




OPINION ARTICLE

Climate change, migration and health systems resilience: Need for interdisciplinary research [version 1; peer review: 2 approved with reservations]

Valéry Ridde^{1,2}, Tarik Benmarhnia³, Emmanuel Bonnet⁴, Carol Bottger⁵, Patrick Cloos⁶, Christian Dagenais⁷, Manuela De Allegri⁸, Ariadna Nebot ⁹, Ludovic Queuille¹⁰, Malabika Sarker¹¹

¹IRD (French Institute For Research on Sustainable Development), CEPED (IRD-Université Paris Descartes), Universités Paris Sorbonne Cités, ERL INSERM SAGESUD, Paris, France

²University of Montreal Public Health Research Institute (IRSPUM), 7101 Avenue du Parc, Room 3060, Montreal, QC, Canada

³Department of Family Medicine and Public Health & Scripps, Institution of Oceanography, University of California, California, USA

⁴IRD (French Institute For Research on Sustainable Development), UMI Résiliences 236, Bondy, France

⁵School of Public Health, University of Montreal (ESPUM), 7101 Avenue du Parc, Montreal, QC, Canada

⁶School of Social Work, Faculty of Arts and Sciences, University of Montreal, Montreal, QC, Canada

⁷Department of Psychology, University of Montreal, Montreal, Canada

⁸Heidelberg University, Heidelberg, Germany

⁹Independent Consultant, Pharmacist and Public Health Specialist, Paris, France

¹⁰Pan American Health Organization, Haiti Office, Port-au-Prince, Haiti

¹¹BRAC James P Grant School of Public Health, BRAC University, Dhaka, Bangladesh

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Abstract

Climate change is one of today's major challenges, among the causes of population movements and international migration. Climate migrants impact health systems and how they respond and adapt to their needs and patterns. But to date, the resilience of health systems in the context of climate change has been little explored.

The purpose of this article is to show the importance of studying, from an interdisciplinary perspective, the relationships between climate change, migration, and the resilience of health systems.

Resilience is an old concept, notably in the field of psychology, and is increasingly applied to the study of health systems. Yet, no research has analysed the resilience of health systems in the context of climate change. While universal health coverage is a major international goal, little research has to date focused on the existing links between climate, migration, health systems and resilience.

We propose an interdisciplinary approach relying on the concept of health system resilience to study adaptive and transformative strategies to articulate climate change, migration and health systems.

Keywords

Climate Change, Migrations, Health Systems, Resilience, Interdisciplinary

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- 1 **Lucy Gilson** , University of Cape Town, Cape Town, South Africa
- 2 **Katharina Waha**, CSIRO Agriculture and Food (Commonwealth Scientific and Industrial Research Organisation), Brisbane, Australia

Any reports and responses or comments on the article can be found at the end of the article.

Corresponding author: Valéry Ridde (valery.ridde@ird.fr)

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Introduction

“Four thousand migrants arrive in Dhaka, the capital of Bangladesh due to various ‘push’ factors including frequent natural disasters”¹. Indeed, environmental changes due to climate change are projected to cause substantial increases in population movement, within and between countries, in the coming decades. Haiti faces a similar situation according to a 2008 report estimating that 100,000 people had moved for climate change reasons from rural areas to the capital Port-au-Prince². Environmental changes (e.g. drought, soil erosion, extreme weather events, etc.) lead to substantial impact on health, economic and political dimensions at the population level, including influencing migration patterns and may result in adverse health outcomes, both for displaced and for host populations, as we will discuss in more detail later³⁻⁵. Consistently, the World Health Organization (WHO) identifies climate change as a defining challenge of the 21st century; and considers it an emerging priority for the public health community to ensure protection against its health impact^{6,7}. In 2015, The Rockefeller Foundation and *The Lancet* published the report of the Commission on Planetary Health⁸ and the UN Sustainable Development Goal 13 calls for “urgent action to combat climate change and its impacts”.

For this article, we conducted an heuristic literature review on climate change, migration and health systems. As a result of a peer-reviewed article search in the PUBMED database using climate change, health systems, and migrants as keywords, only 10 results published between 1994 and 2017 were identified. Of these, six (60%) were written in the past decade and included: two opinion papers, two study reviews, one qualitative study, and one protocol for a review that will be completed in 2018.

In this article, we describe and discuss the fundamental role that health care systems resilience can play in this regard and we identify interdisciplinary research as key to better understand the existing linkages between climate change, migration and health systems and how to build more resilient health systems. We also propose some questions and axes to orient future research proposals.

Climate migrants and health systems

Climate change can be translated into a wide range of environmental degradations, including hurricanes⁹, rising sea levels, and/or reduced rainfall in drylands and water scarcity¹⁰. Populations confronted by climate change consequences such as exposure to hazards, loss in land productivity, absence of habitability, and/or shortage of food/energy/water security may have difficulties to subsist in a given area¹¹. Climate change consequences compounded by socio-economic pressures and/or political instability, increase propensity to migrate. Although evidence is still missing to prove this association, environmental factors are increasingly influencing an already complex pattern of human mobility. A recent paper suggests “a statistically significant relationship between fluctuations in asylum applications and weather anomalies”¹². Climate migrants may be forced to leave their homes due to rapid-onset disasters, such as flooding and hurricanes (as in Haiti and Bangladesh for example)^{1,2,13,14}.

Nowadays, there is no conceptual consensus on the notions of environmental refugee or climate change migrants yet, or the

more rarely used terms ecomigrants or environmentally displaced persons^{15,16}. Since 2007, the International Organization for Migration (IOM) has defined environmental migrants as “persons or groups of persons who, for compelling reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad”¹⁷. Others suggest restricting the definition to victims of extreme weather, drought/water scarcity, and sea-level rise and excluding the effects of the spread of tropical diseases¹⁶. The estimation that is most widely accepted is that over 200 million persons will be displaced globally by 2050 because of climate change^{13,15,18}, and according to the last Lancet Countdown “the total number of people vulnerable to migration might increase to 1 billion by the end of the century without significant further action on climate change”⁵.

Climate-related migrants may or may not perceive how climate change influences and has an impact on their health needs and social patterns. For example, in Burkina Faso, the close relationship between climate change and flooding is not always fully perceived by the Burkina population suffering from it, as documented by the authors of this manuscript in previous studies (Box 1) However, climate-related migrants experience difficulties or face challenges similar to those of refugees fleeing war and/or political persecution: overcrowded settlements, unsanitary conditions, poor nutritional status, unsafety, inequity and limited access to health services^{1,2,19,20}. In addition, environmental change migrant population is usually the most vulnerable as well because migration is often expensive and climate change factors can easily lie on the top of other strong socio-economic factors. For example, Haiti and Bangladesh were respectively ranked 3rd and 6th globally in the Long-Term Climate Risk Index (CRI) from 1995 to 2014²¹, while their health systems’ performances were ranked by the WHO in 2000 as 138th and 88th, respectively, out of 191 countries²². The very recent Global Climate Risk Index 2018 confirms these two places for Haiti and Bangladesh but also shows that several African countries (Mozambique, Malawi, Ghana, Madagascar) are very affected and have little research on climate migrants.²³

Box 1. Local perception about the link between climate change and flooding in Burkina Faso

A recent survey of Sahelian floods in Ouagadougou, Burkina Faso²⁴, reveals that climate change is not seen by the population as responsible for the floods. They consider that the responsibility lies more with the authorities who did not act to maintain the water supply facilities. The links with climate change do not seem to be perceived by the citizens of Ouagadougou. In the meantime, they also report changes in overwintering dates, an increase in extreme rainfall incidence and precipitation variability. There are several documented direct and indirect health impacts associated with such patterns such as water-borne and vector borne diseases or food security^{10,25,26}. These patterns in regards to the change in precipitation regimes with increases in the frequency of extreme wet and dry years are known to be intensified in the context of climate change²⁷. It thus appears that, while the impacts of climate change on precipitation regimes are already observed by local populations, their perceptions about potential links still need to be enhanced.

In parallel, some individuals might be escaping slow-onset disasters, such as rising sea levels and declining agricultural yields; their migration patterns may be more similar to those of rural–urban migrants, and they might experience many similar obstacles and barriers to their health as well²⁸. From the literature, it can be seen that some health related challenges may be identical: 1) Re-emergence of infectious diseases and geographical migration of diseases²⁹: migrants spatially re-distribute infections from endemic areas to new populations; they are also exposed to new diseases due to unsanitary living conditions. 2) Reduced access to healthcare services: mass migration applies population pressure exceeding local health and social services capacity; perceptions of long wait times, confusing administrative procedures, or discrimination also impede health system access for migrants³⁰. 3) Disrupted social support networks contribute to adverse mental health outcomes³¹, higher risk of violence, and spread of STIs, including HIV infection. Migrants are often seen as potential security challenges for countries^{18,32}. Niger is one example for conducting more research to understand the phenomenon of infectious diseases and migration, but at the same time for the health system to better adapt (Box 2)

Box 2. Malaria and migration in Niger

Niger, and its Agadez region, has long been known as a crossroads for the regional transhumance and immigration to the North. Agadez is one of the driest regions of the country with a very low and irregular rainfall level and therefore it's classed as a hypo-endemic region of malaria³³. In 2016, Agadez region reported 55411 malaria cases, of which the age groups of adults aged 25 over and children aged from 1 to 4 being 37% and 20%, respectively. These data contrast with the other countries where adults aged 25 and over account for only 17.4% and children aged 1 to 4 for 42.6%³⁴. In fact, this is not an isolated case because the data for the last 6 years show the same relationship. This may be explained in part by the irregularity of malaria transmission, which leads to a loss of immunity to malaria by the population³⁵. But it is also necessary to take into account that people that travel through this region are mostly young adults. One hypothesis could be that several cases reported as indigenous cases are, in fact, exported cases that have very different profiles (*Plasmodium falciparum* strain, drug resistance, associated pathology, behaviour toward the illness, etc.). Niger's malaria control programs must adapt to these challenges.

However, the lack of consensus of climate change migrant definition makes research on its health needs and patterns still difficult.

Climate change in the global health context

With its inclusion in Goal 3 of The Sustainable Development Agenda, the concept of Universal Health Coverage (UHC) has obtained consensus from the international community³⁶. UHC, regarded as the third global health transition³⁷, or, according to former WHO director Margaret Chan, “*the most effective concept that public health can offer*”, aims at ensuring access to good quality care while limiting the impoverishment of people as a result of their illness³⁸. In September 2015, the Director of WHO/PAHO for the Americas, Carissa F. Etienne, stated that “*we must all cooperate to reduce those factors that are contributing to climate change and to mitigate its health effects.*” Consecutively, in September 2017, the new WHO Director-General has set UHC as his greatest challenge and highlighted at the UN General Assembly on Migration Health in New York City that “*health systems must be sensitive to the needs of migrants.*”

The direct and indirect effects of climate change on population health and disease development are now well discussed^{5,39}, but there is still little literature on the health effects of migration (within and between countries) influenced by natural disasters and droughts exacerbated by climate change⁵. In addition, the role of the health care system as a social determinant of health⁴⁰ and its capacity to protect populations affected by climate change was recently identified by the WHO⁶ and the Canadian Public Health Association⁴¹.

Health systems (and health professionals) suffer the shocks provoked from climate change and migration^{42,43}. These shocks can be the direct consequence of climate change (floods, heat waves, hurricanes, etc) or indirect effects, i.e. the influx of patients suffering from diseases whose emergence or abnormally high frequency is due to climate change⁴⁴. Therefore, health care systems need to adapt to population migrations (in and across countries) due to climate changes by taking into account the effects of both phenomena on the epidemiology of diseases⁴⁵ (e.g. dengue vs malaria) and, more globally, by identifying and responding to specific social (e.g. social acceptability of migrants)⁴⁶ and health problems (e.g. mental health) in this context. In this sense, there is a very close link between UHC and emergency preparedness, as the WHO has just pointed out calling for “*a mutual reinforcement of emergency preparedness and health systems strengthening strategies*”. Health security must also be achieved through good health systems preparedness for the disasters caused by climate change⁴⁷. The capacity of health systems and their actors to prepare for and adapt to these climate-related shocks is known as *resilience*.

Health systems resilience in the climate change context

Resilience is a longstanding concept in the disciplines of life sciences, psychology (Box 3) and climate change⁴⁸, but it is relative new to the study of health systems^{43,49,50}. Health system are compounded of both hardware (structure; organization; technology; resourcing) and software (values; norms; actors; relationships) components, and their resilience require to be measured and understand accordingly⁵¹.

Box 3. The origin of the concept of resilience in the field of psychology and its applicability on climate changes consequences today

According to the Merriam Webster dictionary, the first use of the term resilience dates back to 1807. It was then used in physics about the ability of materials to resist shocks or regain their original shape after being compressed or deformed⁵². During the 1970s, in community psychiatry, we look at the phenomenon of so-called “invulnerable” children who, in the confrontation of stress and adversity, do not develop psychological disorders. In 1979, the child psychiatrist Michael Rutter uses the term resilience to describe these children he is studying to understand what are the protective factors that allow them to cope with stress^{53,54}. His work has notably helped to identify social support as one of the main protective factors. The definition of resilience used today to study the capacity of health systems to cope with the consequences of climate change is consistent with this work. The Intergovernmental Panel on Climate Change: “*The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation*”⁵⁵.

In 2015, the WHO proposed an operational framework to build climate resilient health systems within the context of climate change⁴², but the scientific and empirical basis for its production is unclear, and the issue of population migration is not mentioned

Recently, an article has developed a non-normative index for assessing the resilience of health systems, but its validation has not yet been completed⁵⁶.

The 2017 and 2018 Lancet Countdown paper series suggests some indicators (at least: 2.1, 2.4, 2.6; 2.7, 2.8, 3.9) (Box 4), which could be useful to understand the link between climate change and health system resilience, even though the concept of health system resilience adoption is still limited and “does not capture the quality or effectiveness of efforts”, as it was said for the 2017 report^{5,57} neither the resilience of health staff (at its already important brain drain) nor community is taken into account. Health systems’ resilience cannot be evaluated only in terms of infrastructures. In contrast, from a more holistic and fundamental research perspective, several recent articles propose conceptual frameworks^{49,50,56} that suggest analysing the five main dimensions of a resilient system: awareness, diversity, self-regulation, integration, and adaptiveness⁵⁰.

Box 4. The 2018 Lancet Countdown indicators⁵⁷

- Indicator 2.1: National adaptation plans for health
- Indicator 2.4: Climate change adaptation to vulnerabilities from mosquito-borne diseases
- Indicator 2.6: National assessments of climate change impacts, vulnerability, and adaptation for health
- Indicator 2.7: Spending on adaptation for health and health-related activities
- Indicator 2.8: health adaptation funding from global climate financing mechanisms
- Indicator 3.9: Health-care sector emissions

In addition, according to the Sendai Framework (2015-2030) adopted at the Third United Nations World Conference on Disaster Risk Reduction in March 2015, it is essential “to enhance the resilience of national health systems”⁵⁸ but very little attention has been paid to the role of the health system in responding to climate change and its resilience^{42,43,59}. One of the major global health journals (*Health Policy and Planning*) just released in November 2017 the first, to our knowledge, supplement issue about “Resilient and Responsive Health Systems”⁶⁰. But none of the 11 articles addressed climate change.

As seen and cited, migration and climate connections has followed similar research progress, typically by a different group of scholars, on understanding migration’s health dimensions⁴⁵. In the same way, migration, climate, population’s health and

resilience of health systems are usually analysed as separated components through disciplines and approaches in silos. Research on the intersection between all these components is still very scarce. Consequently, there are gaps and a predominant compartmented analysis on the existing links between all of them. In contrast, interdisciplinary means a certain level of integration of knowledge, methods and/or ideas to construct and analyse the problematic under study^{61,62}. Hence, interdisciplinary research can lead to the understanding of the links between migration and health require mixed methods⁶³, and the collaboration of environmental, health and social sciences, in order to inform strategies and interventions to protect population health. “By learning from other researchers one increases the possibilities of creative solutions”⁶⁴.

For interdisciplinary research

Climate change is one of the main challenges of our century, having the potential to trigger important changes in population health also by forcing migration. The role of health systems in the context of targeting universal health coverage may be central to address these challenges.

As exposed in this manuscript, the research on the intersection between climate change, health systems, and migrants is still very scarce. Because of its complexity, we need to move from a multidisciplinary to an interdisciplinary approach⁶⁴ to understand the multiple pathways that link migration driven by climate change and population’s health.

We believe there is a need for an interdisciplinary approach relying on the concept of resilience to help to study adaptive strategies in both places of origin and destination. Further investments should be made to unravel the link between climate change, migration, and health system resilience. We propose a series of interdisciplinary research questions to provide initial guidance in this direction (Box 5). We suggest in Table 1 and Figure 1 a first summarization attempt of the challenges triggered by climate change for the resilience of health systems.

Box 5. Some (non-exhaustive) future research questions

- How is the concept of climate migrant delineated?
- What conceptual frameworks can support research on health systems’ resilience to climate change?
- In what ways are the health systems resilient to climate change-related migration?
- What role does climate change play in population movements and what are the health impacts?
- How do people displaced by climate change have access to health systems?
- How to promote health systems’ preparedness and resilience in the face of climate change?

Table 1. Pathways, scenarios and challenges between climate change, migrations and health systems resilience.

Pathways	Possible scenarios	Challenges for the health system resilience	
		Hard	Soft
1- Climate => Health System	Heat wave, extreme cold	Adaptation of buildings, targeted financing, electricity and water, cold chain strengthening, solar power, health staff uniforms	Engineer and health staff training
2- Climate => Space => Health System	Flood, hurricane	Adaptation and location of health facilities, emergency referral system, emergency preparedness	Disaster preparedness training for care and logistics, staff delay
3- Climate => Local Population => Health System	Epidemics, new pathologies (dehydration, dengue, etc.),	Organization of an alert system, epidemiological surveillance, adaptation / forecasting of diagnostic capacities (i.e dengue vs malaria tests), vector control prevention	Staff training (pathologies, tests, differential diagnostic, etc.)
4- Climate => Space => Displaced populations => Health System	Population movements, spread of (new) parasites / viruses, mental health	Logistics anticipation of patients' care, free healthcare, surveillance system, emergency referral system	Migration of staff, social acceptance of the arrival of displaced population and free care for them (all), training of health staff (languages, pathologies, etc.)

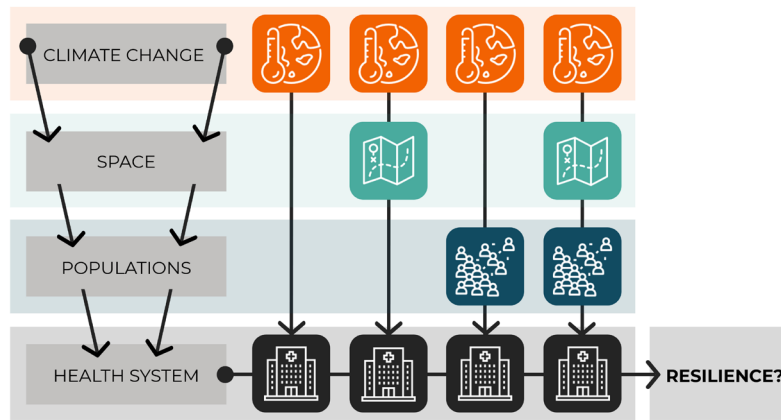


Figure 1. Health systems resilience in the climate change context.

Data availability

No data are associated with this article.

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Katharina Waha

CSIRO Agriculture and Food (Commonwealth Scientific and Industrial Research Organisation), Brisbane, Queensland, Australia

The article calls for further research on climate change, migration and health system resilience and an interdisciplinary approach but does not present a convincing line of reasoning. Often the individual paragraphs seem unconnected.

For example, in the section on “Climate migrants and health systems” I am not sure what the authors are trying to do or say. It’s a loose collection of thoughts to me at the moment. The first two paragraphs are about general impacts of climate change and migration and the authors are careful to not link them directly which is good. The next paragraph is about perception of migrants which is interesting and then the authors move into the Burkina Faso example where it is not clear if people have migrated at all.

I think the topic is interesting and very relevant and one thing that might help to structure the article better, is to clarify whether the authors are interested in the effects of climate change on an *individual's* health (migrants) or a *country's* health system or both. This seems to be mixed up in the article. Table 1 and Figure 1 seems to sort of help with that, but they are not integrated in the text at all, they are just added at the end but should be central to the paper.

Other comments:

- “The estimation that is most widely accepted is that over 200 million persons will be displaced globally by 2050 because of climate change^{13,15,18}”. Inappropriate use of literature. McMichael *et al.* (2012) (13) actually says that 200 million is the figure most widely accepted and refers to Myers (2002) as the source of that figure, but also says that the empirical basis has been questioned. This is an important consideration that needs to be added here. The other two references are not needed then, except if they are given to support the notion of ‘most widely accepted’ in which case I would expect more studies.
- Box 1: Conclusion in the last sentence about perceptions of local populations needing to be enhanced does not follow from previous paragraphs. The authors would have to establish a

disconnect between perceptions of climate change and flooding and results from a detection and attribution study in order to conclude that.

- Box 4 and the resilience section: These indicators seem to be for resilience and adaptation planning, not just for resilience. The concept of resilience seems to be important in the article but only got mentioned once in the second last section and there it gets mixed up with adaptation indicators. The Lancet Countdown Report gives some of them as "Adaptation Planning and Resilience for Health Indicators". Can you strengthen this part and explain better why this is an important consideration?
- "The role of health systems in the context of targeting universal health coverage may be central to address these challenges." The authors speak about universal health coverage only once before and do not give any reason for this conclusion.
- How are health needs and health system resilience different between "climate change migrants" and other migrants that e.g. flee war? The authors state that they "face challenges similar to those of refugees fleeing war and/or political persecution" and "might experience many similar obstacles and barriers to their health as well", so why the need to study this topic separately?

Is the topic of the opinion article discussed accurately in the context of the current literature?

Partly

Are all factual statements correct and adequately supported by citations?

Partly

Are arguments sufficiently supported by evidence from the published literature?

Partly

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Climate change impact research

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 17 Apr 2019

Ariadna Nebot, Independent Consultant, Pharmacist and Public Health Specialist, Paris, France

Answers to Katharina Waha who approved with reservations

- *The article calls for further research on climate change, migration and health system resilience and an interdisciplinary approach but does not present a convincing line of reasoning. Often the individual paragraphs seem unconnected.*

Thank you for your feedback. In light of Lucy Gilson's comments, we have tried to reorganize some sections of the article. We hope that this will make more sense.

- *For example, in the section on “Climate migrants and health systems” I am not sure what the authors are trying to do or say. It’s a loose collection of thoughts to me at the moment. The first two paragraphs are about general impacts of climate change and migration and the authors are careful to not link them directly which is good. The next paragraph is about perception of migrants which is interesting and then the authors move into the Burkina Faso example where it is not clear if people have migrated at all.*

We have renamed this first section to better show that its objective is to set the scene for the relationship between climate migrants and health. We have made it clear that the people from Burkina Faso affected by Box 1 have been displaced by flooding, thank you for the comment.

- *I think the topic is interesting and very relevant and one thing that might help to structure the article better, is to clarify whether the authors are interested in the effects of climate change on an individual’s health (migrants) or a country’s health system or both. This seems to be mixed up in the article. Table 1 and Figure 1 seems to sort of help with that, but they are not integrated in the text at all, they are just added at the end but should be central to the paper.*

We have tried to restructure the article to better show that what interests us is not so much the link between climate migrants and health but rather the link between climate migrants and health system because it has not yet been much addressed by research. We have added text to better integrate and explain Table 1 and Figure 1.

- *Other comments: “The estimation that is most widely accepted is that over 200 million persons will be displaced globally by 2050 because of climate change 13, 15, 18”. Inappropriate use of literature. McMichael et al. (2012) (13) actually says that 200 million is the figure most widely accepted and refers to Myers (2002) as the source of that figure, but also says that the empirical basis has been questioned. This is an important consideration that needs to be added here. The other two references are not needed then, except if they are given to support the notion of ‘most widely accepted’ in which case I would expect more studies.*

Thanks for this very relevant comment. Accordingly, and in order to avoid confusion, we have replaced the figure with empirical basis questioned by the following sentence: “the simple fact is that nobody really knows with any certainty what climate change will mean for human population distribution. Current estimates range between 25 million and 1 billion people by 2050.” (Brown 2008) and we have also deleted the 2 references (15, 18); not necessary in supporting the argument anymore.

- *Box 1: Conclusion in the last sentence about perceptions of local populations needing to be enhanced does not follow from previous paragraphs. The authors would have to establish a disconnect between perceptions of climate change and flooding and results from a detection and attribution study in order to conclude that.*

Yes, thanks for this suggestion. We have just deleted the last sentence in order to clarify the disconnection suggested by the reviewer.

- *Box 4 and the resilience section: These indicators seem to be for resilience and adaptation planning, not just for resilience. The concept of resilience seems to be important in the article but only got mentioned once in the second last section and there it gets mixed up with adaptation indicators. The Lancet Countdown Report gives some of them as “Adaptation Planning and Resilience for Health Indicators”. Can you strengthen this part and explain better why this is an important consideration?*

Yes, thanks for this comment. It is correct that the Lancet Countdown indicator's section 2 refers to "adaptation, planning and resilience for health" and not only to resilience. The reason is of course that *adaptation* and *resilience* are directly related and this section 2 aims to put at the front the adaptation efforts to promote and achieve community resilience, as we can see in p.13 of the 2018 Lancet Countdown's report:

"With the observed and future health impacts of climate change becoming increasingly evident, and emission trajectories committing the world to further warming, accelerated adaptation interventions are needed to safeguard populations' health. As the 2030 agenda shows, 45 strategies to improve community resilience are often linked to poverty reduction and broader socioeconomic development imperatives, creating the possibility of no regret scenarios".

However, in this same p.13, it is said that, although the 2018 Lancet Countdown report counts on improved indicators for this section, the community resilience is still few explored and that collected data give more insights in adaptation than in resilience:

"The health sector should be at the forefront of adaptation efforts, ensuring health systems, hospitals, and clinics remain anchors of community resilience. This underrecognised, yet growing area of practice, is the focus of this section." The data are incomplete, providing more insight into adaptation than resilience, and predominantly allow for process-based indicators."

Therefore, the authors of this paper considered some of these Lancet Countdown indicators as a good example to visibilise the still reductionist and uni-discipline approach of how *resilience* is interpreted. In order to make this intention more explicit; we have added these two-lines in p 7.

- *"The role of health systems in the context of targeting universal health coverage may be central to address these challenges." The authors speak about universal health coverage only once before and do not give any reason for this conclusion.*

We have added some clarifications to this sentence, p 9.

- *How are health needs and health system resilience different between "climate change migrants" and other migrants that e.g. flee war? The authors state that they "face challenges similar to those of refugees fleeing war and/or political persecution" and "might experience many similar obstacles and barriers to their health as well", so why the need to study this topic separately?*

Thanks for this comment. According to what we could find in the literature (and therefore, what is already documented) climate migrants health needs may share similar patterns to refugees and/or to rural-urban migrants (P.4). However, in this same paragraph, we also mention the additional vulnerability that this category of population may have: *"In addition, environmental change migrant population is usually the most vulnerable as well because migration is often expensive and climate change factors can easily lie on the top of other strong socio-economic factor."*

Considering this 'additional vulnerability', the author's underlying hypothesis may be that climate migrants health needs and health system resilience may be slightly different. However, the non-integrated disciplines that can be looking at that doesn't allow to further explore this specificities. We have modified the last statement of this paragraph in order to strengthen this idea: *"However, the lack of consensus of climate change migrant suggests how the same phenomenon is defined from different and non-integrated*

disciplines and, therefore, how climate change migrant health needs and patterns are still scarcely documented. “

Competing Interests: No competing interests were disclosed.

Reviewer Report 04 February 2019

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Lucy Gilson 

Health Policy and Systems Division, School of Public Health and Family Medicine, University of Cape Town, Cape Town, South Africa

This is an important paper on a vital topic. It provides useful directions for future research around climate change, migration and health system resilience. Nonetheless, the overall argumentation of the paper is not fully clear – and so it is difficult fully to judge the use of evidence and assess the conclusions.

The broad argument seems to be intended as:

1. Climate change and migration are inter-linked and have negative health consequences ('climate migrants and health systems').
2. Health systems are vital to tackling public health challenges such as those of climate change and migration ('climate change in the global health context').
3. Whilst there is increasing focus on health system resilience, this has not yet included concern for climate change or migration ('health systems resilience in the climate change context').
4. There is a need for 'interdisciplinary research' on climate change, health systems and migrants ('for interdisciplinary research').

However, whilst the last section presents a case for interdisciplinary research, the earlier sections essentially work towards the conclusion that climate change, migration and health systems are interlinked. In addition, although there is reference to the point that current research is conducted in silos with little consideration of the intersection between these terrains on p.5, this point is not clearly argued previously in the paper.

In supporting the final step of the paper's argument (point 4 above), I suggest, then, that there would be value in strengthening the argument around the current silo-based nature of research in these domains as well as discussing further why and how interdisciplinary research is valuable for this area of work. I propose placing both these sets of issues in the section 'for interdisciplinary research' (some are currently in the previous section). There may also be value in clarifying that in this context 'disciplines' are, I think, equated to areas of work (climate change, migration, health systems) as opposed to e.g. sociology, anthropology, clinical science etc. And then I suggest it would be helpful to: expand on the point that 'interdisciplinary' means 'a certain level of integration of knowledge, methods and/or ideas' (p.5), and to discuss more than the need for mixed methods; clarify why an interdisciplinary approach is better than a multidisciplinary one for this work (p.5); and deepen the point about the value of the focus on resilience and adaptive strategies in supporting interdisciplinary research (p.5) – as well as explaining more of the

detail of Table 1 and Figure 1. (As an aside, in Table 1 I would propose there would be value in thinking about health system software as more than staff training, essentially; relationships among staff within the system and with the public also matter, for example).

In terms of the earlier sections of the paper I was not sure why the first section is titled 'climate migrants and health systems', as the focus is on health challenges rather than health systems. I also found that the logic and structure of the sections 'climate change in the global health context', and 'health systems resilience in the climate change context' made it difficult to follow the argument within them. In 'climate change in the global health context', this might be because the very tight referencing practice has overshadowed the argument. In 'health systems resilience in the climate change context', the linkage between the different points presented is not very clear (i.e. the argument connecting them).

Some other minor points for review in p.3:

- What is an heuristic literature review?
- How are the 10 papers that were identified in the PubMed search used in the text, or is the point here that *only* 10 papers were identified?
- At the first mention, briefly clarify the significance of the Lancet Countdown for this paper.

One final comment: given that this is a very closely argued piece, there would be value in some really close copy editing – as, for example, missing words in sentences, long sentences, and sentences that are phrased quite clumsily, hinder understanding.

Is the topic of the opinion article discussed accurately in the context of the current literature?

Yes

Are all factual statements correct and adequately supported by citations?

Yes

Are arguments sufficiently supported by evidence from the published literature?

Partly

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Health policy and systems research

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 17 Apr 2019

Ariadna Nebot, Independent Consultant, Pharmacist and Public Health Specialist, Paris, France

Answers to Lucy Gilson's comments, who approved with reservations

- *This is an important paper on a vital topic. It provides useful directions for future research around climate change, migration and health system resilience. Nonetheless, the overall argumentation of the paper is not fully clear – and so it is difficult fully to judge the use of evidence and assess the conclusions.*

- *The broad argument seems to be intended as: Climate change and migration are inter-linked and have negative health consequences ('climate migrants and health systems'). Health systems are vital to tackling public health challenges such as those of climate change and migration ('climate change in the global health context'). Whilst there is increasing focus on health system resilience, this has not yet included concern for climate change or migration ('health systems resilience in the climate change context'). There is a need for 'interdisciplinary research' on climate change, health systems and migrants ('for interdisciplinary research').*

Thank you for this summary which indeed corresponds to the approach we adopted in our paper.

- *However, whilst the last section presents a case for interdisciplinary research, the earlier sections essentially work towards the conclusion that climate change, migration and health systems are interlinked. In addition, although there is reference to the point that current research is conducted in silos with little consideration of the intersection between these terrains on p.5, this point is not clearly argued previously in the paper.*
- *In supporting the final step of the paper's argument (point 4 above), I suggest, then, that there would be value in strengthening the argument around the current silo-based nature of research in these domains as well as discussing further why and how interdisciplinary research is valuable for this area of work. I propose placing both these sets of issues in the section 'for interdisciplinary research' (some are currently in the previous section). There may also be value in clarifying that in this context 'disciplines' are, I think, equated to areas of work (climate change, migration, health systems) as opposed to e.g. sociology, anthropology, clinical science etc. And then I suggest it would be helpful to: expand on the point that 'interdisciplinary' means 'a certain level of integration of knowledge, methods and/or ideas' (p.5), and to discuss more than the need for mixed methods; clarify why an interdisciplinary approach is better than a multidisciplinary one for this work (p.5); and deepen the point about the value of the focus on resilience and adaptive strategies in supporting interdisciplinary research (p.5)*

Thanks for this very pertinent comment. Following your recommendations, we have reviewed each section and introduced at the end of section 1, section 2 and section 4 how interdisciplinarity may be useful to address the current gaps regarding the elements we describe about climate change, migration and health systems resilience.

We have also included a few sentences to describe the importance of distinguishing interdisciplinary from multidisciplinary.

- *As well as explaining more of the detail of Table 1 and Figure 1. (As an aside, in Table 1 I would propose there would be value in thinking about health system software as more than staff training, essentially; relationships among staff within the system and with the public also matter, for example).*

A presentation and explanation have been provided in the article now.

- *In terms of the earlier sections of the paper I was not sure why the first section is titled 'climate migrants and health systems', as the focus is on health challenges rather than health systems.*

The subtitle of this section has been changed to "climate migrants and health challenges".

- *I also found that the logic and structure of the sections 'climate change in the global health context', and 'health systems resilience in the climate change context' made it difficult to*

follow the argument within them. In 'climate change in the global health context', this might be because the very tight referencing practice has overshadowed the argument.

We have reviewed the flow of this section, and the subtitle of this section has been changed to "climate migrants and health systems".

- *In 'health systems resilience in the climate change context', the linkage between the different points presented is not very clear (i.e. the argument connecting them).*

We have reviewed the flow of this section and changed its subtitle to emphasize the need to continue research on this concept, which is still a little too vague. The last section has been moved to become the first section on the need for interdisciplinarity.

- *Some other minor points for review in p.3: What is an heuristic literature review?*

A review of the non-systematic literature but which only includes useful articles on the subject and to develop our arguments. We made this clear in the correction.

- *How are the 10 papers that were identified in the PubMed search used in the text, or is the point here that only 10 papers were identified?*

Yes, the point is that only 10 articles have been published, which shows how little is still written on the subject and the most relevant are cited in our article

- *At the first mention, briefly clarify the significance of the Lancet Countdown for this paper.*

Thanks for this suggestion. We have clarified this significance in the text (p.7)

- *One final comment: given that this is a very closely argued piece, there would be value in some really close copy editing – as, for example, missing words in sentences, long sentences, and sentences that are phrased quite clumsily, hinder understanding.*

We had the latest version revised by a scientific editor, Donna Riley. However, for this re-submission, we have asked an additional native English speaker (Lara Schwarz) to review and edit the whole text.

Competing Interests: No competing interests were disclosed.

Comments on this article

Version 1

Author Response 22 Mar 2019

Ariadna Nebot, Independent Consultant, Pharmacist and Public Health Specialist, Paris, France

Answers to Lucy Gilson comments, who approved with Reservations

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- *For example, in the section on "Climate migrants and health systems" I am not sure what the authors are trying to do or say. It's a loose collection of thoughts to me at the moment. The first two paragraphs are about general impacts of climate change and migration and the authors are careful to not link them directly which is good. The next paragraph is about perception of migrants which is interesting and then the authors move into the Burkina Faso example where it is not clear if people have migrated at all.*

***** We have renamed this first section to better show that its objective is to set the scene for the relationship between climate migrants and health. We have made it clear that the people from Burkina Faso affected by Box 1 have been displaced by flooding, thank you for the comment.**

- *I think the topic is interesting and very relevant and one thing that might help to structure the article better, is to clarify whether the authors are interested in the effects of climate change on an individual's health (migrants) or a country's health system or both. This seems to be mixed up in the article. Table 1 and Figure 1 seems to sort of help with that, but they are not integrated in the text at all, they are just added at the end but should be central to the paper.*

***** we have tried to restructure the article to better show that what interests us is not so much the link between climate migrants and health but rather the link between climate migrants and health system because it has not yet been much addressed by research. We have added text to better integrate and explain Table 1 and Figure 1.**

- *Other comments: "The estimation that is most widely accepted is that over 200 million persons will be displaced globally by 2050 because of climate change 13, 15, 18". Inappropriate use of literature. McMichael et al. (2012) (13) actually says that 200 million is the figure most widely accepted and refers to Myers (2002) as the source of that figure, but also says that the empirical basis has been questioned. This is an important consideration that needs to be added here. The other two references are not needed then, except if they are given to support the notion of 'most widely accepted' in which case I would expect more studies.*

***** Thanks for this very relevant comment. Accordingly, and in order to avoid confusion, we have replaced the figure with empirical basis questioned by the following sentence: "the simple fact is that nobody really knows with any certainty what climate change will mean for human population distribution. Current estimates range between 25 million and 1 billion people by 2050." (Brown 2008) and we have also deleted the 2 references (15, 18) not necessary supporting the argument anymore.**

- *Box 1: Conclusion in the last sentence about perceptions of local populations needing to be enhanced does not follow from previous paragraphs. The authors would have to establish a disconnect between perceptions of climate change and flooding and results from a detection and attribution study in order to conclude that.*

*****Yes, thanks for this suggestion. We have just deleted the last sentence in order to clarify the disconnection suggested by the reviewer.**

- *Box 4 and the resilience section: These indicators seem to be for resilience and adaptation planning, not just for resilience. The concept of resilience seems to be important in the article but only got mentioned once in the second last section and there it gets mixed up with adaptation indicators. The Lancet Countdown Report gives some of them as "Adaptation Planning and Resilience for Health Indicators". Can you strengthen this part and explain better why this is an important consideration?*

***** Yes, thanks for this comment. It is correct that the Lancet Countdown indicator's section 2 refers to "adaptation, planning and resilience for health" and not only to resilience. The reason is of course that *adaptation* and *resilience* are directly related and this section 2 aims to put at the front the adaptation efforts to promote and achieve community resilience, as we can see in p.13 of the 2018 Lancet Countdown's report:**

"With the observed and future health impacts of climate change becoming increasingly evident, and emission trajectories committing the world to further warming, accelerated adaptation interventions are needed to safeguard populations' health. As the 2030 agenda shows, 45 strategies to improve community resilience are often linked to poverty reduction and broader socioeconomic development imperatives, creating the possibility of no regret scenarios".

However, in this same p.13, it is said that, although the 2018 Lancet Countdown report counts on improved indicators for this section, the community resilience is still few explored and that collected data give more insights in adaptation than in resilience,:

"The health sector should be at the forefront of adaptation efforts, ensuring health systems, hospitals, and clinics remain anchors of community resilience. This underrecognised, yet growing area of practice, is the focus of this section."

The data are incomplete, providing more insight into adaptation than resilience, and predominantly allow for process-based indicators."

Therefore, the authors of this paper considered some of these Lancet Countdown indicators as a good example to visibilise the still reductionist and uni-discipline approach of how *resilience* is interpreted. In order to make this intention more explicit, we have added this two-lines in p 7.

- *"The role of health systems in the context of targeting universal health coverage may be central to address these challenges." The authors speak about universal health coverage only once before and do not give any reason for this conclusion.*

**** We have added some clarifications to this sentence, p 9.**

- *How are health needs and health system resilience different between "climate change migrants" and other migrants that e.g. flee war? The authors state that they "face challenges similar to those of refugees fleeing war and/or political persecution" and "might experience many similar obstacles and barriers to their health as well", so why the need to study this topic separately?*

****Thanks for this comment. According to what we could find in the literature (and therefore, what is already documented) climate migrants health needs may share similar patterns to refugees and/or to rural-urban migrants (P.4). However, in this same paragraph, we also mention the additional vulnerability that this category of population may have: “In addition, environmental change migrant population is usually the most vulnerable as well because migration is often expensive and climate change factors can easily lie on the top of other strong socio-economic factor.”**

Considering this ‘additional vulnerability’, the author’s underlying hypothesis may be that climate migrants health needs and health system resilience may be slightly different. However, the non-integrated disciplines that can be looking at that doesn’t allow to further explore this specificities. We have modified the last statement of this paragraph in order to strengthen this idea: **“However, the lack of consensus of climate change migrant suggests how the same phenomenon is defined from different and non-integrated disciplines and, therefore, how climate change migrant health needs and patterns are still scarcely documented. “**

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