the topic of unobservable entities to the level of granularity geographers refer to. Sect. 2 has emphasized that some sciences make claims about unobservable entities, whereas other sciences do not. According to Smith and Klagges (2009), such claims may depend on the levels of granularity of different scientific investigations. Since, by following Egenhofer and Mark (1995), the level of granularity of geography coincides with the mesoscopic stratum[11] of spatial reality and includes entities such as «Vienna, with its streets, buildings, parks, and people», «Europe with mountains, lakes and rivers, transportation systems, political subdivisions, cultural variations, and so on», there is no room for unobservable entities in the geographical investigation. In other words, the question of the existence unobservable theoretical entities remains marginal because, from a geographical point of view, SR and SaR cannot disagree on their existence.

R4, in contrast to R3, does not deny the chance of references to unobservable entities within the geographical domain. Sect. 2 has highlighted that un-

[11] Geographically speaking, Egenhofer and Mark maintain that the mesoscopic stratum represents the space where we move. Such a space is distinct from the small-scale space, populated by objects and events smaller than those that can easily be seen by the naked eye.

observable theoretical entities are entities that human beings cannot observe directly. In this regard, Tucker (2009) spots that those entities may refer to a wide variety of phenomena, which include objects unobservable for their size (atoms), or that are somehow hidden (the core of planet earth), or too distant from us (black holes). But Tucker further suggests that "unobservable entities" in geography may also refer to events of the past, which are unobservable because they are distant in time. And this (last) perspective seems to be adopted by Inkpen and Wilson (2013) to describe physical geography and earth sciences (also) in terms of historical disciplines that make hypotheses about unobservable (past) events, and by Tanca (2018) for (further) distinguishing the joint *things* from the joint *representation* (see Sect. 4): the former conceives geographical entities in terms of current existence, whereas the latter does not disregard their past. But the list of unobservable theoretical entities in geography is also enriched by Lawson and Staeheli (1990: 13), who include "the unseen social structures", which influence, and are influenced by, the actions of individuals. On this basis, the question of the unobservable entities would be thus marginal in geography because the references for those entities are fuzzy and may vary from context to context.

8. *Final remarks*

According to Corti (2020: 3), one of the main issues of SR and SaR is that both are umbrella terms: such an issue is so widespread that introducing oneself as a scientific (anti)realist is too vague, if the (kind of) (anti)realism at stake is no further specified. In Sect. 2, this vagueness has been reduced by means of the identification, in [1] and [2], of the minimal claims from which all the variants of SR and SaR start building their views (Corti 2020: 6), without denying that such variants can be enhanced by other claims. On the basis of such claims, this paper has analyzed the reception of (philosophical) SR and SaR within the geographical investigation. Sects. 3-4 have shown that, although SR and SaR are not explicitly mentioned, the different positions on the existence of geographical entities and on the joints characterizing the geo-ontological investigation might be somehow committed to [1] and [2]. Sect. 5 has underlined that, when the locution "scientific (anti)realism" appears in geography, it is mainly associated to Bhaskar's scientific realism, which absorbs the question of unobservable entities posited by [1] and [2] within the three different ontological domains (see [27-29]) stratifying the world. Sect. 6, in contrast, has placed [1] and [2] at the center of the geographical debate, and has suggested that SR and SaR may vary depending on the geographical sub-branches they refer to. Sect. 7 has, finally, emphasized four different reasons why the question

of unobservable entities remains marginal in the geographical debate, namely: the difficult relationship between geography and realism (R1), the multiple and overlapping (anti)realisms populating the geographical investigation (R2), the level of granularity geographers refer to (R3), and the ambiguous references for unobservable entities in geography (R4).

All those considerations could still provide some guidelines to enhance communication between geography and philosophy of science about the question of unobservable entities. The distinction between [1] and [2], for example, would allow us to meet the concern raised in R2: clarifying the claims of SR and SaR may, in fact, reduce the lack of proper understanding of (philosophical) scientific (anti)realism in geography, in its own terms. But the same distinction could also shed light to R1, by considering SR (and SaR) as exclusively philosophical and not geographical. Geography would not, however, be excluded from the debate of unobservable entities: by reconsidering [30] and [31], we could maintain that, while the question of [30] is philosophical, the domain which [30] refers to – that is, [31] – is geographical and should meet the peculiar features of the different geographical investigations. And such features cannot but consider, according to Rhoads and Thorn (1994) and to R4, that the references for unobservable entities in geography may vary depending on the geographical sub-branch (or the theory) we analyze. This means, different geographical sub-branches can refer to different kinds of unobservable entities, not excluding that some of those sub-branches might also leave no room for unobservable entities (see R3). Our proposal is thus close to the thesis of Mäki and Oinas (2004), who suggest a multiplicity of local SRs and SaRs accommodating the needs of different disciplines or even of their sub-branches and particular theories. To [30] and [31], which already apply Mäki's and Oinas' proposal to the specificity of SR and SaR, we could add a further constraint aimed at explicitly remarking that:

[32] references for unobservable entities can vary depending on the geographical sub-branch or theory we deal with, by exhibiting specific peculiarity.

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