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Sustainable Development Goal #3, "health and well-being", and the need for more integrative thinking

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Abstract

Recently, the United-Nations adopted 17 sustainable development goals for the 2030 Agenda. The Sustainable Development Goal (SDG) 3 "Ensuring a healthy life and promoting well-being for all ages" is one of the most transversal goals, which is interconnected with the other SDGs. The health and well-being are the aim of this goal and also, they are the result of other goals that empower people to develop better in different social, economic and productive areas. The SDG 3 is a multiple and universal resource on which sustainable development policies can be based, in particular for the most needed countries, and can lead to the sustainable maintenance of well-being and health. However, SDG 3 faces a high sectorization, so there is a risk of not being able to achieve the stated objectives. Only a national and international reflection on human population and animal health surveillance devices, environmental health, implementation of appropriate indicators and specific research funding will ensure the balance between the legitimacy of society's demands and the needs of scientific and medical excellence. The health and well-being indicators that are needed to achieve the agenda goals are based on reliable and relevant quantitative data, which are currently rare or even non-existent in some regions. Therefore, it is now necessary to initiate a more integrative international animal and public health and research strategy in order to collect new data, particularly those relating to current emerging infectious diseases that affect public and animal health, especially in developing countries.

Keywords: Sustainable Development Goals, Health and well-being, human and animal, systemic approach, One Health, EcoHealth.

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Introduction to SDG 3. Some reminders

The Sustainable Development Goals (SDGs), part of Transforming our World: the 2030 Agenda for Sustainable Development, are a set of 17 global goals to end poverty, protect the planet and ensure prosperity and good health for all. SDGs suggest a new sustainable development agenda to be achieved over the next 15 years. Specifically, the goal of SDG 3, "good health and well-being", *in extenso* "ensuring a healthy life and promoting the well-being for all ages", combines two main ideas: 1) health is a universal right, but it is also an insurance capital that allows the settlement of the sustainable development of nations; and 2) welfare is a state related to different physical or psychological factors considered separately or jointly.

Physical well-being depends on general good health and the satisfaction of the body's primary needs, whereas psychological well-being is a more abstract notion that depends on personal evaluations and can appeal to social or economic success, pleasure, and harmony with oneself, other persons or the environment.[1] Individual and collective health and well-being constitute an extraordinary resource that acts on social and economic development, bringing a return of better health and well-being of the populations that endorse it.[2-4] A critical analysis, performed by the International Council for Science and the International Social Science Council,[1] specifies the links between SDG 3 and other SDGs, where health and well-being are considered factors or assets derived from the actions undertaken in the SDGs.[5]

The SDGs, implemented in the year 2015, include 17 objectives and 169 goals, of which 13 (9 goals and 4 implementation means; see at https://sustainabledevelopment.un.org/sdg3) are related to health and well-being and are possibly informed by less than 169 indicators (see Gostin and Friedman 2015).[6] A recent report from the Sustainable Development Solutions Network suggests the use of 84 indicators only,[7] and the work of indicator selection is still ongoing.[8] Recently, the United Nations Sustainable Development Goals Report 2017 reviewed the progress made towards these 17 goals, highlighting both the gains and challenges that still need to be accomplished to reach the agenda.[9] Concerning SDG 3, unparalleled successes have been achieved, particularly in terms of poverty reduction, access to safe drinking water for the more marginalized countries on the planet, and the fight against HIV/AIDS pandemic, malaria and tuberculosis. However, even though the results of the Millennium Development Goals (MDG) implementation are globally observable, progress must be accelerated, particularly in regions with the highest disease burdens, such as sub-Saharan Africa.[10,11]

In addition to infectious diseases and maternal and child health, SDG 3 is also concerned with chronic diseases, the use of tobacco, alcohol and narcotics, mental health, road safety and pollution. To a greater extent, SDG 3 also includes aspects related to universal social coverage, health financing and the development of health systems.[5] SDGs are based on the idea that the sustainable development of nations depends on the transversal and integrative consideration of the development of social (e.g., poverty and gender equality), environmental (e.g., climate change and erosion of biodiversity and resources) and economic (e.g., wealth growth and infrastructure) components. The SDG intention, contrary to earlier sectoral MDGs, is to link the economic, social and environmental challenges faced by the populations and consider these in an integrative context.[12]

Therefore, SDGs are more ambitious than MDGs, which in turn are more focused on fighting against poverty. Such SDGs, at least on paper, have the potential

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to fight more systematically against poverty and injustice by considering the interconnected dynamics between economic development, social aspirations of people, and environmental changes confronting aquatic and terrestrial ecosystems today.[13] A strong analogy exists with the recently used approach by some theoretical ecologists who are interested in the complex interactions between infectious disease transmission and economic development.[14,15] These ecological studies highlight the important role of nonlinear relationships between infectious diseases and economic growth in generating poverty traps in the human populations of less developed countries. Coupled models of this sort could be usefully developed in many economically socio-biophysical systems and serve as the foundation for exploring how fundamental ecological processes influence human health, animal health and economic development together. We think that this is where a more integrative approach, such as the One Health/EcoHealth approaches, can be operationalized through integrated risk assessments and structured decision making to improve our understanding of decision consequences across sectors, i.e., trade-offs and synergies among the achievements of multiple SDGs, as the actions conducted for one SDG can have detrimental effects on one or more other SDGs. This initiative would allow the proactive reduction or minimization of the incidence and risk of harm, and the neglect of development decisions in the progress of SDGs.

Recognizing the interdependence between economic development, social aspirations, including health and well-being, and the environment is a remarkable international advancement. The notion of this complex system induces positive or negative feedbacks among the economic, social and environmental elements, since better health and well-being are not only the result of a higher economic prosperity but also the result of the preservation of environmental quality, which can be altered or even destroyed by uncontrolled development.[16] Undoubtedly, the SDG Agenda framework may seem broad; however, it invites a profound paradigm shift, including a systemic, ecological approach that takes into account different economic, social and environmental cross-dynamics in order to achieve an inclusive economic model.[12] This paradigm shift should be included in all health-related and agricultural fields of research, based on a multidisciplinary framework aimed at achieving the One Health/EcoHealth principles.[17]

At present, there are more than 7.5 billion humans on the planet, and forecasts predict a population of 9 billion people by the year of 2050. The global technological, industrial and agronomic-food capacities would allow even higher population levels, but what could be the environmental, social and health costs of such a demographic explosion on Earth? Today, humans are distributed in rich, emerging or poorer countries. Many of them face environmental (e.g., naturally poor or depleted soils with bioclimatic conditions that negatively impact species survival) and economic (e.g., national and local markets for products such as maize, cocoa, coffee, etc. that are determined by international markets) difficulties, inequalities (in wealth, jobs, and gender), and poor access to drinking water, medical care or good-quality education.[18] The natural environment can be significantly degraded or threatened by the development of intensive and extensive agriculture, livestock or mining, as in several tropical and developing countries.[5] There are populations suffering from conflict and displacement or exposed to insecurity. Globalization entails interdependencies between states, whose consequences are discovered in the wake of health crises (e.g., Ebola, Chikungunya, and Zika) and the resistance

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to current and future antibiotic drugs. The climatic imbalances caused by human activities, mainly those of the northern countries, weaken populations, especially the most vulnerable populations of the southern countries.[18] However, why is it necessary to set up these SDGs? What does SDG 3 represent concerning health and well-being? What do we have to do and develop in the fields of scientific, veterinary and medical research in order to be in agreement with and fulfil this goal?

Health and well-being for all people are universal rights, which, together with education, undoubtedly represent our best civilization tool for building a lasting harmonious, equitable and just development. We invite the reader to take note of a recent study published in *The Lancet*, which measured 33 health indicators for 188 different countries between 1985 and 2015.[19] Overall, this study shows that, since 2000, notable improvements have been recorded for several health-related SDG indicators, particularly those that are also MDG indicators (under-5 mortality, modern contraception, and neonatal mortality). However, minimal improvements were found for indicators such as those for HIV and tuberculosis incidence between 2000 and 2015. More generally, during this period, there were minimal improvements for non-MDG indicators, such as those for Hepatitis B incidence and worsening, e.g., childhood obesity. Specifically, this analysis calls for a substantial change in the present trajectory of major infectious diseases, such as HIV, malaria and tuberculosis, to meet the target 3.3., which calls for the end of these major epidemics by 2030. Furthermore, this synthesis not only highlights the importance of income, education, and fertility as drivers of health improvement but also emphasizes that investments in these areas alone will not be sufficient. It notably preconises the better quantification and analysis of the roles of other potential drivers of health development, the interactions that may exist between different SDGs, and the possible indirect impacts on health from other SDGs to produce a more concise, cohesive and actionable framework for the SDGs.[19] Arguably, adopting a One Health/EcoHealth perspective for the SDGs, by examining the way people interact with their natural and man-made environments and characterizing the fundamental drivers of environmental changes and their health consequences, will provide a promising approach to explore and address these issues.

A health and well-being SDG 3 that is inter-linked with multiple other SDGs

SDG 3 relates to almost all other goals, either because it directly or indirectly influences them or because the situations and conditions of those goals have obvious repercussions on the health and well-being of individuals and populations. Climate change will have evident health repercussions, and good health should favour a better resilience of the affected populations.[20] The phenomenon of massive urbanization in different regions of the world will affect the health status of populations, particularly due to air pollution and urban heat island phenomena.[21] Intensive agricultural and livestock production, while providing food resources for the world's population, may also contribute, in part, to the destruction of natural habitats, biodiversity loss, decreased water quality and soil erosion, as well as the deterioration of peasant and farmer health. For example, a case study of schistosomiasis in Africa underscores how habitat modification through the development of agriculture and

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irrigation can facilitate disease invasion and increase health consequences for both human communities and animal populations.[16] Schistosomiasis constitutes one of the most debilitating tropical endemic diseases, currently infecting hundreds of millions of people and killing tens of thousands, but some animal schistosomes can also affect herds and wild animals. Schistosomiasis is re-emerging in different African and East Asian countries today, whereas it was considered to be under control during the 90s. Despite the undisputable improvement in socio-economic and sanitary conditions in those tropical areas of the world, human-created or modified habitats have facilitated the development of snail species that host human and animal schistosome larvae. Snails also benefit from rice field cultures, dams and aquaculture production, resulting in increased schistosome transmission and increased human and animal morbidity and mortality. Molluscicides can help reduce snail populations in the field, but they may add to further losses in biodiversity and have serious health consequences in the human populations.[16]

Other infectious diseases have responded similarly after habitat fragmentation and biodiversity loss, such as Hantavirus Pulmonary Syndrome, Lyme disease, Malaria, West Nile virus, Nipah and Hendra viruses and coral diseases causing massive bleaching in marine ecosystems; these, among others, affect native species of high biological significance, and other infectious diseases are considered as domestic animal and public health threats.[22] For example, Vampire Bat Rabies (VBR), transmitted by the vampire bat *Desmodus rotundus*, has been reported as the oldest known infectious disease affecting both humans and animals and has caused severe economic impacts on the livestock industry in Latin America. Despite several national campaigns applied for decades in the continent, with extensive vaccination programmes and massive bat control strategies, VBR today is increasing in many places throughout Latin America, such as in Mexico.[23] It is considered one of the most important diseases causing public and animal health concerns in many countries.[24] Land-use changes, habitat fragmentation, and increases in livestock distribution and abundance, in isolation or synergistically, have increased the geographic range and population size of vampire bats, thus increasing the risk for VBR transmission to human communities and domestic animals. This suggests that developing an integrative strategy to control vampire bats and fight VBR must take all valuable improvements into account to inform prioritization exercises.[25]

In addition, expanded cattle ranching and habitat fragmentation have favoured the loss of ecosystem services, resulting in impacts such as reduced carbon storage, increased soil pollution, increased greenhouse gases, biodiversity losses, and increased risks of invasive species that carry zoonotic infections such as hantaviruses and rabies at local and regional scales.[23,26] Areas inhabited by invasive rodents, which are hantavirus reservoirs, and vampire bats are highly fragmented and simplified, not capable of sustaining complex ecological functions and ecosystem services.[27] Integrating sustainable food production practices and correct landscape management under multidisciplinary approaches, including medical sciences, can satisfy the demand for food and simultaneously guarantee the provision of ecosystem services that sustain the health of all living forms.[28]

The important role of land use in the mitigation of infectious diseases has been appreciated only recently, and how land-use changes affect disease dynamics in time remains largely unknown. In Amazonian Peru, it has been observed that the feeding rates of malaria vectors transmitting the infection to humans were nearly

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300 times higher in deforested man-made ecosystems than in pristine rainforest areas.[29] Fine-scale landscape modifications, such as forest elements in farmland or newly opened areas for agricultural development may influence abiotic factors (e.g., sun and moisture) and biotic factors (e.g., local extinction of competitors and predators) that affect vector habitat use and, therefore, disease dynamics. By examining how avian malaria prevalence is affected by agricultural intensity and extent, Mendenhall and collaborators have investigated how ecosystem modifications over time, i.e., the proportions and configurations of tree clusters on farmland, may affect disease dynamics.[30] Their results show how fine-scale landscape modifications resulting from the development of agriculture influence the prevalence of tropical avian malaria in a human-dominated ecosystem. With this kind of analysis, which is still rare, we gain a better understanding of how biodiversity, ecosystem services, agricultural yield, and human well-being intersect in complex ecosystems. Further studies focusing only on species diversity and food production and ignoring other critical ecosystem processes should expand their scope to encompass disease dynamics in humans, domestic animals and wildlife.

Despite the inherent difficulty of these integrated approaches, the results obtained so far indicate that integrated analyses crossing environmental, sociological and economical domains have the potential to provide new insights into the causes and consequences of human health and well-being and to better integrate SDG 3 with other goals (see section hereafter).

In a critical SDG analysis conducted by both ICSU and ISSC, Aitsi-Selmi and Murray (2015) discuss the close links between some SDGs (particularly SDGs 1, 2, 4-9, 11, 12 and 16) and health and well-being.[31] According to these authors, the goals could be better coordinated with those concerning health and well-being. Table 1 compiles the associations that may exist between SDG 3 and other SDGs.

Health and well-being, a multiplied and universal lever

Etymologically, a lever is an object or an action that serves to lift, move or overcome resistance. Using a multiplied lever effect allows the relation of different involved forces to be increased; its universal quality allows it to adjust to and act under different conditions. Previously, we mentioned a direct universality form, i.e., a nexus, of SDG 3, one that is indirectly associated with other SDGs (see Table 1). This poses the question: how can SDG 3 and its derived measures provide a leverage effect for multiplied action?

Some economists, such as Kraay and McKenzie (2014), pose three competing reasons why poverty still persists in many countries or regions,[32] particularly in Africa; these reasons are the lack of individual and community efforts, the resulting fundamental deficiencies (underdeveloped institutions, insufficient public endowments, lack of qualifications, and others) and poverty. The final reason is interpreted as a vicious circle, also known as the poverty trap concept, which specialists such as Sachs and Malaney (2002) or Azariadis and Stachurski (2005) interpret as "any self-reinforcing mechanism [generally complex, *authors note*] that causes a persistence of poverty".[3,33] Here, we choose to illustrate the poverty trap phenomenon by means of two recent studies that break down the complex mechanisms

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Table 1. Relationships between 16 Sustainable Development Goals and the one related to health and well-being (SDG 3). Modified and adapted from Aitsi-Selmi and Murray (2015).

SDG	Relation(s) with health or well-being	Targets
› 1	Poverty is the main cause of poor health, and its eradication should improve the overall health, and reduce health inequalities	All (Particularly, 1.3, 1.4, 1.5)
› 2	Food security is a major determinant factor of health	All (Particularly, 2.2, 2.4, 2.c)
› 4	Education is a major determinant factor of health, and may contribute in the reduction of health inequalities	All (Particularly, 4.1, 4.2., 4.4)
› 5	Gender can be a barrier for accessing some types of services, which causes certain social exclusion. Women pertaining to some low- or middle-income countries are particularly exposed in terms of access to medical and social services	All (Particularly, 5.2, 5.3., 5.6)
› 6	Drinking water and sanitation are key factors for health and well-being, and can contribute significantly to the reduction of child mortality	All (Particularly, 6.1, 6.2, 6.3)
› 7	Climate change and non-renewable energies are the main threat sources for human health and well-being in the next years	All (Particularly, 7.1, 7.3, 7.a)
› 8	Access to paid employment and decent working conditions, determine the physical well-being for families, young people and adults	8.3, 8.5, 8.6, 8.7, 8.8, (Particularly, 8.6, 8.7, 8.8)
› 9	Durable practices and associated behaviors should help develop healthy and durable environments in the long term, and minimize the effects of catastrophes	All (Particularly, 9.1, 9.3, 9.5)
› 10	Socioeconomic inequalities are important as inequality factors in health	All (Particularly, 10.3, 10.4, 10.5)
› 11	More equitable policy decisions for reducing socio-economic inequalities should allow the reduction of health inequalities Quality of housing, transportation and access to green areas are important determinants of good health and well-being	All (Particularly, 11.1, 11.2, 11.b)
› 12	The consumption or overuse of natural resources including land use, inadequate food production, and excessive dietary behaviors, are a source of bad health and a major threat, both to climate malfunction and to the development of epidemics, such as, obesity. The use of durable resources, agricultural and livestock practices and reasonable consumption, as well as, a better redistribution of the resources should be encouraged	All (Particularly,12.1, 12.6, 12.a)
› 13	Threats related to climatic malfunctions and extreme events are included in the main risk sanitary factors of today	All (Particularly, 13.1, 13.2, 13.3)
› 14	Over-exploitation of the oceans affects the world food consumption and has health consequences. Freshwater environments are the main cause of infections and parasites, and their destabilization increases the health risk	All (Particularly, 14.3, 14.a, 14.c)
› 15	The use and irrational land management are a threat to food and health security	All (Particularly, 15.3, 15.5, 15.c)
› 16	A defect of governance and organized crime can paralyze citizen actions and contribute to the increase of crime and poverty	All (Particularly, 16.2, 16.3, 16.8)
› 17	Good governance and fair macroeconomic policies are determinants that generate the necessary social structures, which enable citizens to project and build a good health and to live happily	All (Particularly, 17.6, 17.7, 17.19)

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acting between health and development economics and between agriculture and economic development.

The multidimensional approach to infectious diseases and their control, since 62 to 75% of new emerging infectious diseases are shared between humans and domestic and wild animals, explicitly underlines the difficulty of medical interventions. In general, vaccinations, particularly those related to the eradication of the human smallpox virus, represent an obvious success. However, in some regions of the world, such as sub-Saharan Africa, public health interventions are still difficult to carry, or their results do not live up to expectations. For many territories, the health situation is catastrophic, and many infectious or parasitic diseases affecting public and animal health that were previously under control, currently show dramatic levels of incidence and prevalence.[34]

Health and poverty

Poor health and poverty often go together because an infected person becomes less productive and therefore has a lower capacity to generate income. In this way, the poverty trap could be caused by infections, particularly since many endemic tropical diseases develop all or part of their transmission cycle in the environment; therefore, they are not eradicable *per se*. Clearly, One Health/EcoHealth approaches adopting a broad ecological perspective may help to anticipate and proactively mitigate these kinds of risks by considering interactions with ecosystems.[35] Additionally, some countries or regional territories may have managed to overcome certain infectious diseases by proximity effects. However, if the interventions of the surrounding territories or countries fail, the failure can influence the reinvasion of the pathogen, its vectors or its reservoir.[25] Therefore, understanding the regional dimensions of infections is obviously crucial. Biomedical and epidemiological approaches to researching health tend to treat individual environmental factors separately, ignoring the interrelationships among them and the importance of spatial patterns and processes in the colonization and spread of disease. The One Health/EcoHealth approaches consider the complexities of dynamic social and environmental systems by thinking about population health in ecological and spatial terms, even if medical and veterinary epidemiology have gained insight into the importance of space to health.

The relationships between infectious diseases and poverty are not linear or homogeneous, and they depend on income level to a large extent. In poor countries, a higher income allows a better protection against infectious disease risks (e.g., purchase of drugs and bed nets) and has more complex effects on household members. However, the high incidence and prevalence of such diseases can affect individual or collective life conditions. The relationships between health and income also involve other variables, such as education. In general, many of the poorest regions of the world face situations that are vicious circles, that is, where complex dynamics prevail to maintain poverty, especially vulnerability, exposure to certain types of risks (infectious or parasitic) and other contextual variables that increase the risk of some individuals falling or staying in poverty.[36]

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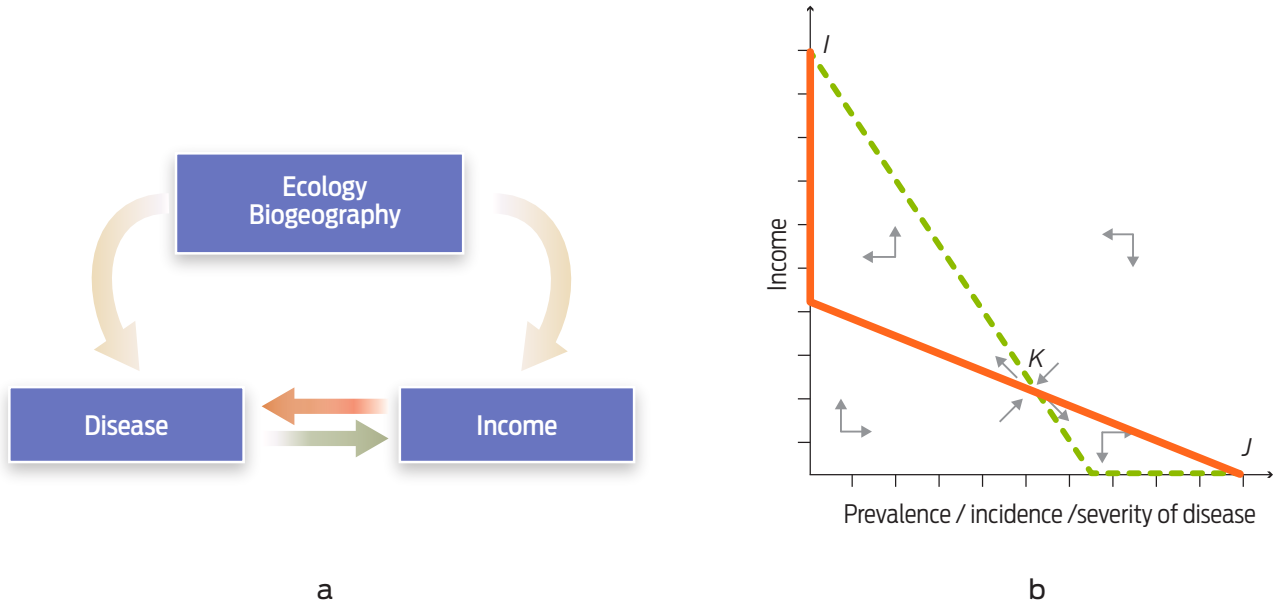

Figure 1. (a) Simplified representation of the relationships between the environment and its different ecological and biogeographic components, depending on the distribution and abundance of infectious diseases and their hosts (vectors and/or reservoirs), and to the individual and family income. The form and severity of infections interact with the income by introducing a complex dynamic between these two parameters. (b) Simplified forms of statistical relationships between income and infectious transmission (here, the prevalence of an infectious disease). In theory, the prevalence, incidence or severity of the infection decreases as a function of increased income (in red); and inversely, the income declines when the prevalence, incidence, or severity increases (in blue). See text for further explanation. The functions are in stable equilibrium in *I* and *J*; and in unstable equilibrium in *K*. The functions delimit two attraction basins, one located in the right part of the diagram around *J*, named as "poverty trap". Adapted from Bonds et al. (2010).

SDG 3 and neglected tropical diseases

Buruli ulcer is one of the least studied tropical diseases (STDs) in the world, despite its strong disabling power and its estimated annual incidence of approximately 5 to 10,000 cases per year. Although the incidence and prevalence of this disease remain low and are undoubtedly underestimated, Buruli ulcer contributes to the economic damage of affected families and people by depriving sick individuals of job or education access. Through a combination of data and epidemiological and economic models, Garchitorena and his colleagues were able to demonstrate that such rare but highly disabling tropical diseases can have important consequences for the most vulnerable socio-economic groups, such as populations in Cameroon.[15] Therefore, Buruli ulcer conditions can cause very serious inequalities within disadvantaged families and villages. The communities affected by this disease, which often co-occurs with other infections or parasitosis, such as bilharziasis, loasis, sleeping sickness and many other disease systems embedded into ecosystems, are economically weakened and sent into a spiral that prevents communities and populations from normal development (Figure 1).

In addition, the multiple infections caused by neglected infectious or parasitic diseases, such as those not considered by international funding (almost exclusively HIV/AIDS, malaria and tuberculosis) can generate additive or synergistic effects, which increase the attraction surface or strength of the "poverty trap" phenomenon, as represented by *J* in Figure 1. Ngonghala and colleagues showed the existence of

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this exacerbated phenomenon through a theoretical model in which the diseases were combined with each other to represent real local contexts.[37] Obviously, this phenomenon stands out when it concerns rural poor populations that are far away from medical centres; these medical institutions can quickly diagnose a disease and either prevent its serious evolution or treat it in time, in order to prevent sequelae.[15] It should be noted that past priorities concerning the fight against infections, particularly those advocated by the MDGs that prioritize the three major infectious diseases listed above, may have left a gap in which infections or parasites (classified today as "neglected") multiplied, exacerbating contextual inequalities and participating insidiously in vicious poverty circles. Within the SDG framework, a higher battle synergy, also known as diagonalization by our Anglo-Saxon colleagues, is currently needed to prevent individuals or communities from suffering infections or parasitosis, which have not been considered a priority by the international community.

Based on a formalism of complex biological, physical and economic processes, Ngonghala and colleagues have extended this same approach to agricultural development, nutrition and the use of arable land in the poorest countries.[37] For the most underprivileged people, the dependence on market variations is very strong when, without a minimal capital, production strategies cannot be deployed. They are the first to suffer not only the conjunctures upheaving the purchase price of a cereal but also climatic caprices. Market failures and credit access difficulties imply that growth alone cannot remove poor populations from these poverty traps. In combating these deficiencies, we can "kill two birds with one stone"; the effectiveness of individual or collective initiatives is reinforced, allowing an escape from poverty and inducing an increment in wealth production.[38] At the heart of these ecologically inspired actions is the realization of the existence of complex dynamic balances that associate environmental, biological, physical, social and economic phenomena; it would be possible, for example, to associate the work of Garchitorena et al. (2015) with that of Ngonghala et al. (2014) to establish an interest in the cross-dynamics between local economies, infectious diseases and agricultural development.[15,37] In particular, the appearance of the bacillus that causes the *Buruli* ulcer has been associated with modifications of natural ecosystems, such as deforestation for agricultural development, especially in Côte d Ivoire and Cameroon.[39,40]

Discussion and implications for research and post-2015 health devices

According to Buse and Hawkes (2015), the scientific and medical communities currently face five major challenges to meeting their objectives.[12] These authors note a very important and necessary paradigm shift; according to them, the scientific and medical spheres have not yet measured the extent of the demanded change. In addition to the fight against dominant mercantilism, which we will not address because it depends on national and international political decisions, we face four important challenges:

P. Producing change that focuses on preventative actions through the involvement of local communities.

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L. Leadership development aiming at a higher coherence and coordination among the goals to integrate different health determinants.
I. Integration of individual and peoples' rights.
E. Enlistment of civilian populations and their guaranteed participation.

The "L" challenge will require better governance and more integrative approaches in scientific and medical research, both in public and animal health. The "I" challenge will require greater inclusion of specialized lawyers in health law, the biomedical and environmental fields, national and international governances or even intellectual property; for some of these specialties, which are currently poorly or not represented, university training is necessary. It is striking, for example, that biomedicine and public health are currently concerned with the Nagoya Protocol (2010) on the access to genetic resources and equitable sharing of benefits, as their implications are highly relevant to these areas.[41] Renewed scientific and medical training requires more openness and transversality in their foundations. The "E" challenge not only consists of considering the opinions and advice of civil society but also is related to the process of research and decision-making. The human and social sciences, particularly anthropology, sociology, and communication sciences, play a key role in this challenge. These sciences should allow the understanding of intellectual and collective difficulties associated with the implementation of field studies and the analysis of an expert's reluctance to engage in dialogue with civil society.

Among these four challenges, approaches concerning preventive counselling rather than curative counselling can obviously satisfy epidemiologists and public health specialists. This type of approach is less prevalent in the biomedical field, where most studies aim at alleviating already acquired health problems and remedying them momentarily or indefinitely. Although there are prophylactic vaccines for many infectious diseases, and not all medical research should be questioned, advances in health determinants that affect those with a higher influence on the health state of a population should be privileged (this is called a health promotion policy). This concept is fundamental when epidemiology and public health are combined within the scope of environmental, ecological and evolutionary sciences.[42] This international orientation is derived from the economic evidence of recent studies questioning biomedical postulates, as well as the possibility of participatory actions from civilian populations, as performers of their health and the conditions that predispose it. Let us take a quick look at three ideas. The experience France has gained since the River Gard floods in 2002 and their health consequences have shown that the direct economic costs associated with the extreme flood events represent 30 % of the estimated total cost. The indirect and intangible costs at an intermediate or long-term scale represent 70 % of the total cost. The increasing frequency and intensity of exceptional climatic events in southern France have caused more careful attention to be paid to intermediate and long-term health effects and have encouraged the French to favour less onerous, risky policies for future care. Sometimes, cases in which the treatment cost is less expensive than the prevention policy solution can also occur. Through modelling scenarios, recent new studies are trying to analyse what types of approaches should be favoured by understanding the contexts and taking into account the socio-economic situation of a region or country; this is the scientific approach that we suggest, namely, using mathematical and computer science inputs. Regarding the second idea, the set of facts that can

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be gathered related to understanding structural and endogenous biomedical factors (e.g., the virus and its eradication and the disease and its genetic determinants), which often remains a matter for specialists, opposes the phenomenological and exogenous understanding that rejects the *a priori* isolation of determinants from each other, which was conceptualized through the exposome notion. The current awareness of the importance of life conditions, environmental pollution and environmental changes leads us to believe that everyone can act on health determinants and achieve a more favourable life. This finding favours the third challenge, which encourages the active participation of citizens.

A French report by Guesnerie and Hautcoeur (2004) regarding research about sustainable development services,[43] although clearly published prior to the implementation of the SDGs, examines the priority needs in terms of research tools. Imagine its application to the SDGs as we review their general lines of research.

Multidimensionality of sustainable development issues.

All SDGs are characterized by common features: interconnections between the SDGs, systemic dimensions, the need for boundary-crossing competences derived from different disciplines, the emergence of new phenomena with danger or risk dimensions that imply new scientific questions, and several uncertainty degrees that public decision makers must manage. Regarding SDG 3, environmental global changes, dynamic and natural resource management, lifespans, the environment, and economic and social crises reveal the complexity of this issue and invite us to consider it within the context of biomedical research and global animal and public health.

Research between study objects or disciplines.

As we already expressed extensively, the SDG approaches are of transversal nature; thus, it is necessary to establish an important interdisciplinary exchange of research studies. They must open the door to new problems, to the emergence of new specialties and even to new disciplines that consider these SDGs as study objects; at the same time, they need to have a potential and important social impact. According to Guesnerie and Hautcoeur (2004), the response to these needs requires a more federative structure and scientific studies on sustainable development.[43] Ideally, in our opinion, it should be developed within the framework of long-term observations; however, for tropical and southern countries, the options for observation and intervention systems in health should be discussed and organized with national or regional partners.

Data and indicators for SDGs.

The main problem related to the research data here is capital, and the studies must be redesigned for a large number of goals. Regarding SDG 3, the data scope suffers from a lack of epidemiological, socio-economic, demographic, environmental, and long-term data, particularly on tropical and southern countries. The need for such data is imperative in order to observe the temporal evolution of the implemented indicators. In particular, Boulanger (2004) presents the scientific and social implica-

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tions of collecting new data and implementing reliable and operational indicators.[44] The articulation between long-term environmental changes (e.g., global warming and its sanitary consequences), long-term economic development and short-term political decisions, particularly those concerning health-related public decision making, implies that new data must be collected and even (re)designed to organize systems that will meet new data needs. For many tropical and southern countries, public statistical institutes do not exist, or if they do exist, data are missing and are often incomplete, inaccessible, or unable to respond to newly raised scientific questions (e.g., chronic diseases related to pollution and pesticides in many African countries).[18,44] It is important to emphasize the fact that chronological data sets are important for observing and preventing risks and for improving early warning systems concerning, for example, epidemic threats.

The availability, at no cost, of these data for researchers, decision makers and citizens should be seriously considered. Here, we will not address the issue of databases, which is equally important; they should be established in collaboration with sampling and collection plans while ensuring a relationship between data of very different origins. In this way, when statistical problems arise concerning data aggregation/disaggregation or the bioinformatic investigation of forms or structures, they pave the way towards new disciplinary investigation routes.

Modelling for a better understanding, anticipation and prevention.

Modelling cannot be developed and validated without the provision of reliable qualitative and quantitative data; furthermore, it should not be considered as a sufficient and definitive answer, in isolation, for posed questions. Regarding the epidemiology of infectious diseases, the most informative research studies over the last 15 years have relied on statistical and mathematical analyses of long-term data series about measles and whooping cough cases in England and Wales.[45] These studies show a regularity in the epidemic appearances, with highly periodic cycles that resemble certain well-known physical phenomena. No research focusing on fine, molecular, or cellular levels of organization, for example, reveal the existence of these recurrent epidemic phenomena. These studies note the efficacy of the vaccine; nonetheless, they also reveal that the two infectious agents continue and persist in the British population and keep causing infections. The clear understanding of these two childhood diseases depends on appropriate quantitative data, which allow a better comprehension of measles and whooping-cough transmission and the difficulty of eradicating these diseases, as well as a better organization of future vaccination campaigns. Other studies on meningococcal meningitis in the Sahelo-Sahelian African fringe have also shown the seasonal regularity of epidemics with outbreaks that can be accurately predicted today.[46] All the aforementioned studies depend on exceptional quantitative data, which are rare and enable the development of early-warning and follow-up systems in the implementation of adequate preventive measures.

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Conclusion

The SDG 3 implementation of "good health and well-being" simultaneously addresses the biomedical field and health-related research in an extensive way, addressing not only their topics and habits but also their relationships with civil society. SDG 3 questions and sometimes revolutionizes disciplinary knowledge; it demands a higher interdisciplinarity, according to the One Health/EcoHealth approach, which already exists in the fields of ecology and evolutionary biology, in order to meet the challenges and compromises of new directions of scientific research and practices. This approach is a key element for reaching the agenda of SDG 3; since an almost complete lack of adequate data, particularly from tropical and southern countries, calls for a profound reorganization of monitoring, surveillance and tracing systems for animal health, public health and welfare statistics. In this review, we did not discuss certain aspects, such as new health technologies (e.g., telemedicine) and individual and collegial expertise, and we briefly addressed the issue of school and university education in relation to the problems of sustainable development and the defined goals for achieving it. The idea to develop pilot schools under the auspices of the United Nations in different countries of the world, particularly in countries of the south, has not yet been implemented. This emerging notion will permit younger generations, who will constitute new decision-makers, to be sensitized to current problems that can severely affect their own future. This constitutes a strong method of teaching and enabling the participation in action plans. In fact, the types of scientific and medical approaches that we use are passed down from an earlier period and organize our relationships with decision makers, politicians and citizens by placing the discipline in context, first and foremost. The aims of sustainable development invite us to position ourselves differently, according to the new demands that currently confront national and international research policies.

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Conflicts of interest

All authors declared no conflicts of interest and no competing interests in this study.

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Author contributions

JFG and GS conceived the design of the paper, and all authors (JFG, GS, SKC, DNB, JPM) contributed to the writing of the paper.

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