7 Risk and adaptation options in a warmer world

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Risks and options for action: a common equation for investigating analogies and differences between Covid-19 and climate crises

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The urgency of action to contrast climate change and its impacts is not properly understood by the population, not being grounded on a sound perception of the phenomenon. On the contrary, the urgency to act against Covid-19 epidemic has been promptly caught by common people and, often, also by policy makers around the world.

Why this difference? After all, from a scientific point of view it is possible to show that the two phenomena have similar dynamics and inertia. In fact, the natural evolution law of an epidemic is exponential if we do not act with social distancing or even "lockdown" measures; similarly, the increase in global temperature will be nonlinear if we do not strongly reduce our greenhouse gases emissions. Furthermore, in both cases there is an inertia, which leads to a delay between the date in which we act and the results of these actions: for Covid-19 this delay is about 15 days (the incubation

period for this virus), for the climate systems is several tenths of years (decades), because of the inertia due to the long persistence time of CO_2 in the system and to the slow response time of the oceans.

Of course, the incorrect perception of a phenomenon, which leads to a lack of urgency in actions, is also a sociological problem with many aspects: insufficient scientific culture, economics interests, ideological polarization, etc. Thus, we do not deal with it in this context. Here, instead, we would like to focus on the concrete possibility of actions to contrast climatic impacts, by performing a comparison between coronavirus pandemic risks and climate change ones in a common framework. For us, such a common framework is given by the so called "risk equation":

$$R = H \times V \times E,$$

where H = Hazard, V = Vulnerability and E = Exposure. As well known, this equation is frequently adopted in any risk assessment of natural hazards on territories and population. In this somewhat "conceptual paper" we limit ourselves to qualitative reasoning which, however, can shed light to analogies and differences between the two phenomena of interest and the various chances of action.

This equation "splits off" the risk in its main factors and, when applied to different fields, obviously the meaning of the single factors is not unique.

If we consider the risk coming from meteo-climatic extreme events - as in Pasini (2020) -, Hazard H measures the probability of occurrence of a phenomenon characterized by certain frequency and intensity. Today, owing to climate change, some phenomena, such as heat waves, are changing these characteristic features in many places of the world and their future behaviour is projected to increase in frequency and intensity, with a high level of confidence (IPCC, 2013). As for other phenomena, such as heavy storms, floods, tropical cyclones and even tornadoes, our confidence in a significant change is lower (especially as for their frequency, which critically depends on atmospheric circulation), but thermodynamic fundamental laws and numerical modelling experiments let us think of an increase in their future intensity as anthropogenic forcings will increase (Lebeaupin et al., 2006; Miglietta et al., 2017). Vulnerability V of territories crucially depends on the use of soils by humans. For instance, waterproofing by asphalt or concrete tremendously modifies rainfall absorption capacity of terrains, so that intense precipitation can cause violent floods and disasters. Anthropogenic land consumption is increasing vulnerability of terrains to extreme events and could keep doing it in the future if the unbalanced exploitation will continue. Exposure E depends on the presence of buildings, infrastructures and people. Anthropic activities tend to extend the presence of humans and their structures over lands, even vulnerable ones. If we will not follow strict rules and regulations, E will increase its value in the future.

With reference to a virus epidemic, instead, through Hazard H we estimate the "strength" of the virus itself and the frequency of appearance in our territory. In the case of Covid-19, we are sure that it is more dangerous than a typical winter flu virus and it is also more contagious than Ebola or SARS viruses, even if less lethal (Rajgor et al., 2020). Concerning its appearance, this seems quite random. However, some human actions, such as heavy deforestation in tropical countries for setting up monocultures and intensive livestock or expanding towns inside a forest, increase the probability of spillover from wild animals to humans (Allen et al., 2017; Rohr et al., 2019). Vulnerability V estimates

the vulnerability of the human body of a person in presence of Covid-19. One can be young or old, healthy or affected by previous diseases, maybe concerning respiratory system. In these different cases, the consequences of the infections can be more or less serious. In any case, the only direct way to reduce the factor V is to vaccinate population, but at present a specific vaccine (or therapy) for Covid-19 does not exist. Exposure E estimates the exposure to contacts with infected persons. As far as we currently know, the only way to reduce E is defusing physical connections by means of social distancing and isolating infected people. Actually, the principal measures adopted to contain the pandemic around the world were applied at this level, something that occurred in a traumatic and emergency way.

Even if the risk equation is quite simple and the hypotheses of its application are not always satisfied, e.g. the independence of probabilities, it can represent a useful tool for comparing Covid-19 and climatic crises.

In this framework, it is quite clear that, in order to reduce the urgent risk coming from Covid-19, our possible actions are very limited: at present, due to the rapid evolution of the pandemic, we have more chances to influence the factor E than the others, by regulating our contacts and social life. In a longer range we could stop our activities of deforestation and proximity with wild animals and, hopefully, develop a vaccine.

What's about the risk by climate impacts on territories? In this case, the previous analysis of the risk equation shows that we can act now on all factors, because each factor's value partly depends on our actions. Even if the inertia of the system (some decades) suggests us to act rapidly, however we can plan these actions until we are not in emergency, acting in many synergic ways.

In short, a unified scientific framework can help to achieve a correct perception of these two very impacting phenomena and shows that, even if climate change and its impacts are probably more critical and long-lasting than the contingent Covid-19 crisis, we have more instruments of action for reducing its risks.

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