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Geography for environment and health in the time of COVID-19

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Abstract

As the anthropic action on the Planet becomes more pervasive (Anthropocene), the environment and health intensify their relationship, as witnessed by the COVID-19 pandemic, which is only one testimony of the failures produced by environmental deterioration in societies, both locally and globally. The Anthropocene is the framework within which to lay the first bases of investigation to interpret and review the behaviour of the Earth system in the light of the great ecological, socio-economic and political problems that humanity must face. The environment and health geography binomial should be looked to with great attention and new perspectives, with an intensification of the collaboration between geographers (physical and human) and scholars of the medical area.

Keywords: Anthropocene, COVID-19, Environment and Health, Geography

1. Introduction. Five introductory annotations on the subject

First. "Geographical Sciences for environment and health" is the name of the three-year degree course set up by the Sapienza University of Rome in 2008-2009[1]; it is an inter-faculty course associating the Faculty of Pharmacy and Medicine with the Faculty of Letters and Philosophy, where the geographical element is to be found. In this way, to the geographical contexts in its environmental and socio-cultural divisions are added the fundamental ones of the area of medicine (in particular the epidemiological one), which is vital for the understanding of the state of health, quality of life and risk factors of disease linked to the physical-environmental substratum and socio-economic fabric[2]. Moreover, the degree course deals with the elaboration of

[1] Even though its creation may be recent, the degree course in Geography in the Faculty of Letters and Philosophy, the first in Italy, dates back to the 1930s.

[2] The further expansion of the course (2019-20 academic year), with the Economics Faculty for an in-depth study of the aspects relative to the organisation of territory, contributes to creating professional figures "with the know-how for the identification and analysis of the complex interactions between environment and society and their effects in terms of health".

data and digital cartographies with the use of GIS, in the context of spatial and temporal analysis of the contingent phenomena of social and healthcare interest.

Second. At the Sapienza University the collaboration between the geographical and medical areas has been ongoing for some decades; in fact, the geographers of the Faculty of Letters have been profitably engaged with the medical area through a number of channels, such as the *Interdepartmental Centre for the Prevention and Study of Social Diseases,* within which it actively ran a Section of Medical Geography, directed by Cosimo Palagiano[3].

Third. The relations existing between the environment and state of health go back a long way, since the negative influence of some places on health can easily be found. It suffices to remember Hippocrates (Greek doctor born mid V century BC) who – for example in his treatise *Airs, waters and places* – highlights the role of climatic and environmental conditions in the genesis of diseases, offering guidelines to discover the causes and specifying the risk factors to be removed to foster recovery. The research carried out above all in the area of medicine – to identify the causal relations between one specific disease and the environmental factors that encourage their growth and spread – have achieved increasingly satisfying results, making it possible to evaluate the existence of risk factors and to set up suitable measures to eliminate them.

Fourth. In geography the scientific and didactic attention for the subjects dedicated to the relationships existing between health and environment has been quite recent, even if the results obtained in the medical and healthcare implications appear significant and extremely encouraging for the future. In the first case, various studies concern the distribution modalities of diseases and the different levels of health, the interrelations between the physical-biological factors of the environment and human behaviour, the presence of causes of risk in the different geographical areas. In the second case, research on the facilities of the healthcare services are significant, also to assess their efficacy and efficiency[4].

Fifth. Nevertheless, while health geography (or medical geography), as methodologically structured knowledge, has only made its appearance in recent years, it is also true that it has become firmly established in many countries. At international level, worthy of mention are the results achieved by the Commission on Health and Environment (CHE), operating in the context of the International Geographical Union (IGU/UGI). Over the mandate period 2016-2020 the Commission listed among its members of the Steering Committee scholars coming from all continents, including – significantly – Africa, aiming to "contribute as health geographers to the international efforts to improve global health and global health governance"[5].

2. Divergence between physical and human geography

Before considering the health-environment combination, it is worth reflecting on the wider container made up of the society-environment relationship, which has always been the foundation of geographical knowledge and which is now taking on new and meaningful connotations.

From the second post-war period onwards the community of geographers – the references concern the situation in Italy in particular – has been increasingly differentiated, creating closer ties with scholars of the Earth Sciences, especially geomorphologists and geologists, or finding

[3] The Interdepartmental Centre was set up at the Sapienza in 1986 to join the units carrying out research at the university on subjects of social medicine. In collaboration with Giovanni De Santis, Palagiano organized twelve International Seminars of Medical Geography every three years, precisely in the years 1982, 1985, 1988, 1991, 1994, 1997, 2001, 2004, 2007, 2010, 2014 and 2017.

[4] With regard to epidemic diseases the work of Peter Haggett was meritorious and studied how geographical concepts relative to the environment are useful to search for the genesis and development of epidemics, also in order to slow down their spread (Haggett, 2000; Cliff et al., 2004). See among others: Gatrell, 2002; Gatrell and Elliott, 2014; Palagiano and Pesaresi, 2011.

[5] The Steering Committee is co-chaired by Profs. Thomas Krafft (Netherlands) and Paula Santana (Portugal).

fruitful exchanges with the social or political sciences and economics.

The testimony of the scientific divergence is also to be seen from the legal provisions that have grouped together the teachings into 'scientific-fields according to criteria of scientific and didactic homogeneousness'[6], as a result of which physical geography is to be found on one side – together with geomorphology and associated with applied geology – which merges into the "Earth Sciences" area and on the other side geography – associated with economic-political geography – which merges into a large and rather composite area, defined as the "Historical, Philosophical, Pedagogical and Psychological Sciences".

The divergence between physical and human geography, albeit with fluctuating progress for the first half of the last century, became broader and deeper particularly between the 1950s and 70s[7]. In this period geographical-anthropic research, even though going in new prolific directions, underestimated environmental issues like those relative to the protection and valorisation of landscapes. New inputs came later, also thanks to the considerable development of ecological studies and to the fact that the interactions between nature and human societies have changed radically, above all in some highly industrialised countries, thus becoming so pervasive and ingrained as to threaten the very stability of the Earth system. It is on the very concept of vulnerability and environmental awareness that geographical insight can offer significant perspectives in the study of the consequences of *global change*, since human beings are becoming an essential part of the geomorphological processes affecting the very forms of the Earth (Cooper et al., 2018). The unprecedented situation – new not only because of the speed and sudden accelerations imprinted on the change, but also owing to the planetary scale whereby it is manifested in multiple ways – has led to the recent appearance and affirmation of the idea of Anthropocene: a framework within which to place the first bases of investigation to look into, interpret and re-examine the behaviour of the Earth system in the light of the huge ecological, socio-economic and political issues that humanity finds itself facing (Kolbert, 2011; Zalasiewicz et al., 2011).

3. For a "reconciliation" between physical and human geography

The term Anthropocene has been widely used since it was coined by Paul Crutzen[8] to define the conclusion of the Holocene, which, beginning at the end of the last Ice Age (about 11,700 years ago), would be the shortest age in

[6] The reforms of the university programme regulations refer to acts No. 341 of 1990 and No. 240 of 2010.

[7] Some geographers, linked to the traditions of unitary geography, highlight the importance of the "philosophical unity" of the subject and the harm that this has received from the "splitting". Below are a number of passages taken from a small volume by Osvaldo Baldacci dedicated to the developments of geographical thought: "Among the many dualisms existing in the subject of geography, the one which sets physical (and biological) geography against anthropic geography is worthy of the appellative *classical*: it is a dualism that sinks its roots into the fundamental specialisations of geography, when the geographer is incapable of conducting a unitary discourse […] In the specific case of geography, dualism arises when the breaking point is reached between the naturalistic component and the anthropic one. There exists an error of superficial terminology underlying those who are not able to recognise the concept of geography, which is a discipline that is not separated into its parts, but which is structured in its entirety by means of the single divisions" (Baldacci, 1975, p. 180, p. 191).

[8] The first person to use the term Anthropocene in the early 1980s was Eugene Filmore Stoermer; the American biologist was referring to the great impact of human activities on the Earth. The term was then officially proposed jointly by Stoermer and the Nobel Prize for Chemistry Paul Crutzen in 2000 to identity a new geological age characterised by the influence of human activities on the atmosphere: "For the past three centuries, the effects of humans on the global environment have escalated. Because of these anthropogenic emissions of carbon dioxide, global climate may depart significantly from natural behaviour for many millennia to come. It seems appropriate to assign the term 'Anthropocene' to the present, in many ways human-dominated, geological epoch, supplementing the Holocene – the warm period of the past 10-12 millennia" (Crutzen and Stoermer, 2000; Crutzen, 2002).

the very long history of the Earth, and the one in which human societies developed without generating excessive damage to the natural environment.

According to the scholar, the Planet has entered a new geological age in which the environment has considerably altered owing to the anthropic impact, becoming a real "geological force" able to speed up even the natural successions in the Earth's history[9]. Nevertheless, at the moment the studies for the inclusion of the Anthropocene in the *International Chronostratigraphic Chart* have not been completed; the *International Commission on Stratigraphy* (ICS), the constituent scientific body of the *International Union of Geological Sciences* (IUGS)[10], is working to reach a decision on this.

While on the one hand, the scholars of the Earth Sciences are evaluating the actual entry into the *geological Anthropocene*, a problem of a purely stratigraphic nature on a global scale, the new era of man, as the researchers coming from different areas of study write: "provides an independent measure of the scale and tempo of human-caused change – biodiversity loss, changes to the chemistry of atmosphere and ocean, urbanization, globalization – and places them in the deep time context of Earth history" (Steffen et al., 2011, pp. 756-757). Therefore, the concept of Anthropocene – by reason of its evident polysemic imprint – opens up paths that can be taken by different subject areas, and can thus represent a stimulating opportunity for integration and exchange: for the geographic sciences for example, the ideas to reconsider the processes of anthropisation of the Earth are significant.

Even though the idea of a joint geography is unthinkable, the extreme pervasiveness of human action, well expressed by the Anthropocene, urges a reconsideration of the two fields of study of geography (physical and anthropic) which by working together can better interpret the impacts of human action on nature and its cycles. In fact, it clearly appears how too distinct a separation between physical and human geography does not allow a full evaluation of the new problems – including those generated by the emerging social needs – which the research on the processes of anthropisation of the Earth must take into examination. A new unprecedented phase is opening up, with a redefinition of the society and environment dualism and with a broadening of the basic hypotheses on which to work, in the awareness that the study of the anthropisation of the planet involves two distinct but inseparable parts of a same concept.

Demographic distribution of a world population in continuous growth, excessive land consumption and overbuilding of increasingly vast surfaces, intense and often uncontrolled urbanisation, overly intensive agriculture and breeding, enhanced industrialisation and mobility cannot be analysed without a detailed scientific examination relative to the "spheres" of the Earth system: lithosphere, hydrosphere, atmosphere, biosphere. In this perspective a rapprochement between physical and human geography seems inevitable, which in collaboration with other disciplines linked to the Anthropocene can lead researchers to investigate how the transformation process of the Planet might be governed, since the risk exists of pursuing a trajectory towards situations from which it becomes difficult to turn back (Steffen et al., 2005, 2011)[11].

[9] On these subjects, the research is useful that aims to map and characterize anthropogenic transformation of the terrestrial biosphere before and during the Industrial Revolution, from 1700 to 2000 (Ellis et al., 2010).

[10] The ratification to include the Anthropocene in the *International Chronostratigraphic Chart* depends on the Executive Committee of the International Union of Geological Sciences: "The Anthropocene is not currently a formally defined geological unit within the Geological Time Scale… officially we still live within the Meghalayan Age of the Holocene Epoch". In particular a Working Group was set up on the 'Anthropocene' (AWG), following guidance from the Sub-commission on Quaternary Stratigraphy and the International Commission on Stratigraphy; according to the AWG the beginning of the Anthropocene: "would be optimally placed in the mid-20th century, coinciding with the array of geological proxy signals preserved within recently accumulated strata and resulting from the 'Great Acceleration' of population growth, industrialization and globalization" (http://quaternary.stratigraphy.org/working-groups/anthropocene/).

[11] Bruno Latour, in the IV Conference of his volume dedicated to the new climatic regime, observes how

Lastly, it must be remembered how the International Geographical Union has always proposed an overall vision of geography through the activities of numerous Commissions; two in particular set out to implement interdisciplinary research on the Society-Earth system: *Geography for Future Earth: Coupled Human-Earth Systems for Sustainability* and, recently published, *Geomorphology and Society: Past, Present and Future*[12].

4. The Anthropocene: inequalities and spatial justice

The concept of Anthropocene calls for urgent answers to the problems brought about by anthropic activities which are leading the Planet to an extremely critical point: the acceleration of physical and biological changes in fact constitutes an unsustainable process demanding a definite change in direction. The effects of urban sprawl and unchecked industrialisation, the excessive use of fossil energy resources (Summerhayes and Zalasiewicz, 2018), the indiscriminate use of land, deforestation with the relative terrifying wildfires, the mindless exploitation of water resources are linked to dangerous phenomena, such as climate change (global warming, drought, the intensification and worsening of extreme meteorological events), ocean acidification, the erosion of land and coasts, salinisation of land, desertification and desertisation. The threat to be faced is of such complexity as to require a close collaboration among the scholars of different subject areas; even the *2030 Agenda for Sustainable Development*[13] stresses this, when it states that the plan of action to achieve sustainable development must be based on three fronts: economic, social and environmental, tackled simultaneously and in an integrated way.

Nevertheless, the Anthropocene should be made clear, as the simple enunciation of a planet deeply altered by the effects of an indistinct anthropic impact, which puts everyone at the same level of responsibility, is a distortion of reality. In fact, there is no homogeneousness in anthropic activities, for which reason the human being of the Anthropocene must be distinguished in populations, groups, individuals, each of which having their own and very different specific characteristics (Moore, 2016). It is thus essential to include the reference to territorial inequalities in the Anthropocene, the study of which might help to better understand the crucial questions on whose solutions the fate of humanity lies: justice and spatial dignity, power and the dynamics of capitalism (Harvey, 2014; Ranasinghe et al., 2020; De Vecchis, 2018)[14]. Those of the ruling

the Anthropocene focusses the attention on something that is more than a reconciliation of nature and society and later on adds how the divide between physical and human geography is no longer unbridgeable (Latour, 2015). In Italy the subject was the theme of the XXXII Congresso Geografico Italiano with the Session "Geografia fisica e geografia umana: teoria e prassi di una possibile integrazione" (Bagnoli et al., 2017). A recent volume, which deals with geographical issues related to the Anthropocene, has recently been edited by Cristiano Giorda; see in particular the contribution by Marco Giardino (2019).

[12] The first Commission sets out to promote Geography so that people can move forward in a sustainable and equal world; the will is declared to foster: "wider analysis and innovative thinking about global land sustainability through the bridging and synthesis of physical geography, human geography, ecology, hydrology, atmospheric, climate and social sciences". Also the scholars of the second Commission – in all awareness that "we now live in a world in which the relationship between environment and society has been fundamentally changed by the nature and scale of the human footprint on the planet" – want to develop "an international network of scientists with common interests in the complex relationship between landforms, landform processes and people".

[13] Resolution adopted by the General Assembly on 25 September 2015 (*Transforming our world: the 2030 Agenda for Sustainable Development*).

[14] Angelo Turco writes how capitalist production produces territorial imbalances and social inequalities: "Nevertheless, the accumulative process, by its very perpetual and never concluded nature, is for this reason therefore at risk of falling into a crisis. Owing to stagnation or over-accumulation, the capital betrays its function and, more serious still, ends up losing its nature: reproducing itself, or that is to say producing capital through itself. It is in this way that, in the absence of new investment opportunities, new resources (material and symbolic) to exploit, the capital avoids the crisis by means of a geographic strategy, that is, making a resource out of the territorial imbalance that it creates and fuels itself. And this, since in the imbalanced (backward, underdeveloped) territories considerable pockets of non-capitalist

class, at different levels, should be concerned by the rise in the frequency and intensity of environmental crises, associated with the acceleration of the global change brought about by anthropisation, also because the greatest impacts affect above all poor populations (Biggs et al., 2011).

It comes as no surprise therefore that the problem of the disparity and unequal distribution of resources, both within the single states and at international level, is becoming more and more important, producing transformations in the social structures themselves with repercussions that can generate dangerous conflicts[15].

Economic imbalance becomes evident with respect to birth and death, diseases and nutrition, education and the enjoyment of leisure time; but equalities and disparities have to contend with many other concepts like, for example, those of freedom, responsibility and solidarity. In such an unbalanced system, in which can be included indifference with respect to the protection of nature, the environmental inequalities and the high number (200m in 2050 according to UN estimates) of environmental and/or climate refugees produced by the same are alarming, owing to the high financial costs and huge social charges. In fact, the most serious consequences due to environmental/climate changes are felt by the poorest countries, whose populations live in places subject to phenomena linked to global warming and who are forced to endure the damage even if they have contributed to it less than others.

Other crucial contexts where inequalities take on aspects of iniquity are to be found in the healthcare and pharmaceutical sector, with the exclusion from possible treatment for huge numbers of poor people, since the market demand targets clinical trials and new drugs at wealthy nations.

5. Planetary Boundaries

The growing environmental degradation jeopardising the survival of humanity and increasing territorial inequalities highlights the critical areas for the future of the humanity living on Earth, since the latter will equally survive even if it changes its features and natural equilibria. The habitability of the Planet Earth is at stake: the ecumene, "the house where we all live"; in this regard Johan Rockström (of the Stockholm Resilience Centre, Stockholm University) and other scholars of Earth System Sciences and sustainability have identified nine "thresholds" (Planetary Boundaries) beyond which we must not go to avoid destabilising the Earth System (Rockström et al., 2009)[16].

Even though the quantitative identification of the *Planetary Boundaries* is by far a simple task – both owing to the difficulty in making exact calculations relating the figures to the progressive effects on human beings and to the close interaction existing between these same planetary boundaries – their formulation has the merit of offering a more precise framework to understand the socio-ecological relations existing in the Earth System[17].

Another crucial aspect concerns the scalar perspective of the critical thresholds, for which reason from many local situations one passes – through successive and spatially broader transitions – to a planetary involvement, as demon-

economy to be exploited are created, in a continuum that the saturation of the developed areas and their capitalist homologation would otherwise make impossible to put into practice" (Turco, 2017, p. 36).

[15] Of great impact are the words of the Message of Pope Francis for the celebration of the XLIX World Day of Peace (1 January 2016): "Moreover, indifference to the natural environment, by countenancing deforestation, pollution and natural catastrophes which uproot entire communities from their ecosystem and create profound insecurity, ends up creating new forms of poverty and new situations of injustice, often with dire consequences for security and peace. How many wars have been fought, and how many will continue to be fought, over a shortage of goods or out of an insatiable thirst for natural resources?".

[16] The nine Planetary Boundaries refer to: Climate change, Ocean acidification, Stratospheric ozone depletion, Interference with the global phosphorus and nitrogen cycles, Rate of biodiversity loss, Global freshwater use, Land-system change, Aerosol loading, Chemical Pollution.

[17] It is also useful to understand how in time human beings have interacted with nature in order to clarify the complex relations between environmental stress and social change (Costanza et al., 2007).

strated by locally easily identifiable ecological systems which, having crossed the critical thresholds, have passed irreversibly from a sustainable state to another unsustainable one. There are increasing alarm signals that the Earth System is approaching a critical "turning point" on a planetary scale, as the outcome of an unchecked anthropic impact.

Of the nine Planetary Boundaries the one regarding climate change most attracts the attention of the mass media and public opinion, above all young people, as highlighted by the Swedish student Greta Thunberg, who has become internationally famous since when on 20 August 2018 she began to protest in front of the Stockholm Parliament, claiming that, after years since the Paris Agreement on climate change, the commitments made on polluting emissions and greenhouse gases had not been transformed into concrete actions.

How is it that the various ecological issues, even though improcrastinable, seem only to interest a small part of the population? First of all, the processes able to "cure" environmental degradation and social inequalities would entail a profound change in lifestyle which is not particularly welcome, above all by the high income brackets and populations. The problem has thus been postponed to an undefinable and sufficiently distant future, entrusting the solution to the ecological crisis to be collocated in other spaces and times to some other entity (Progress, Technology, Adaptation, human Superiority, Providence).

Consequently, the anthropisation processes of the Planet Earth continue with increased pervasiveness, without considering that all forms of life are in a dynamic balance on the Earth and that the breaking of this balance could put it at grave risk, human species included.

6. COVID-19: environment and health, rich and poor

An unprecedented shock arrives right at the end of 2019, pressing the whole world to make renewed reflections and evaluations on the environment and health, the latter being seriously jeopardised by the new flu pandemic, called COVID-19 by the World Health Organization (WHO)[18]. At this moment of writing it is not possible to foresee what effects – especially on health and the world economy – will be produced by this virus, a sign of the global complexity able to generate a polycrisis, which is biological, sanitary, economic[19] and anthropological-cultural with the brusque passage from a civilisation of mobility to one of immobility in extreme cases. The pandemic reveals a new world, which forces each one of us to reconsider almost every aspect of their life (Tyner and Rice, 2020).

This is not the first mournful pandemic to be recorded over the millennia to have such a violent impact on the life of societies[20], but it is the first to develop in full swing globalisation, by means of a world network of spatial connections and functional interdependencies, linked to a speed of movement of flows and persons, by far greater than that of the past. The speed and power of contagion show how the planetary community today behaves as a single organism, while the global system has difficulty in governing the many mechanisms undermined by the virus (De Vecchis, 2020). COVID-19 contagion shows not only to what extent the world is interconnected, but also its fragilities deriving from these concatenations and the need to reflect on the modalities for the reconversion of production and consumer systems in the correlation between environment and health, since changes in the ecological balance can increase the risk of diseases[21].

[18] This serious syndrome appears in Wuhan, in the Chinese province of Hubei, and spreads rapidly to other parts of China and progressively to the whole world. On 11 March 2020 the WHO declares that the international outbreak of infection with the new coronavirus SARS-CoV-2 is a pandemic.

[19] The necessary containment measures of the virus, even adopted with the same timing in the different countries of the world, cause an unprecedented economic crisis affecting at the same time the offer (closure of activities and interruption of the value chains) and the demand (fall of consumption, reduction of incomes).

[20] For the sake of brevity, it must be remembered that the Spanish Flu, an influenza type pandemic, of one century ago (1918-19), which – according to some estimates – hit one third of the world population causing about 50 million deaths.

[21] High levels of atmospheric pollution affect the health of the infected, as the link between long term

The virologist Massimo Clementi writes: "For many decades it has been a struggle to consider the study of the environment as a principle element for the understanding of the emergency of new pathogens" (Liotta and Clementi, 2020, p. 40). The forced proximity between persons and animals entails an environmental promiscuity, which facilitates the passage of viruses among different species, which, once confined to a single animal species, are transmitted to man by an intermediate host[22]. Zoonoses, animal infections that can be transmitted to human beings, represent the most consistent threat to the health of the population; and on the other hand, the environmental circumstances actually foster the opportunity for the *spillover*: a term used to indicate the moment in which a pathogen passes from one host species to another[23].

COVID-19, with its manifested aggressiveness and the capacity to hit the global system, highlighting its vulnerability and fragility, "perceived" how a sick planet can foster its spread. Nevertheless, it is not certain that this serious crisis will teach man to rethink a more sustainable anthropisation, since many ongoing "narrations" offer alternative versions deforming scientific truth[24].

First of all, there is the climatic crisis that negatively interferes in the environment health relationships, since the rise in temperatures fosters the transfer of even lethal pathogens; for example, dengue fever, yellow fever, zika and chikungunya, as well as malaria are the main viral infections using mosquitos as vectors[25]. The rise in temperatures is furthermore producing the melting of the permafrost, with the consequent freeing of potentially pathogenic species frozen inside it, as well as extraordinary weather events, increasingly frequent and intense in recent times, with the destruction and devastation of vast areas (Morrone, 2020).

Favourable conditions for the development of new pathogens also derive not only from famines following the climate crisis, insofar as they force the inhabitants of economically poor and ecologically fragile areas to use previously unconsidered food resources, but also from intensive farming and deforestation, which attack the habitats of the wild animals, forcing them to get closer to inhabited centres and in contact with human beings.

A contribution to the spread of COVID-19 depends on its high infectiousness, which is present even before the onset of symptoms or even in asymptomatic persons, but intense mobility has a very active role in this as it allows the virus to travel everywhere in a very short time[26]. COVID-19 has no locomotor organs but hitches a lift on human beings who travel continuously from one continent to another.

The virus hits everyone without distinction of class or wealth, but the forms of spread are very different between people with high income and mobility and the poor living in fragile environments with high levels of promiscuity. With re-

exposure to pollution and the mortality rate from COVID-19 is all too clear (Friedman, 2020).

[22] Possibilities of transmission are recorded in the wet markets, places where live wild animals are sold, and butchered there and then. The Chinese authorities indicated one of these markets in Wuhan as the first outbreak cluster of the COVID-19 pandemic.

[23] David Quammen (2012), American writer and science communicator, in one his volumes dedicated to spillover had considered the possibility that a new virus (*The Next Big One*) could subvert the world order.

[24] Even Pope Francis in his recent Encyclical "All Brothers" (3 October 2020) invites us not to forget the lesson given by COVID: "All too quickly, however, we forget the lessons of history, *the teacher of life*. Once this health crisis passes, our worst response would be to plunge even more deeply into feverish consumerism and new forms of egotistic self-preservation" [35].

[25] In an article, written as an open letter to the WHO, a group of international researchers and representatives of indigenous populations, basing themselves on the latest data on climate, takes stock of the consequences of global warming on health, and urges research organisations to study the infective agents previously stored in the strata of earth (including the frozen ones) and progressively released (Charlier, Héry-Arnaud, Coppensy et al., 2020).

[26] In 2003 the previous serious acute respiratory syndrome (SARS) spread from China to 25 countries in less than four months, becoming the first new easily transmissible infectious disease of the 21st century. The role of air transport in the diffusion of the disease became evident right from the beginning of the crisis (Bowen and Laroe, 2006).

gard to assistance and healthcare, difference in income considerably affects the possibility of treatment, both by comparing the different geographic areas and within a same state, above all where the socio-economic diversities are deep. In its global path the virus comes across huge territorial and demographic inequalities, which unfortunately it reveals and increases. For this reason, it is indispensable that in the search for cures and vaccines the national and international healthcare policies pay attention to all social groups, including the poorer ones.

7. Conclusions and Geographical perspectives

The effects of COVID-19 can be studied through a multiplicity of perspectives, since the pandemic – a complex phenomenon involving many different levels – is expressed, on various spatial scales, in medical-healthcare, environmental, political, economic and psychological terms.

Moving among these levels, where is geographical research to be placed? Summarising the reasoning begun with the increasingly pervasive anthropisation of the Planet, the first perspective lies in the intensification of the collaboration among geographers: in the physical and human fields of study. The situation sparked by COVID-19 can represent a further stimulus in this direction, and one that has already been tackled at the IGU meetings; on the other hand, the researchers will manage to communicate more efficiently the more elements and methods there are to share.

However, this collaboration can get stronger only if based on solid research programmes, chosen where social, cultural and economic issues merge with physical-environmental ones. With an interdisciplinary approach, geography for health and the environment is enriched with fruitful scientific and didactic exchanges with the medical area, already favourably experimented. The epidemiological space can thus represent an interesting starting point for an investigation relative to the relationship that the pandemic develops with territoriality. The interrelated physical-environmental space (in its geomorphological, climatic, ecological… manifestations) and the anthropic one (in its demographic, socio-cultural, economic-political manifestations) make up the bases to analyse both the quantitative spread of the disease and its spatial distribution, and the impact of the crisis on the territory, depending on its responsiveness and vulnerability.

Moreover, there are numerous interdisciplinary areas of research where geography offers a substantial contribution for the realisation of a computerised cartography relative to the spatial and temporal spread of the virus, also for the purposes of forecasting and prevention: hence geolocalisations by microzones, rapid mapping (almost in real time) of the epidemic's spread to evaluate possible correlations between the hardest hit zones and their geographical-environmental features, predictive risk mapping thanks to the use of data relative to the movements of the population and the tracing and mapping of the trajectories and contacts in space and time. Distribution, spatial and temporal diffusivity, speed, intensity, limits, spatial continuity and discontinuity are proving to be indispensable for a monitoring and a timely and effective epidemiological response[27]. In this way, being open to dialogue with the various social components, geographical research could show its public usefulness in order to demonstrate its central-

[27] With regard to this, we must remember the significant function carried out by the *International Journal of Health Geographics* which "improves our understanding of the important relationships between people, location (and its characteristics: for example environmental or socio-economic), time, and health". The journal pays particular attention to geospatial information systems and the scientific applications in the healthcare context, to which it dedicates numerous in depth contributions; with regard to the spread of COVID-19, see the research by Maged N. Kamel Boulos and Estella M. Geraghty (2020). A example of the potential of GIS in the environment-health context appears in this journal J-Reading (Pavia, Pesaresi and De Vito, 2019), that presents a column called Health Education (edited by Corrado De Vito). In No. 1 of 2020 appear two articles*: Using GIS in the Time of the COVID-19. Crisis, casting a glance at the future. A joint discussion* (edited by Jack Dangermond, Corrado De Vito and Cristiano Pesaresi) and *Spatial inequalities of COVID-19 in Italy* (edited by Giuliano Bertazzoni, Margherita Ruggiero and Beatrice Bertazzoni).

ity in the resolution of complex problems like that of COVID-19 (Turco, 2020; Casti, 2020b)[28].

Nonetheless, the territorial aspects of the epidemic should not only pass from the research level to the attention of a vaster public as an important answer to social expectations, but should also involve the didactive level for an overall education to active citizenship and sustainability[29]. Besides the educational aspects, a geography for the environment and health could create, at higher education and university level (see the degree course at the Sapienza University), new professional figures, suitably prepared who will always be needed in the future, since emergencies similar to the COVID-19 pandemic – linked to the speed whereby the risk factors of transmittable diseases are spread on a planetary scale and to environmental policies often aimed at a mindless exploitation of natural resources – are regrettable likely to return (Maciocco and Santomauro, 2014).

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[28] Emanuela Casti (2020a), in a collective piece of work promoted by the University of Bergamo, carried out research on the spread of COVID-19 (on national scale, of Lombardy and the province of Bergamo), putting it in relation with the distribution and composition of the population. The data were processed by means of cartographic mapping systems: a cartographic representation that recovers the cultural and social sense of the area.

[29] Great support for the teaching of the subject is thanks to the *International Charter on Geographical Education* (2016). See in particular the paragraph *The Contribution of Geography to Education*. Education in times of crisis is another significant aspect for a geographical education that pays attention to the environment-health combination, so that the students are able to well interpret the information that they receive and defend themselves from the disinformation circulating on the social media (Kidman and Chang, 2020). Stimuli of great interest in the didactic context are to be found in this number thanks to the contribution by Joop van der Schee (2020).

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