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7   18 June 2020

8   Dear Editorial Staff,

9

10   **Key opportunities and challenges for the use of big data in migration research and**
11   **policy**

12   I am writing to submit the above manuscript for consideration for publication in UCL Open:
13   Environment, as previously discussed with Ian Caswell and Professor Dan Osborn.

14   Migration is high on the global political agenda, with one billion people recorded as having
15   migrated in 2018 alone. Such levels of migration have great implications for global health,
16   the global development agenda and political discourse at all levels of society. Meeting the
17   needs of migrant populations requires accurate data on who is moving, where to and from,
18   and what is driving their movements. However, current information on migrant populations is
19   relatively scarce, leading to the UCL-Lancet Commission on Migration and Health to propose
20   'big data' (from mobile phone data to satellite data) as a potential solution to help address
21   these knowledge gaps.

22   In response to the Commission's call, we held a cross-disciplinary workshop in London, UK
23   in July 2019, bringing together UN representatives, humanitarian NGOs, policymakers and
24   academics to facilitate knowledge exchange and identify the key opportunities and
25   challenges for the implementation of big data in migration research. This workshop was
26   supported by a UCL Grand Challenges grant for projects focusing on migration and
27   displacement.

28   Here, we provide a summary of key discussion points and conclusions identified in the
29   workshop to assist migration experts in deciding whether the use of big data is appropriate
30   for their work. We also aim to stimulate discussion about the potential of this approach in
31   aiding future migration research and policy and the needs of migrant populations globally,
32   especially given ongoing high-level political narratives about migration, environmental
33   drivers, and migrant health. Furthermore, the workshop was a highly interdisciplinary event
34   and we take the opportunity to discuss how to develop further cross-disciplinary solutions to
35   migration research.

36   I confirm that I have agreement from all authors to submit this paper and that the manuscript
37   is not submitted elsewhere and is original.

38   I look forward to your response in due course.

39

40   Yours faithfully,

41

42   Dr Lydia Franklinos

Key opportunities and challenges for the use of big data in migration research and policy

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Abstract

Migration is one of the defining issues of the 21st century. Better data is required to improve understanding about how and why people are moving, target interventions and support evidence-based migration policy. Big data, defined as large, complex data from diverse sources, has been proposed as a solution to help address current gaps in knowledge. The authors participated in a workshop held in London, UK, in July 2019, that brought together experts from the UN, humanitarian NGOs, policy and academia to develop a better understanding of how big data could be used for migration research and policy. We identified six key areas regarding the application of big data in migration research and policy: accessing and utilising data; integrating data sources and knowledge; understanding

environmental drivers of migration; improving healthcare access for migrant populations; ethical and security concerns; and addressing political narratives. We advocate the need for increased cross-disciplinary collaborations to advance the use of big data in migration research whilst safeguarding vulnerable migrant communities.

Keywords

Big data; migration; cross-disciplinary research; policy; humanitarian; environment; displacement; climate change; health; data security.

Introduction

With the number of global refugees reaching the highest levels since the second World War (1) and one billion migrants recorded in 2018 alone (2), human migration is high on the global political agenda. The UCL-Lancet Commission on Migration and Health (2) and the UN Global Compact on Migration (3) have called for improved data to understand drivers of migration, target interventions and support evidence-based migration policy. The application of big data in migration research and policymaking has been proposed as a possible solution to help address these knowledge gaps (2,4). Big data refers to large, complex data from varied sources, ranging from social media and mobile phone data (Figure 1), to electronic health records and satellite data, and has the potential to provide new sources of information for migration research (5,6). Previous studies have used big data to predict patterns of human movement during natural disasters (7) and track movement in near real-time (8), quantify migration at national scales (9–13), guide and evaluate humanitarian interventions (14) and examine the effects of human movement on disease transmission (15). In addition, satellite-based earth observation data has been used to map the relationship between environmental change and human movement (16,17), model subnational migration flows (18) and inform policy decisions (17,19,20). Despite the immense opportunity big data can provide for migration research and policy, several challenges have hindered its widespread implementation (2,4).

In response to the call for increased collaboration (2) and improved research on ways to utilise big data sources in the field of migration (4), we participated in a cross-disciplinary workshop in London, UK 3rd July 2019, bringing together UN representatives, humanitarian NGOs, policymakers and academics to facilitate knowledge-exchange and identify the key opportunities and challenges for the implementation of big data in migration research. Here, we provide a summary of key discussion points identified in the workshop via presentations,

114 panel discussions and break-out groups in which participants explored different topics and
115 possible solutions. We provide major conclusions from the workshop to assist migration
116 experts in deciding whether the use of big data is appropriate for their work and to stimulate
117 discussion about the potential of this approach in aiding migration research and policy, and
118 the needs of migrant populations globally. In particular, the outcomes of this workshop may
119 provide a timely resource for the recently launched Lancet Migration, a global collaboration
120 of migration experts that aims to address evidence gaps and drive policy change in the field
121 (21).

122

Opportunities and challenges relating to big data

124 We identified six important topics for the application of big data in migration research and
125 policy which we summarise here and in Table 1.

Accessing and utilising big data

127 The first issue focused on the access, awareness and expertise required for big data use.
128 The application of big data is often hindered by the fact that many big data sources such as
129 mobile phones, internet-based platforms and other digital devices are managed by private
130 companies who collect the data for business purposes. Therefore, costs associated with
131 accessing big data and issues of ownership are significant barriers to its use (22). Big data
132 generation will vary geographically, and may be reduced in many high mobility contexts
133 where infrastructure (i.e., cell towers, wi-fi connection and electronic bank transfer services)
134 is less established. In addition, there are significant issues around the potential extraction of
135 sensitive information contained in big data (23,24) and data sources are often fragmentated
136 across disciplines which reduces the awareness of available datasets (25). Accounting for
137 multiple biases and the complex analyses required to interpret the data are further examples
138 of methodological difficulties associated with the use of big data (6,26).

139 Workshop discussions highlighted the importance of understanding how, why and when the
140 data were collected to identify potential gaps and biases, therefore ensuring it can be used
141 effectively. There is great need for more centralised repositories of data, projects and
142 publications as such as The Humanitarian Data Exchange (27), to promote knowledge-
143 sharing, collaborations and inform evidence-based programming. Increased partnerships
144 between governments, international agencies, civil society, and the private sector are also
145 required to improve data access and ensure the optimum exploitation of available data and
146 technologies. Furthermore, capacity building in countries or organisations with an interest in
147 big data analysis is needed to support cross-disciplinary research and improve specialist

148 knowledge in certain regions. This could be achieved via collaborations with relevant

149 partners and agencies such as demonstrated with the United Nations Economic Commission

150 for Europe's (UNECE) Big Data Sandbox which provided a platform for statistical

151 organisations to collaborate and learn to use big data analytics (28). However, there may be

152 ethical considerations for private-public partnerships. For example, published commentaries

153 have voiced fears over the partnership between the UN's World Food Programme and the

154 data analytics company Palantir which may have serious consequences for the privacy and

155 security of aid recipients due to the company's links to US intelligence agencies (29).

156

157 **Integrating data sources and knowledge**

158 The second topic concerned the integration of data and knowledge across disciplines. The

159 main source of data for migration statistics originates from traditional methods such as

160 household surveys recorded at local scales and national population estimates (Figure 2), as

161 well as data on forced displacement collected through key informant networks (4). Big data

162 sources have the potential to complement traditional data and address significant spatial and

163 temporal gaps via updating migration statistics in an accurate and low-cost way (4,10). For

164 example, analysis of mobile phone call detail records (CDRs) can be used to replicate

165 national internal migration statistics and complement outputs from censuses (10). However,

166 integrating migration data from traditional methods with varied sources of big data requires

167 new methodology that considers complex interactions over differing geographic and

168 temporal scales. Indeed, the slow adoption of big data analyses in the humanitarian sector is

169 partly due to a lack of expertise in how to apply these approaches in operational settings

170 (30). Workshop participants discussed the need to bridge the gap between experts on the

171 ground collecting the data via traditional methods and big data analysts via increased

172 transdisciplinary training and collaborations. A recent workshop hosted by the International

173 Organization for Migration (IOM) and the German Federal Foreign Office concluded that

174 "greater cooperation and engagement among stakeholders" both within and external to the

175 migration sector are required to inform decision making (31). If we are to integrate different

176 data sources effectively, a collaborative cross-disciplinary approach is required to ensure we

177 understand the data and how they can be used to deepen our understanding of the drivers

178 and impacts of migration. This approach is practiced in "Data Collaboratives"; collaborative

179 projects in which different sectors including private companies, research institutions, and

180 government agencies collaborate to enable data exchange and help solve public problems

181 (32). NetHope is an example of a Data Collaborative project which helped to integrate data

182 sources and produce maps of connectivity sites across Puerto Rico to assist in delivering aid

183 in the aftermath of Hurricane Maria (33).

184

Understanding environmental drivers of migration

186 The third topic considered the use of big data in informing environmental drivers of migration

187 such as natural disasters and climate change (34). Currently, there is no internationally

188 agreed definition for "environmental migrant'' despite it being required to collect long-term

189 data and guide the policies of governments and international agencies. The IOM have

190 proposed a broad working definition (35) which importantly considers that environmental

191 migration might be triggered both by sudden-onset disasters (36), such as earthquakes and

192 cyclones, and slower environmental change processes, such as desertification and sea-level

193 rise. In the context of slow-onset disasters and gradual environmental change, migration is

194 often difficult to quantify since it can be hidden behind more immediate socioeconomic

195 drivers such as poverty or political processes (37). Human mobility can improve resilience

196 and attenuate the negative outcomes of environmental degradation, but poverty, disability

197 and social exclusion may limit people's ability to resort to migration as an adaptation strategy

198 (38). When used in combination with traditional datasets, big data has the potential to

199 identify these vulnerable populations that are unable to migrate in response to environmental

200 change. Satellite data is a particularly valuable resource in migration analysis as it enables

201 the systematic, consistent and accurate monitoring of areas (even if remote or inaccessible)

202 that are affected by conflicts or by anthropic or natural hazards. Indeed, satellite-based

203 technologies are key to analysing climate change effects and predicting environmental-led

204 migration (39,40). This is particularly useful in contexts where administrative and health

205 records are lacking and there is limited mobile network or internet connection. However,

206 satellite data alone may not provide the spatial resolution required to capture needs, and

207 cannot reveal the lived experiences of migrants required to inform actions. In this case,

208 satellite data can be combined with traditional datasets to identify the location of internally

209 displaced people, as performed by IOM's Displacement Tracking Matrix in response to

210 flooding in South Sudan in 2019 (41). One of the most valuable aspects of satellite-based

211 analyses is the capability for retrospective analysis which is required to detect changing

212 patterns across space and time and to inform predictions. However, a recent review stated

213 that current initiatives do not exploit the full possibilities of satellite-based earth observation

214 in migration with a lack of services offering the systematic flow of detailed information to

215 researchers, managers and migration analysts (42). One of the main gaps identified was that

216 currently consolidated satellite-based monitoring systems work at regional scales which it is

217 often too coarse to understand the specificities of particular communities, thus unable to
218 inform sub-national policies design, implementation and monitoring.

219

220 **Improving healthcare access for migrant populations**

221 A fourth area of discussion focussed on the potential for big data to improve migrant health
222 via identification of vulnerable groups, increased access to healthcare and in informing
223 evidence-based health interventions. Often there is limited information on undocumented
224 migrants and vulnerable groups (i.e., unaccompanied children, people with disabilities and
225 members of the LGBTI community) in traditional datasets such as semi-structured
226 interviews and surveys (2). Discussions focused on whether big data could provide
227 information about these groups, their health and differing healthcare needs. In addition, it
228 was suggested that the healthcare needs of migrants settled in countries such as the UK
229 could also be improved by big data analysis, for example via a general migrant longitudinal
230 study such as the cohort studies performed by the UK Economic and Social Research
231 Council (42). A further question focused on the potential for big data to support on-the-
232 ground activities, helping to address the immediate health needs of displaced persons and to
233 predict potential disease outbreaks. During an Ebola virus disease outbreak in the
234 Democratic Republic of Congo, IOM employed Flow Monitoring Registry surveys to gather
235 anonymous information about people on the move at key transit points to inform public
236 health interventions (43). Using this system, hundreds of thousands of individual journeys
237 were tracked, making the datasets a hybrid between traditional randomised surveys and big
238 data. There are also potential applications for big data in implementing evidence-based
239 health interventions that need to be explored, specifically in informing cost-benefit analysis
240 and analysis of intervention effectiveness.

241

242 **Ethical, privacy and security concerns**

243 The fifth topic focussed on ethical, privacy and security concerns regarding the use of big data
244 in migration research. The collection of personal data including migrant status is a contentious
245 issue. There are concerns that information on personal migration status may create or
246 increase existing discriminatory practices in society such as provision of healthcare and
247 access to state funds, or that mobile tracking devices may be used against a migrant to forcibly
248 return them to a previous location (2). Ethics in the context of big data in migration may be
249 considered in several ways. First, it may relate to the way in which the research is conducted
250 and whether there has been consideration for data privacy and security. Secondly, it could

251 refer to decision-making regarding migrants with consideration for their lived experience,
252 especially in humanitarian situations. A recent report on migration noted that discussions on
253 ethics often focus on the legal aspects of data protection rather than understanding how the
254 results of analyses may detrimentally impact affected populations and counter the
255 humanitarian principles to "do no harm" (31). Furthermore, data protection measures are often
256 focussed on personal data (e.g. General Data Protection Regulation in EU) and do not
257 consider group data protection needed to work with vulnerable groups (44).

258 It is important to consider who benefits from the use of big data sources in migration research.
259 At the individual level, migrants may not wish for additional data to be gathered about them
260 and may perceive no benefits of the process (45). However, at the community level, such data
261 and analysis may help to address the health needs of migrants more generally. Certainly,
262 there will be benefits to the academic community seeking to study migrant health needs and
263 to decision-makers seeking evidence-based solutions. Pursuit of these research and policy
264 goals can result in overlooking the individual rights and raise ethical issues for many
265 vulnerable people (45). Furthermore, forcibly displaced people fleeing persecution may have
266 little trust in authorities and therefore be less willing to seek healthcare or consent to having
267 their data collected. This creates a barrier for healthcare professionals, humanitarian workers
268 and researchers who wish to respect the rights of the individual, whilst deriving a better
269 understanding of migration pathways and healthcare needs. Workshop discussions
270 highlighted the power imbalance between various parties involved; those seeking data
271 including governments and academics (often from the Global North with inherent biases and
272 power), and those the data is being sought from who are often vulnerable persons in
273 precarious or dangerous situations, many originating in the less represented Global South
274 (46). Even with applying advanced safeguarding practices and aggregated outputs,
275 researchers may still be reluctant to apply big data analysis for migration research as policy-
276 makers often tend to have their own agendas and may use the methods and deliverables in
277 ways not intended or anticipated by the research authors.

278

Addressing political narratives

280 The final topic concerned the role of big data in high level political narratives around migration.
281 With ongoing antimigrant rhetoric existing at all levels of government and society, migrant
282 research has the opportunity and mandate to address such political narratives. There are
283 many examples of authorities treating migrants as political pawns or as statistical figures (47).
284 Therefore, it is imperative that big data is not used to further discriminate against migrant
285 communities or to target certain populations, but rather to support inclusive and fair migration

286 governance. An example discussed within the workshop was the Sentinel project which is an
287 NGO that works to gather and disseminate trusted information to local people and
288 governments in order to counter the spread of misinformation, antimigrant rhetoric and prevent
289 resultant hate crime and genocides (48). Participants also deliberated whether the increased
290 evidence provided by big data would be instructive and powerful enough to overcome political
291 and social biases associated with the topic. Given the highly political nature and high stakes
292 of migration policy for governments and the international community, more evidence may
293 alone be insufficient to achieve multilateral, progressive action. It is worth therefore
294 considering other factors contributing to the political discourse and designing strong, cross-
295 disciplinary communication tactics to support maximum impact of evidence. Furthermore, it is
296 worth considering how paucity in migration data has helped to shape public and media
297 perceptions of global migration patterns to date, and whether big data could be used to
298 address these perceptions.

299

Discussion

301 The application of big data in migrant research shows much promise in addressing the current
302 gaps in knowledge. Big data sources can help to update internal migration statistics by
303 addressing the significant gaps in quantity and quality of data collected from traditional
304 methods (4,10). When combined with field-level data derived from household surveys and
305 key-informant networks, big data can be used to detect how sudden onset natural disasters
306 and gradual environmental change (e.g. desertification and sea-level rise associated with
307 climate change) impact migration patterns. This can help to inform planning and scenario
308 building, as well as contributing to a more comprehensive definition of "environmental migrant"
309 which is critical for migration policy with in the context of ongoing environmental change. In
310 addition, it has a potential application in considering the differing healthcare needs of migrants
311 as well as identifying vulnerable populations unable to migrate due to environmental change.
312 There is also scope for big data to inform evidence-based health interventions for migrant
313 populations in everyday and emergency (including displacement) settings. Yet despite the
314 vast opportunities that big data present, there are some important areas to consider before
315 using these varied and complex data sources. Increased cross-disciplinary partnerships are
316 required to improve data access, knowledge-sharing and capacity building across sectors and
317 regions. In addition, a collaborative cross-disciplinary approach is required to ensure the
318 different datasets are understood and to develop new methodologies to integrate data sources
319 and identify complex interactions that influence how and why people are moving. Furthermore,
320 the reported lack of agreement within the humanitarian sector on how migration modelling

321 should be applied needs to be addressed so analyses can be effective (31). International
322 legislation is required to sufficiently address how migrant data should be collected and used
323 to ensure ethical conduct by data gatherers and owners and the safeguarding of human rights,
324 even in sensitive migration contexts (49). The United Nations Development Group (49) and
325 Office for the Coordination of Humanitarian Affairs (50) provide guidelines for safe and ethical
326 data management in humanitarian situations however, there is no legal enforcement of these
327 practices. Although researchers would like quicker and easier access to data, workshop
328 discussions challenged whether the process should be hastened, suggesting that
329 administrative obstacles force researchers to duly consider whether additional data is
330 necessary and beneficial to the current state of knowledge, given the risks and trade-offs that
331 must be made. A key output of the workshop was a consensus that researchers and decision-
332 makers must first ask why they require additional data and whether this is what all parties,
333 particularly migrants, would want. As well as data protection issues, it is also imperative to
334 understand the potential harmful impact of analyses on vulnerable migrant populations (31).
335 It is especially important that big data is not used to further discriminate or target migrant
336 populations considering current antimigrant political narratives.

337 In pursuit of cross-disciplinary collaboration, the workshop brought together a range of
338 representatives from the UN, government, humanitarian agents and academics from a range
339 of backgrounds. Cross-sector engagement in the workshop was difficult to achieve which
340 may be due to differences in the objectives of different sectors, as well as the language of
341 engagement used. We trialled different methods to stimulate interdisciplinary work including
342 the use of business canvases (51) to explore and present solutions to questions. This
343 approach was useful for stimulating debate within the groups and producing well-considered
344 outputs. However, future interdisciplinary events would benefit from the development of
345 methods that consider the language styles and information sharing techniques of different
346 disciplines and thus facilitate effective communication and knowledge-sharing (4,31,52,53).
347 Overall, the workshop highlighted the benefits of cross-disciplinary work, enabling the
348 identification of key topics from a variety of angles and providing meaningful and effective
349 outputs. Furthermore, we hope this workshop assists in cultivating a future transdisciplinary
350 approach to migration research, whereby there is a move beyond the collaboration of
351 individual disciplinary perspectives to develop curriculum integration that organises
352 knowledge production in the context of real-world problems (54).

353

354 **Table 1.** Opportunities and challenges for the use of big data in migration research and
355 policy.

| Topics	Key research and policy questions
Accessing and utilising big data	How can we improve access to big data sources? How can we enhance awareness of available data? How can we develop the expertise required to use big data across disciplines?
Integrating data sources and knowledge	How can we produce more detailed and recent migration statistics using big data? How can we best integrate data from different sources? How do we manage fragmented data sources across varied spatial and temporal scales? How can we develop a collaborative cross-disciplinary approach to address the challenges in the field of migration?
Understanding environmental drivers of migration	How can big data be used to assess the ongoing impact of climate change on migration? Can big data help to identify populations that are vulnerable to environmental change? How can big data be used to predict mass migration events due to environmental change?
Improving healthcare access for migrant populations	How can big data be used to address the immediate health needs of displaced persons in camps? How can big data help us learn more about undocumented migrants, their health and healthcare needs? How can big data be used to implement evidence-based health interventions; e.g. cost-benefit analysis, analysis of intervention effectiveness?
Ethical, privacy and security concerns	What is meant by ethics in the context of big data in migration research? Who benefits from the use of big data (migrants at individual or community level, academic community, policymakers)? How do power imbalances influence the use of big data? How can we achieve ethical data usage?
Addressing political narratives	How can we prevent the use of big data for the discrimination of certain populations? What role could big data have in addressing the negative political narratives around migration?

356

357 **Figure 1. Key statistical indicators for global big data use**. The number of users and
358 portion of the population that has access (penetration) to the internet, mobile phones, social
359 media and mobile social media. Data were accessed via the Global Digital Report 2019 (55).

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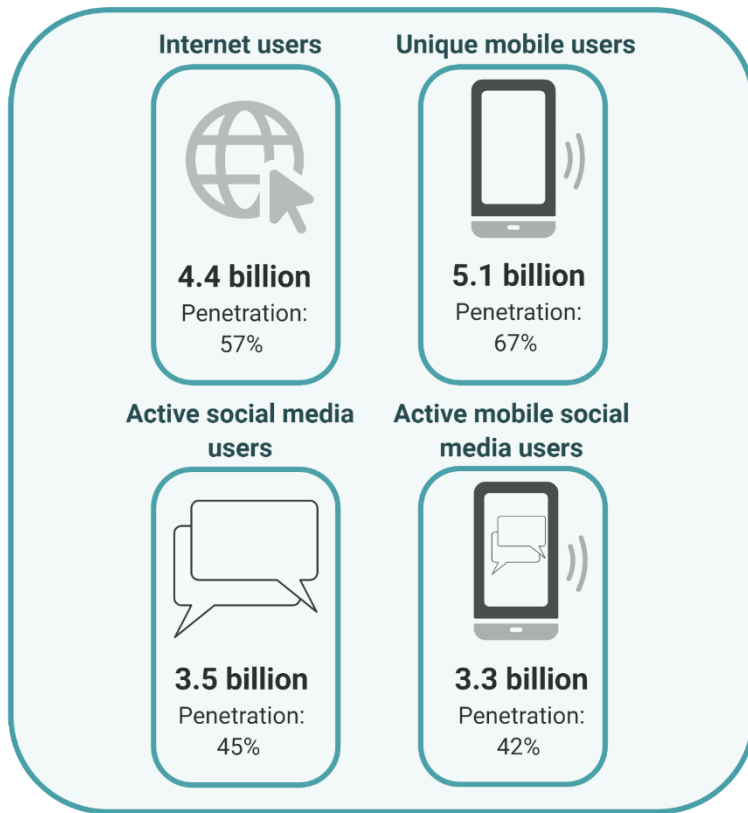
Figure 2. Net number of international migrants (both sexes combined) by global subregion 2015-2020 (thousands). The net number of migrants varies from -6,490,000 in Southern Asia (dark blue) to 5,982,000 in North America (yellow). Data were accessed via the UN Department of Economic and Social Affairs, Population Division database (56).
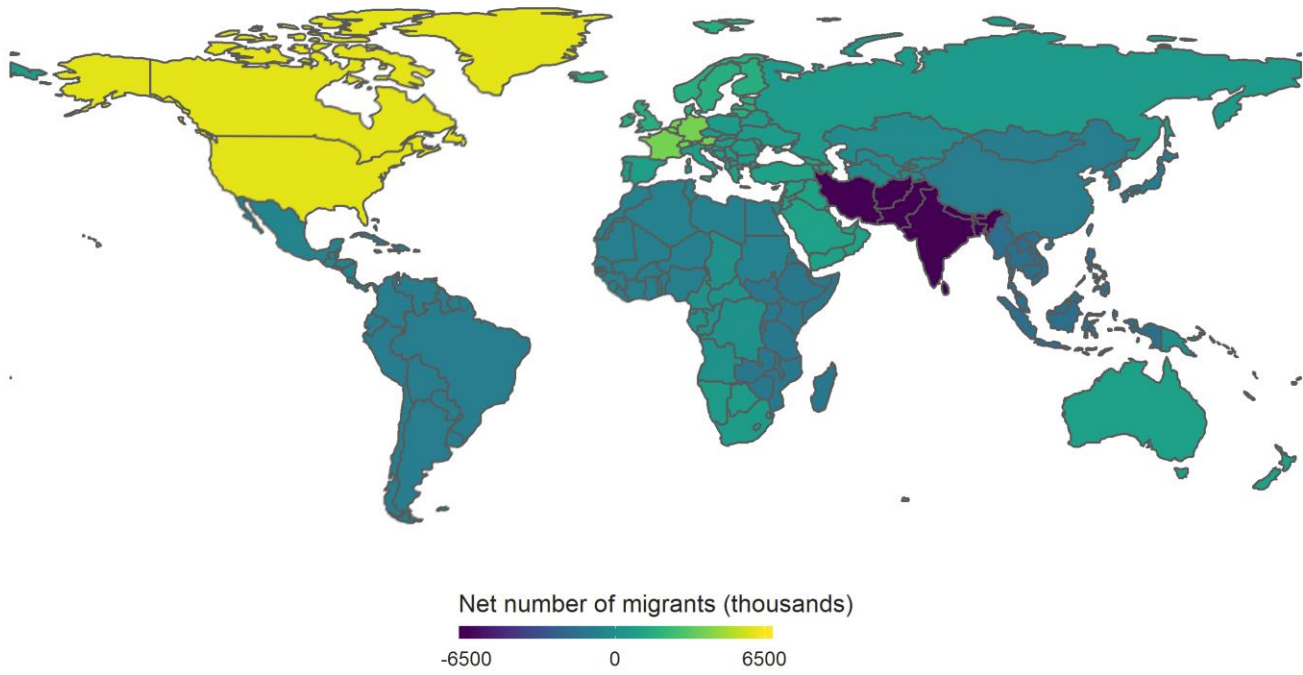
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Author contributions

LF and RP led the workshop and took the lead role in writing the report. All authors participated in discussion sessions at the workshop and contributed to the report. Authors 3–10 are listed alphabetically.

Declarations and conflicts of interest

All other authors declare no conflicts of interest in connection to this article.

Open data and data availability

No further data were used in addition to referenced works.

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