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Article

What Does It Take to Establish that a World Is Uninhabited Prior to Exploitation? A Question of Ethics as well as Science

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Abstract: If we find life on another world, it will be an extremely important discovery and we will have to take great care not to do anything that might endanger that life. If the life we find is sentient we will have moral obligations to that life. Whether it is sentient or not, we have a duty to ourselves to preserve it as a study object, and also because it would be commonly seen as valuable in its own right. In addition to this we would also have a duty to our fellow humans and other earthly life forms not to expose them to danger by advertently or inadvertently exposing them to potentially harmful space organisms. When space exploration turns into exploitation it will therefore be important to be able to show that a world that is up for exploitation is uninhabited before the exploitation starts. Showing that a world is uninhabited is, however, a different kind of task than showing that it is inhabited. The latter task can be accomplished through one positive finding but it is not clear how to go about the former task. In this paper I suggest that it is a gradual process asymptotically approaching certainty rather than a discovery in the traditional sense of the word. It has to be handled in two steps. The first is to connect degree of certainty with research setup. The second is to decide how certain we need to be. The first step is about the number, diversity and quality of observations. The second step is a decision we have to make based on the purpose of the investigation. The purpose and therefore the degree of certainty needed to establish that a world is uninhabited will be different for a world that is up for exploitation than for a world that is not. In the latter case it is only a matter of epistemic values. In the former case also ethical values have to be considered.

Keywords: astrobiology; epistemic values; non-epistemic values; space commercialization; space ethics; geoethics; space exploitation

1. Introduction

When looking for life on other worlds we are obviously most preoccupied with thinking about how to establish the positive results we hope for. The many faulty claims that have been made about extraterrestrial life through history, and even in very recent times, show us that the question of what it takes to establish that there is or have been life on another world is very important but also very difficult. The opposite question, that is, what it takes to show that there is no life on another world, does not seem as fun or constructive and has consequently received less attention. It is also as we shall see even more difficult than the positive question. Even so, it is nonetheless important, and it might even be more urgent than the positive question.

The negative question is important for both principal and practical reasons. In principle, it is important for our ability to be able to say at some point that a world is uninhabited and thus add new knowledge to the corpus of scientific knowledge, instead of just postponing the judgment indefinitely. Being able to establish that a world is uninhabited is also becoming increasingly important for practical reasons as space exploration is expected to turn more into space exploitation.

We can predict that commercial exploitation of a world that is already inhabited will both affect and be affected by the indigenous life. This will in turn severely complicate the project and it might even put an end to the exploitation plans. It will therefore be very important to be able to establish that a world is uninhabited before the exploitation commences.

I will argue that the answer to what it takes to establish that a world is uninhabited needs to be different depending on whether the world in question is up for exploitation or not. I will also argue that because of the strong ethical implications of exploiting an inhabited world, the criteria for establishing that a world that is singled out for exploitation is uninhabited must be informed by ethics as well as by science.

When the time comes, there will no doubt be very different opinions of how certain we need to be. A constructive and well-informed discussion about what it takes to establish that a world is uninhabited therefore needs to be initiated as soon as possible. The main purpose of this paper is to do just that.

The exact policy implication and practical measures needed if one *fails* to establish that a world is uninhabited prior to exploitation is beyond the scope of this paper. It is my hope, however that the discussion initiated in this paper will lead to further discussions also regarding these questions.

2. Commercial Exploitation of Other Worlds

Commercial use of space is not a futuristic fantasy. It happens as we speak. Commercial companies have been part of space exploration as contractors already from the start of the space era [1]. This kind of private involvement is increasing as several new private companies are involved in building everything from parts of instruments to whole satellites [2].

Private companies have also for a long time operated their own telecommunication satellites for commercial use. The first of these commercial satellites, Early Bird, was launched already in 1965 [3].

The new stage in the commercialization of space, that we are now experiencing, takes the form of private space ports and companies with their own launching capabilities. This step is strongly

encouraged by the U.S. government [4]. The U.S. Department of Commerce has opened an office of space commercialization [5,6] and the U.S. Federal Aviation Administration has opened an office for commercial space transportation [7].

Stimulating business opportunities connected with space is also an important part of the rational for the International Space Station (ISS) [8], and commercial contractors are already sending payloads to the station [9,10].

Giacalone describes the present stage of space related business as "space-related but earth-based" [4], meaning that the production takes place on the earth using earth resources. In the future this will probably change. There will be companies using resources extracted in space for production that takes place in space. We will probably also see private companies running their own space operations with a purely commercial agenda.

Space tourism is a good example of this kind of operations that is expected to set off in a not too distant future. The U.S. has recently decided to legalize space travel by private companies [1]. Several companies plan to send tourists to space in the very near future and many new spaceports are opened or are on their way [1], (see [11,12] for examples). The most immediate plans are about low orbit trips and will therefore not have any implications for possible life forms on other worlds, but the most adventurous prospective travellers and visionary investors hope that eventually landings and even hotels on for instance Mars and our moon will be parts of the concept.

Mining is the other big hype in space commercialization at the moment. A consortium has recently been formed with the purpose of taking on a mining project on an asteroid [13,14]. Mining is probably also the form of commercial space exploration that will create most conflicts with indigenous life.

These are just some examples of how space is becoming an arena for commercial activities, and the number of commercial space projects is rapidly increasing (see [1,3–5,9,10,14–21] for more examples).

3. The Importance of Establishing whether a World is Inhabited before Exploitation

The question of what it takes to establish that a world is uninhabited has so far not achieved much attention. I have gone through all volumes of the journals "Astrobiology", "Extreme Life, Biospeology & Astrobiology", "International Journal of Astrobiology" and "New Space" to date (May 2014), and not found any attempt to specify the criteria for deciding that a world is uninhabited. This is understandable both because the task of establishing that a world is uninhabited is much more difficult and because it is simply much less exciting compared to establishing that it is inhabited. In a situation where a world is about to be exploited, however, showing that it is uninhabited suddenly becomes a very important challenge with high values at stake.

If there is already life on a world set out to be exploited, it will have far reaching consequences for the exploitation plans due to the strong ethical implications of exploiting an inhabited world [22–31]. What kind of moral obligations life on another world gives rise to, depends on what kind of life we are talking about. The most important divide is between sentient and non-sentient life. Sentient life forms can experience what happens to them, which means that they have their own perspective from which what we do to them matters to them. They are in other words moral objects in their own right [29,32–38]. As long as we talk about exploitation of our own solar system, the most probable life forms to encounter will be non-sentient microbial life, however. Some claim that also microbial life can have moral

status [24–26,39,40]. In that case our obligations will be more comprehensive. This is a controversial statement though and it is difficult to maintain that what we do to a non-sentient organism can matter to that organism (see [29] for an overview and discussion of some theories regarding the moral status of different types of extraterrestrial life). Even if we do not agree that non-sentient life forms have moral status interactions with non-sentient life will still not be ethically unproblematic, however. They will still have value for members of our species. Extraterrestrial life forms might be valued by many humans as ends in themselves [29]. They will probably also be considered very valuable as objects for scientific studies [29]. They might even be valuable as resources [25–27,29,41]. The value of even very primitive life to researchers and space authorities on the earth can be demonstrated by the fact that spacecrafts going to Mars are sterilized [42]. We are, in other words, eradicating earth microbes in order to protect Mars microbes. This shows that even if the life we find is too primitive to have their own moral status, they will surely be valuable to us, which means that even though the exploiters do not have any moral responsibilities to the microbes as such, they will have moral responsibilities to humans who value these microbes. These moral responsibilities will in turn lead to moral restrictions to what can be done on the world in question, which means it will be very important for prospective exploiters to show that a world that they intend to exploit is uninhabited.

It can also be that the life forms on the world we are about to exploit pose some kind of danger to the human miners, builders and tourists, and also to the rest of us if extraterrestrial life is (advertently or inadvertently) brought back to the earth. Either of these scenarios might entail restrictions on what we can do on the world in question, or even lead to a total ban on human activities on this world.

Some of these concerns are to some extent codified in the outer space treaty from 1967. Article IX in the treaty reads:

"States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose" [43].

There is one more aspect we have to consider and that is the values that stand to be gained by the exploitation. In addition to the monetary return to the investors, there might also be significant values to the rest of humanity in the form of jobs, access to resources and other opportunities. It might also be argued that we as a species have an inherent urge to push both our own limits and the geographical borders of our species. Satisfying this urge can then have value as an end in itself. All of this means that we might have a duty to facilitate the realization of these values, or at least not to obstruct them unnecessarily.

Exactly how the moral and legal obligations will be implemented in a case where an inhabited world is about to be exploited is so far very uncertain and has for obvious reasons never been tested. It seems clear, however, that establishing that a world is uninhabited will be very important before any kind of human activities can take place on that world. It also seems clear that on the one hand, the values that can be obtained from exploitation provide us with a duty not to postpone our judgment on whether the world in question is uninhabited for too long. On the other hand, it seems equally clear that the positive values that can be gained by the exploitation cannot outweigh our duties to protect sentient or non-sentient life on another world or on our own world.

Taken together, this means that when searching for life on a world that is about to be exploited, the situation differs in two ways from searching for life on a world that is not about to be exploited:

(1) When trying to establish that a world that is up for exploitation is uninhabited, there is a time constraint. When we ask the same question about a world that is not up for exploitation we do not need an answer at any particular point in time.
(2) When dealing with a world that is up for exploitation, our conclusion has ethical consequences in addition to the scientific consequences it would have if we manage to establish that there is no life on another world whether it is picked out for exploitation or not.

These two differences mean that we need to approach our question differently depending on whether the world we are talking about is up for exploitation or not. In a situation where the developers wait eagerly to start mining or building, we must draw the line somewhere and decide that we are certain enough. On the world where this is not the case, we can always postpone our judgment while planning for new missions. On the other hand, if the world is up for exploitation, we also need to be very certain that there is no life before we start. If we make a false conclusion that the world is uninhabited it might cause serious problems both for the domestic life forms and for us. This means that when deciding whether a world that is up for exploitation is uninhabited, we need to be fast but also accurate.

4. The Asymmetry between Proving an Instance and Proving a Universal

Establishing that there is life on a planet, moon or other celestial body, and establishing that there is not, are in spite of being opposite sides of the same coin, two very different types of tasks. The former task can be achieved through one discovery, but how many "non-discoveries" does it take to achieve the latter? Strictly speaking, no number of failures to find life on a particular world, or in the universe outside our own planet in general can prove that it does not exist in the same sense that one positive discovery can prove that it exists. This does not mean that trying to establish that a world is lifeless is a meaningless task, however. Even though it cannot be proved in the same strict sense as the existence of life, it still makes good sense to claim that the higher the number of failed attempts, and the better the attempts, the more justified we are to claim that the world is lifeless. Establishing the non-existence of life is thus more of a gradual process asymptotically approaching certainty than a discovery in the traditional sense of the word.

The asymmetry between proving a universal statement and proving an instance is not unique for questions regarding extraterrestrial life. This is a well known problem in the theory of science [44–47]. (The asymmetry is due to the (in that world) universal nature of the statement we want to prove, not to its negative nature. A positive statement saying that every time a stone is dropped it will fall to the ground can be refuted by a single instance of the stone not falling to the ground but how many instances of the stone falling to the ground does it take to convince us that it is true). It is also a problem that has important practical implications on our own planet. It means for instance that there is an asymmetry between showing that a process or a substance is dangerous and showing that it is safe, thus complicating the efforts to protect the environment and human health from dangerous substances and practices by reversing the burden of proof [48–58].

One way of describing the asymmetry is by saying that our conviction that a world is uninhabited can be stated along a scale from *zero* to *one*. On this scale, *zero* is practically achievable (finding life and can therefore prove that the world is not uninhabited), while *one* (finding conclusive proof that it is uninhabited) is not. What we have to do to answer our main question about what it takes to establish that a world is uninhabited is:

(1) To find a way of connecting the scale of certainty with the research so we can determine where on the scale we are, based on our results—and so we can decide what research missions that need to be done to end up at a particular spot on the scale.
(2) To decide where on the scale we need to be in order to be certain enough for our purpose, which is either (a) to add new knowledge to the scientific corpus; or (b) to give green light for exploitation.

5. Connecting the Search for Life with Degree of Certainty

It is common practice in empirical science to handle the task of connecting research results with degree of certainty by assuming that if A happens in X% of the observations in a well planned and performed study, then we can conclude that there is a probability of X% that A will happen the next time we perform the same study under the same circumstances. That is, degree of certainty is defined as probability and the probability is derived from relative frequency. This way of looking at evidence is sometimes called "frequency theories of evidence". Well-known examples are Carnap's frequency theory [59] and Popper's propensity theory [60]. The use of confidence levels, which is common in empirical science, is an implementation of this idea.

This way of looking at degree of certainty will not work here, however. We cannot say that we found life in X% of the missions to this world so therefore there is an X% chance that there is life on this world. If we find life in X% of the missions then there *is* life on this world no matter how large X is as long as it is larger than zero. If X is exactly zero on the other hand we are back in our original cumbersome situation, that is we still do not know how certain we should be that there is no life. (We can obviously use confidence intervals in certain analyses, for instance chemical analyses looking for certain signatures of life in a soil sample, but not for the main question.) In our case, it is a prerequisite of the problem that the relative frequency of positive results is zero. If it was not, we would know that there is life and our question would be mute. The problem is how to decide where we are on the scale of certainty *given* that we have zero positive results.

The usual way of deciding degree of certainty does therefore not work in our case. In this case, the relative frequency is useless but the absolute number of negative observations is useful. The more we look without finding life, the more justified are we to claim that there is no life on this world.

This is not the whole truth however and we cannot directly translate the number of negative results to a particular degree of certainty. It is also important to consider how and where we look. Looking a hundred times in the same place with the same instrument and making the same analysis of the findings will not make it significantly more justified to claim that the world is uninhabited. An additional negative observation can significantly increase our certainty that a world is lifeless only if it differs somehow from previous observations. The diversity of the observation methods, instruments, and locations is therefore as relevant as the number of observations.

Diversity and frequency are not enough either, however. The quality of the observations is also a necessary factor to consider when deciding how certain we are that a world is lifeless. A high number of observations using different methods, different instruments and looking at different places will not help us at all if our methods and instruments are seriously flawed or if all or a large number of the observations will be aimed at the wrong world.

In our particular case, the degree of certainty therefore has to be a function of (I) the number of observations; (II) the diversity of observations and (III) the quality of the observations.

To construct a scale that can be used to translate these three factors into a particular degree of certainty will not be an easy task. I believe, however, that the scale has to take a shape that accounts for the process of asymptotically approaching certainty. I also believe that even if we cannot say exactly where we are on the scale of certainty from zero to one, it is still possible to say that one result or set of results objectively justifies a higher degree of certainty that a world is uninhabited than another result or set of results, and that there is an objective basis for this in the form of the three factors I–III.

6. How Certain Do We Need to Be? A Question of Ethics as well as of Epistemic Values

A high score for the three factors I-III thus makes us objectively more justified to claim that a world is uninhabited than a low score for these factors, but the question remains: When are we certain enough?

The answer to this question depends on how we answer another question (to paraphrase Monty Python): "Enough for what purpose?" In other words, it depends on our goal [61]. It is not uncommon that research has other motives than pure thirst for knowledge [61]. Grimm distinguishes between epistemic and prudential curiosity [62]. The former type of curiosity is determined by a search for knowledge for its own sake. The latter is determined by the instrumental value of knowledge. The instrumental value can for instance be the value of knowing whether a world is inhabited because of a need to avoid problems in connection with exploitation of the planet.

It makes a big difference whether we try to establish that a world is uninhabited because we are curious, or because we try to avoid a catastrophe on a world that is about to be exploited. Note that I do not claim that one of these purposes is better than the other, only that they need to be approached differently. We should also note that the epistemic curiosity will be present in both cases while the prudential curiosity is only present when the world in question is up for exploitation. In the latter case we thus want to satisfy both types of curiosity.

Because it depends on our purpose, the question "when are we certain enough" cannot be given an objective answer in the same sense as the question "which result of set of results grants a higher degree of certainty". The purpose of an investigation is ultimately a matter of values.

It should be well known by now that science is not, and cannot be, value free. The values that guide science are called epistemic values and deal with the value or values of knowledge and the values that guide the search for knowledge (For some definitions of "epistemic value" see [61]). These values are so to speak non-optional. Without them there would be no science. A study that only aims to produce knowledge for its own sake is motivated by a high evaluation of knowledge as an end in its own right (end value). This is the case when we search for life out of curiosity. If we have searched thoroughly for life and not found any we will eventually ask ourselves whether we should conclude that the world we investigate is uninhabited or if we should postpone our judgment until we (for instance) have

access to new instruments. When our search for life is also motivated by the purpose of avoiding that an imminent exploitation will affect extraterrestrial life or earth life it is also motivated by the ethical values we identified above. The question we have to ask ourselves is how to account for the additional values without compromising the epistemic values.

Steel argues that it should be possible to amend the standards of evidence by the presence of risk (risk avoidance is a non-epistemic value) [63]. I think it is important, however, not to compromise our wish to satisfy the epistemic curiosity when we set the standards aimed at satisfying our prudential curiosity. This includes that we have to make sure not to interfere with the research set up or the scientific method in general, or with how we connect the research with degree of certainty. The three criteria identified above—number, diversity and quality of observations—tell us what kind of evidence we need to increase the degree of certainty in our statement of whether a world is uninhabited. That does not change depending on our purpose and should therefore not be changed. What they do not tell us is to what degree these criteria need to be satisfied. That is, they do not tell us how many observations we need, how diverse they need to be or how good they have to be for us to be convinced that a planet in uninhabited (*i.e.*, task 2 as identified above) and this is where it would be fitting to let the answer be influenced by non-epistemic values, in our case by the ethical responsibilities we identified above.

I would therefore like to suggest that the non-epistemic values such as the ethical values we are dealing with here, should be accounted for not by changing the research as such and not when we connect the research to the scale of certainty (task 1 as identified above) but when we decide where on the scale we need to be to declare a world uninhabited (task 2). We can then decide two different standards, one for the when our epistemic curiosity is satisfied and one for when our prudential curiosity is satisfied.

7. Contradicting Demands

The decision to exploit a world means that we have a time constraint to consider. As we saw above, the aim of the exploitation is to secure things that have value for many of us. This can lead to demands that we settle with a lower degree of certainty compared to what is motivated by epistemic values in order not to delay the exploitation. On the other hand, as we also saw above, we also have moral obligations to consider the safety of both extraterrestrial life and earth life. These obligations demand a higher degree of certainty. This means that the non-epistemic values we have to deal with when searching for life on a world about to be exploited point in totally opposite directions. How can this be dealt with in a constructive way? First of all, the fact that there is a time constraint means that we cannot postpone the answer indefinitely. If we did, it would mean one of two things. Either the death sentence to all exploitation plans of other worlds or a carte blanche for exploitation as long as no one has positively shown that a world is inhabited. Both alternatives seem unreasonable. The latter alternative would be equivalent to the habit on our own planet to assume that a substance or encroachment is safe until accidents have actually happened and we have been able to show beyond doubt that the substance or encroachment is behind the accidents. This has led to a huge amount of problems [49,52,64–75]. Assuming this strategy in situations where we plan for exploitation missions that might threaten the very existence of life on a world (including our own life on our own planet) can never be acceptable.

What we need is instead a reasonable standard for how certain we need to be that a world is uninhabited based on the factors I-III and informed by the ethical considerations mentioned above.

Exactly where to set this standard has to be the object of thorough and well-informed discussions and these discussions have to start now. It will take time to reach a decision that we all can live with and when we get to the point where it is technically and economically feasible to start exploitation, it will be too late to start the discussion.

8. Geoethics and the Quest to Establish that a World is Uninhabited

Searching for life on a distant world will (and does) involve geoscientists. It is therefore interesting to connect what we have found so far with a relatively new branch of ethics called Geoethics. Geoethics is developed for the purpose of providing ethical training and guidelines for people working with geosciences. Geoethics deals with a wide array of different subjects, one of which is mining (see e.g., [76,77]), which is also one of the business opportunities in space that has drawn the most attention from investors and that can be expected to have a large impact on any indigenous life. It therefore seems that the issue of finding a standard for when we are certain enough that a world is uninhabited prior to exploitation would be a suitable task for geoethics.

Geoethics emphasizes the social responsibilities of geologists [78,79]. Their main aim is that ethical and social responsibility is incorporated into the profession of geosciences—Including mining [77,80]. Matteucci *et al.* suggest a Hippocratic Oath for geoscientists that will include the duty of those who are equipped with special knowledge to use that knowledge to protect the earth even "outside of their professional duties" [79]. They also stress that geoscientists need to act according to "science and conscience". This means that our need to include both epistemic and ethical values fits well into the existing framework of Geoethics.

One problem from our perspective is that even though the environmental effects of projects like mining is an important part of geoethics today, they are usually approached from an anthropocentric perspective, that is, only the human perspective is considered by geoethics so far (see, e.g., [79,80]). I believe there are good reasons to consider other perspectives. The sentientistic approach saying that all sentient beings have a moral status has been shown to be much more reasonable [29,33,37,38]. The basic idea behind this approach is that when the things we do and the decisions we make affect others in a way that matters to them, then their interests in the matter have to be considered. This means that everyone who can experience what happens to them as pleasant or disturbing need to be considered. In situations where the very conditions for life will be affected on other worlds and maybe also on this world, all sentient beings, not just humans, will be affected in ways that clearly matter to them and a purely anthropocentric approach seems insufficient. It is therefore necessary that geoethics takes on a wider perspective to be able to handle our question in a satisfactory way.

From the start, geoethics was primarily concerned with our own planet [79]. This seems to have changed, however. Martínez-Frías suggests a definition of geoethics that specifically includes astrobiology: "*Geoethics is a key discipline in the field of Earth and Planetary Sciences, which involves scientific, technological, methodological and social-cultural aspects (e.g., sustainability, development, museology), but also the necessity of considering appropriate protocols, scientific integrity issues and a code of good practice, regarding the study of the abiotic world. Studies on planetary*

geology (sensu lato) and astrobiology also require a geoethical approach." [80]. This formulation has also been included, in a more elaborated version, in the definition of geoethics on the official webpage of the International Association for Geoethics [81]. In a 2011 paper, Martínez-Frías *et al.* also describes the relation between geoethics and planetary protection in more detail in [82].

The expansion of its area of concern to include astrobiology further stresses the need of geoethics to leave anthropocentrism behind. When that happens, geoethics will be able to provide important contributions to the discussion on what it should take to establish that a world is lifeless prior to exploitation.

9. Conclusions

Establishing that a world is uninhabited is theoretically more difficult than establishing that it is inhabited because of an asymmetry between the two tasks. It only takes one finding of life to show that it is inhabited while it cannot be objectively defined how many non-findings it takes to establish that it is not inhabited.

Determining what it takes to establish that a world is uninhabited can be divided into two tasks:

(1) To identify which properties in a study that determines whether its results increase our certainty that the world is inhabited. The criteria were found to be: number, diversity and quality of observations.
(2) To decide how certain is certain enough to be able to declare the world uninhabited. This decision has to depend on the purpose of the investigation.

Establishing that a world that is up for exploitation is uninhabited is different from establishing that a world that is not up for exploitation is uninhabited. The two situations differ in two ways:

A The former situation implies a time constraint not present in the second situation.
B The importance of finding the right answer in the former situation has ethical implications in addition to the epistemic implications that are present in both situations.

Because of these differences, task 2 needs two different answers. For a world that is not singled out for exploitation the search is based in so called epistemic curiosity and when it is time to conclude that such a world is uninhabited depends only on epistemic values.

For a world singled out for exploitation, task 2 is a matter of combining epistemic and ethical values. The ethical values are made up by our responsibilities to consider both possible sentient extraterrestrial life and sentient (including human) earth life for which the possible extraterrestrial life (sentient or non-sentient) can have value or pose a threat.

The impeding exploitation and the values expected to emerge from the exploitation urge us not to wait too long to conclude whether a world that is up for exploitation is uninhabited. The risks we take if we start the exploitation based on insufficient evidence that the world is uninhabited on the other hand urges us to be very certain that a world that is up for exploitation is uninhabited before the exploitation commences. It is my conviction that the worst case scenario of massive extinctions is a several magnitudes more severe problem than the possible loss of opportunities, and that it therefore has to have precedence, but that the former still plays a role in that it means that we cannot postpone our judgment indefinitely as we could if only epistemic values are involved.

To agree on the exact number, degree of diversity and quality standards of the observations necessary to establish that a world is lifeless in a way that gives due consideration to the values at stake will be difficult and take time. We therefore have to start the discussion already now and not wait for the exploitation to begin.

Conflicts of Interest

The author declares no conflict of interest.

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