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# Manned Missions, Geoengineering and Planetary Protection – How Safe is Safe Enough?



**Decontamination of landers, rovers and other equipment sent to another world (planet or moon) can never be perfect. A sterilization process that would guarantee to kill off all life would also destroy the equipment. This is (for obvious reasons) true to an even larger extent for human astronauts.**

**If we ever decide to start geoengineering another world, and maybe even terraform a world that is not presently habitable for humans, it is also highly probable that it will become less habitable for any indigenous life. Making sure, or at least trying to determine the probability that a potentially habitable world is in fact uninhabited will thus be an important step before we start any geo-engineering on that world, and possibly even before we let humans land there in the first place.**



## How certain can we be and how certain do we need to be?

In order to give green light for different kinds of activities on another world we therefore need to answer two separate questions:

- **How can we determine the probability that a world is uninhabited?**
- **How certain do we need to be in order to give green light for different types of activities?**

There is no strictly objective way of answering the second question. It is a decision we have to make based on our plans for the world in question, which in turn include science objectives, possible commercial plans and also ethical considerations.

The first question is about how to connect degree of certainty with research setup. Establishing that a world is inhabited can be accomplished through one positive finding, while establishing that it is *uninhabited*, is more of a process asymptotically approaching certainty. My suggestion is that the degree of certainty that a world is uninhabited, has to be decided by three factors:

- **The number** \
- **The diversity** – **of negative observations.**
- **The quality** /

These three factors can be measured or at least ordered with respect to certainty in a fairly objective way.

## Suggestions

The values (scientific, commercial and other) that can be obtained from exploration or 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 our duties to protect the life on another world as well as on our own world and the life of future human explorers and settlers on the new world are at least as strong and they tell us not to be too premature in our decision.

There is no objectively true answer for how to handle this dilemma. Eventually it comes down to values and the values need to be discussed by experts as well as lay-people.

A constructive and well-informed discussion about what it takes to establish that a world is uninhabited and about which values are at stake and how to compare them, needs to be initiated as soon as possible in order to prepare for our future in space.

The main purpose of this poster is to set the stage for that discussion.

## A Bayesian approach

The next step will be to use these three measurements to assess the probability that the world in question is uninhabited. This cannot be done in the traditional way by using relative frequency as a proxy for probability. If we perform 100 experiments on Mars designed to look for life and one of them provides a reliable unequivocal positive result, it does not mean that there is a one in hundred chance that Mars is inhabited. It means that Mars *is* inhabited. If we get zero positive results, it does not necessarily mean that Mars is uninhabited, however. We may just have looked in the wrong place or in the wrong way. Instead, we need a Bayesian approach to estimating the probability, where each new failed attempt to find life leads us to update the probability based on the three factors above: The number, the diversity and the quality of the failed attempts.

## Being in time versus being right

A complicating factor is that practical decision-making usually involves a time constraint. This is also true for decisions regarding exploration, and even more so for decisions regarding exploitation, of other worlds. This can lead to demands that we settle with a lower degree of certainty in order not to delay the missions. On the other hand, it is also very important to consider the safety of both extra-terrestrial life and earth life. These obligations demand a higher degree of certainty. How can the conflict between safety and timing be dealt with in a constructive way? 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 a death sentence to all exploration and exploitation plans of other worlds, or a carte blanche for any kind of activity on other worlds as long as no one has positively shown that it is inhabited. Both alternatives seem unrealistic.

### I discuss these issues in more detail in the following papers:

Persson, E. (2012) The Moral Status of Extraterrestrial Life *Astrobiology* 12:976-984

Persson, E. (2013) "Philosophical aspects of astrobiology" in Dunér, D.; Pathermore, J.; Persson, E.; Holmberg, G. (eds.): *The History and Philosophy of Astrobiology* Cambridge Scholars pp.29-48

Persson, E. (2014) What does it take to establish that a world is uninhabited prior to exploitation? – A question of ethics as well as science *Challenges* 5:224-238