



HUMAN MIGRATION AND NATURAL RESOURCES

Global Assessment of an adaptive complex system

Summary for Policymakers

© **2023 United Nations Environment Programme**

ISBN: 978-92-807-4028-8

Job number: DTI/2526/PA

This publication may be reproduced in whole or in part and in any form for educational or non-profit services without special permission from the copyright holder, provided acknowledgement of the source is made. The United Nations Environment Programme would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme. Applications for such permission, with a statement of the purpose and extent of the reproduction, should be addressed to the Director, Communication Division, United Nations Environment Programme, unep-communication-director@un.org.

Disclaimers

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Mention of a commercial company or product in this document does not imply endorsement by the United Nations Environment Programme or the authors. The use of information from this document for publicity or advertising is not permitted. Trademark names and symbols are used in an editorial fashion with no intention on infringement of trademark or copyright laws.

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the United Nations Environment Programme. We regret any errors or omissions that may have been unwittingly made.

© Maps, photos and illustrations as specified

Photo cover: Somalia © Amors photos/ Shutterstock.com

Suggested citation: United Nations Environment Programme (2023). Human Migration and Natural Resources: Global assessment of an adaptive complex system. Nairobi, Kenya.

Production: UNESCO

<https://www.resourcepanel.org/reports/human-migration-and-natural-resources>

Acknowledgement

Lead Authors: Saleem H. Ali, Dominic Kniveton and Riyanti Djalante.

Contributing Authors: Sonja Ayeb-Karlsson, Michael Brottrager, Oli Brown, Jesus Crespo Cuaresma, Martin Clifford, Kyle Davis, Gemma Hayward, Noam Levin, Kopo Oromeng, Jamon Van Den Hoek, Caroline Zickgraf, Jonas Bergmann, Pablo Escribano, Ilan Kelman, Christopher Schulz, Jamie Skinner.

Research assistance, feedback and data: Sophie Bernier, Sofie Bouteligier, Kimberly Cochran, Jeff Herrick, Andrea Hinwood, Luca Marmo, Merlyn Van Voore, Steven Stone, Elisa Tonda, colleagues from the International Organization for Migration and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

This report was written under the auspices of the International Resource Panel (IRP) of the United Nations Environment Programme (UNEP). Thanks are extended to Janez Potocnik and Izabella Teixeira, co-chairs of the IRP, and the members of the IRP and its Steering Committee.

The authors are thankful to the Review Editor, IRP member, Mark Swilling for his leadership and support in the external review process. They are also grateful for the External Expert Review provided by Basak Yavcan, Nichole Barger, Irene Schoefberger, Sophie de Bruin, Atle Solberg, Sana Essaber Jouini, Ingrid Boas, Ricardo Safra de Campos, Tasneem Siddiqui, Bina Desai, Pierre Lacroix, Nathalie Guillaume and other anonymous expert reviewers.

The authors are grateful to the Secretariat of the International Resource Panel hosted by the United Nations Environment Programme, and to Christina Bodouroglou and Vira Khoroshavina in particular, for the coordination and technical support provided for the preparation of this report.



International
Resource
Panel

HUMAN MIGRATION AND NATURAL RESOURCES

Global Assessment of an adaptive complex system

Summary for Policymakers

Prepared by the International Resource Panel

This Document highlights key findings from the full report of the same title and should be read in conjunction with it. References to research and reviews on which this report is based are listed in the full report. The full report can be downloaded at: <https://www.resourcepanel.org/reports/human-migration-and-natural-resources>

Preface

Availability, access to and use of natural resources are key intervening variables for understanding, analysing and managing local or global relationships between climatic or environmental changes and population distribution and movements. While much debate and research has focused on the effect of climate change on migration worldwide, surprisingly little attention has been paid to the role and governance of natural resources in this relationship.

Since 2007 the International Resource Panel has provided independent, authoritative and policy-relevant scientific assessments on the status, trends and future state of natural resources. This report opens a discussion about the natural resource nexus with human mobility, using an integrative approach that considers multiple causalities and networks of interaction. The research in this report, which involved qualitative and quantitative methods, shows that the relationship between natural resources and migration calls for a consideration of human-environment interactions as a complex adaptive system.

This report finds that natural resources have a significant impact on human mobility, but that the relationships are not linear. They can both mitigate or exacerbate involuntary migration, depending on specific ecological and economic constraints. Natural resources act as an intervening pathway between environmental change, climate change and human mobility. Hydropower

projects represent the most direct connection between natural resource development and involuntary migration, and their expansion as a cleaner source of power generation in the years to come will need to be carefully managed. As an example of such complexity, mineral rushes can accentuate localized migration but may reduce voluntary international migration.

The impact of refugee camps on resource use and degradation was studied using geospatial analysis. The negative impact was found to be minimal and, in some cases, areas were restored for the purposes of food production. As the impact of sea-level rises on migration has been examined in previous work by development agencies, this report focused instead on other environmental variables that have a direct resource linkage (while also considering policy interventions such as “managed retreat” from coastal areas). Based on scientific findings, the report advocates for a complex adaptive systems approach to policy interventions. These should consider sociopsychological, financial and demographic factors that mediate natural resource-(im) mobility pathways. The report further identifies efficient policies within the resource-mobility nexus such as: land ownership and tenure rights and migrant remittances (including “green remittance bonds”) as a way to manage the resource-mobility nexus more effectively for better ecological and economic outcomes. The report calls on policymakers to recognize the need for monitoring resource security areas with vulnerable human populations.

The lead authors and their teams have succeeded in drawing together an evidence base that proves the need for managing the intersection between resources and mobility.

The report recognizes that the recent war in Ukraine, and earlier wars and crises in the past decade, demonstrate the lack of a global governance system for migration. Although the Global Compact for Safe Orderly and Regular Migration could serve as a policymaking framework for managing the intersection between resources and mobility, it needs further development if it is to offer more formal mechanisms for international engagement that take account of differences in natural and cultural environments.



Izabella Teixeira
Co-Chair
International
Resource Panel



Janez Potočnik
Co-Chair
International
Resource Panel



10 KEY MESSAGES IN BRIEF

Policymakers should recognize the complexity of the resource-migration nexus and the need for monitoring resource security areas with vulnerable human populations. Current crises in Ukraine, Venezuela, Afghanistan and the Middle East have led to a focus on forced displacement. While such tragic episodes can have a resource nexus as well, they are part of a much wider range of human mobility phenomena that can have negative as well as positive outcomes for human development. Resource abundance can attract immigration; resource scarcity can either trap populations or lead to emigration, where that is possible. This assessment considers all these aspects of the resource nexus with human mobility. The following 10 key messages have arisen from the analysis:

1

Natural resources mediate the impacts between global environmental change and human mobility dynamics. However, the relationship is not linear and can be bidirectional. Human migrations have occurred for much of the history of the species. Policy interventions linking climate change and migration need to distinguish between voluntary aspects of adaptive migration and forced displacement as a result of disasters and rising sea levels.

2

Natural resources policies that affect mobility should be aligned to increase resilience of population to avoid migrating or to do so safely if needed. The first aim should be to enhance adaptation potential, sustainability of resources and socioeconomic and environmental resilience so that resource pressures do not force people to move. When this cannot be ensured, the second aim should be to promote the safe and well-managed movement of people to other locations.

3

Land ownership and tenure over resources can mitigate forced migration, while also facilitating greater opportunity for voluntary mobility. Property rights to resources can create resilience for populations in times of natural systems stress and may prevent involuntary migration. However, such tenure can also facilitate greater mobility and hybrid livelihood situations where one family member may move temporarily for supplemental income.

4

Resource rushes are often accompanied by relatively rapid internal movement of population and abrupt land-use changes for the purposes of settlement establishment and mineral extraction. Such rushes are typically characterized by trade-offs between improved socioeconomic outcomes for migrants (and local communities) and widespread environmental externalities. Policies to address rushes need to be calibrated around such trade-offs.

5

Impact of droughts on migration is highly dependent on local income. Using episodes of drought as an indicator of land resource stress, throughout Africa internal mobility increases with natural resource stress. However, for the relatively richer African countries, drought is associated with increased international mobility. This contrasts with the finding that, for poorer countries, drought is associated with decreased international mobility and poverty traps, indicating liquidity constraints on this type of mobility.

6

Reductions in soil carbon are not significantly related to mobility flows. According to quantitative analysis of data sets linking ecological indicators and migration flows in Africa, soil carbon is impacted by a variety of fire ecology factors that offset any link to migration flows.

7

Hydropower infrastructure is the most direct example of a link between resource development and involuntary migration. Globally, the top 200 recent hydropower developments (2000-2018) are estimated to have displaced between 900,000 and 2 million people (mostly in Asia), as well as giving rise to substantial land-use change since the start of the century. This has been despite the work of the World Commission on Dams, which in 2001 published its findings on the prior century of social disruptions caused by dams and the need for reform.

8

The establishment of refugee camps is associated with rapid land-use changes. However, the activities of camp inhabitants (such as fuelwood gathering or subsistence farming) often constitute productive land use in and around the camp where access and use are permitted. Policies related to refugee encampment choice and resettlement should consider how socioeconomic vulnerability, freedom of movement and host community relations all impact natural resource access.

9

Incorporating systems mapping into policy intervention planning could help visualize trigger points and areas in need of support. Systems maps highlight factors that can trigger policy interventions to reduce the link between natural resource shocks and forced or undesirable mobility or immobility. Such systems mapping practices could be used by organizations working on early warning assessment.

10

Migrant remittances to home countries can be leveraged for natural resource restoration efforts. The economic value of migrant remittances to vulnerable resource-stressed countries can be a useful way of promoting policy innovations such as “green remittance bonds”. A systems approach to the positive feedback loops of migration would be one example of such interventions.





INTRODUCTION

The relationship between natural resources and migration requires a consideration of human-environment interactions as a complex adaptive system. Key properties of such systems suggest that a direct causal relationships between resource scarcity and human mobility will remain elusive. Resources can be an intervening variable between global environmental change, including climate change, and human mobility. This means that resource scarcity measurements can provide an early warning on the possible impact of global change on proximate indicators of migration. An abundance or scarcity of minerals, arable land, water and energy delivery are key resource drivers of human mobility. Property rights to these resources, as well as opportunities for international migrant remittance flows, can be key determinants of migrant decision-making.

Migration has been an adaptive human response and is increasingly considered a right within national jurisdictions, and in some cases also across international borders. Policymakers should recognize the complexity of the resource-migration nexus and the need for monitoring resource security areas with vulnerable human populations (for example, the Sahelian regions of sub-Saharan Africa, parts of Central and South America, and Small Island Developing States (SIDS), which are all the subject of case studies in the main report). Resource abundance can attract immigration, while resource scarcity can either trap populations or lead to emigration (where this is possible). Natural hazards and associated disasters can trigger disruptive changes and an adaptive capacity in human populations. As such disasters become more frequent alongside global environmental change, international governance mechanisms for human mobility need to account for the dynamic nature of resource constraints.

Like climate change, variations in resource quality, availability and access can exacerbate pre-existing vulnerabilities and inequalities. Mobility linked to resources can therefore be understood as part of a wider framework of vulnerability. A community's vulnerability determines the extent to which it is affected by environmental hazards. For example, flooding events have a very different impact in the Netherlands, which has the resources and expertise to invest in appropriate infrastructure and contingency planning, compared to Bangladesh, where the outcomes are much more detrimental. Vulnerability is described as the state of susceptibility to harm from exposure to stresses associated with environmental change and from the lack of capacity to adapt to those stresses.¹ The Intergovernmental Panel on Climate Change (IPCC) (2014) suggests that the phenomenon of trapped populations arises when vulnerability is greater than people's ability to move (see Figure 1).

¹ Adger, W. Neil. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281.

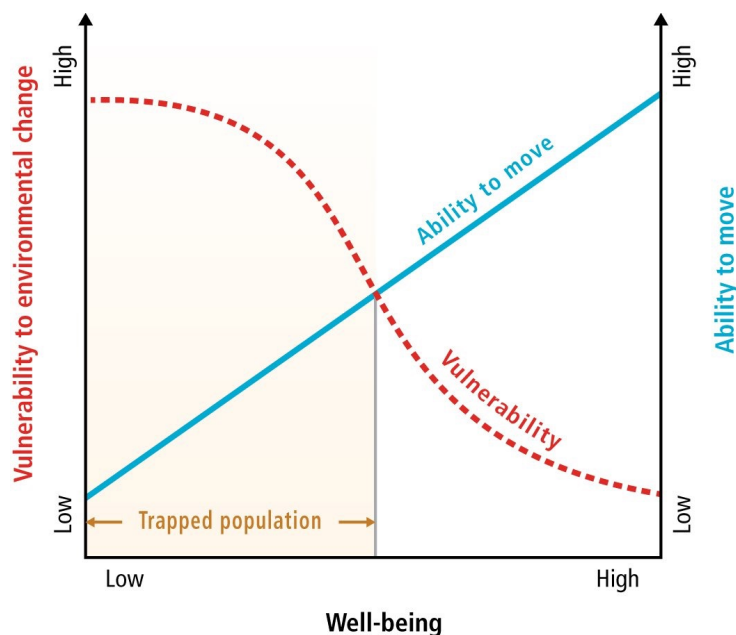


Figure 1: Relationship between well-being and vulnerability and trapped population phenomenon (IPCC, 2014)

While there is no universal linear relationship between natural resources and human mobility, various studies have identified mechanisms through which resource dependence and vulnerability to slow-onset environmental change influence the likelihood of more voluntary forms of migration. Reliance on natural resources can increase the vulnerability of a community, household or individual, but operates in conjunction with other factors. For example, there is some evidence that vulnerability and the probability of migration among individuals in West Africa are influenced by the extent of their dependence on natural resources, their socioeconomic status and their demographic characteristics.² In fact, much of the literature on human mobility in response to slow-onset changes cites the importance of natural resource-dependent livelihoods in explaining the vulnerability of rural and urban populations, thereby demonstrating the links between climate change, economic and environmental drivers of mobility.

² Gemenne, F. et al. (2017). Climate change, natural disasters and population displacements in West Africa. *Geo-Eco-Trop*, 41(3), 317–337.

Although urbanization and rural-urban migration trends have dominated global human mobility (as also demonstrated in the *Weight of Cities* report by the International Resource Panel (IRP)), the direct link between that mobility and resources is tenuous. Economic and educational opportunities and wealth clusters account for many of these trends. Ethnographic network mapping and interviews have shown the potential indirect connections with resources in these contexts. Urban migrants also circulate back to rural areas at different times of the year and at certain life stages.

In 2015, the destination of most international migrants was in their continent of origin, except for Oceania, where 56% of the outward flows of people are destined for Asia (see Figures 2 and 3). In Africa and Asia, 76% and 75% of migrant flows, respectively, remained within the same continent. This indicates that cost considerations affecting mobility decisions may be a limiting factor for intercontinental movement. Asia and Europe were the most mobile regions in 2015, with over 30 million and 20 million people, respectively, moving from and within each region. Intercontinental flows were significant in Europe and the Americas, which received 14 million and 9 million people, respectively, from other continents. There is a need for yearly series datasets of mobility flows that might reveal long-term trends, convergences and regions of stability or volatility.

Options for “moving” include effectively managing resources that may “pull” people towards them, as well as movement of people away from areas of resource limitations, in the form of resettlement from one country to another, and “managed retreat” of populations away from vulnerable areas. This applies to the Netherlands, low-lying coastal regions and small island States, both within and across national borders. Conceptually, “mobility justice” and resource-linked “climate reparations”, particularly for Small Island Developing States (SIDS), may provide guiding principles for future approaches to the resources-mobility nexus.³ The Global Compact for Safe, Orderly and Regular Migration could provide a policymaking framework for managing the intersection between resources and mobility. The Platform on Disaster Displacement also has the potential to have resource-linked early warning mechanisms incorporated within its implementation plan.

For mobility that is related to resources, a systems approach and related adaptive planning framework, with continuous monitoring of a range of data and thresholds, should be adopted. Policymakers need to be flexible in their decision-making approaches and be informed by systems planning frameworks that are underpinned by empirical evidence. Such data could be used to generate scenarios that can be considered through an assessment process involving multiple criteria and a consultative process with community members to generate contingency plans for voluntary and involuntary mobility.

³ Sheller, M. (2018). *Mobility Justice: The Politics of Movement in an Age of Extremes*. Verso.

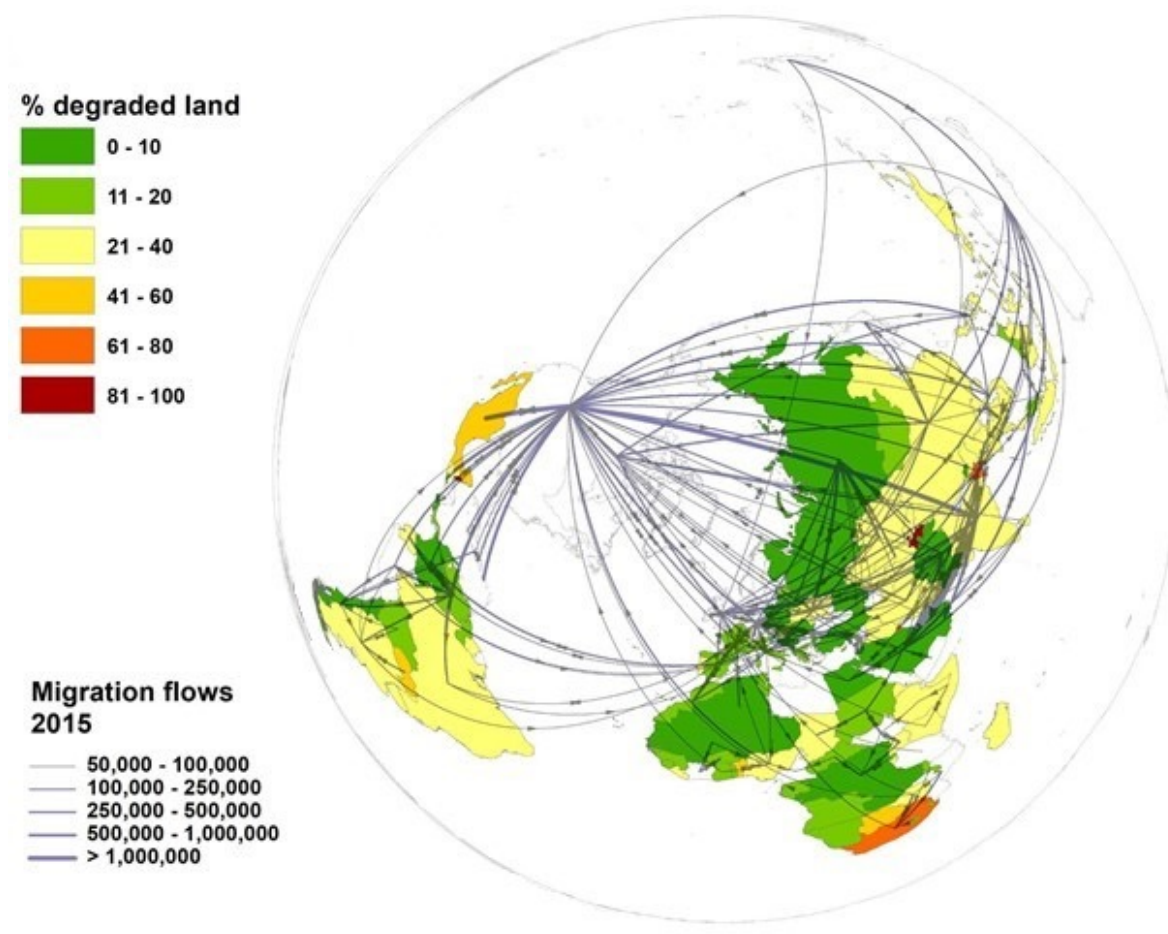


Figure 2: Global bilateral mobility flows for 2015, based on Abel and Sander (2014) and Azose and Raftery (2018)

Note: Flows are shown if they are greater than 50,000 people. Sustainable Development Goal 15, indicator 3.1 - the percentage of degraded land is mapped, which incorporates subindicators of land productivity, land use and land cover change, and carbon stock above and below ground for 2015. Degraded land is based on changes in land cover, productivity and carbon stocks relative to the baseline year (2000), and is where there is a negative change relative to previous conditions. Countries shown in white have unreported data for SDG Indicator 15.3.1.

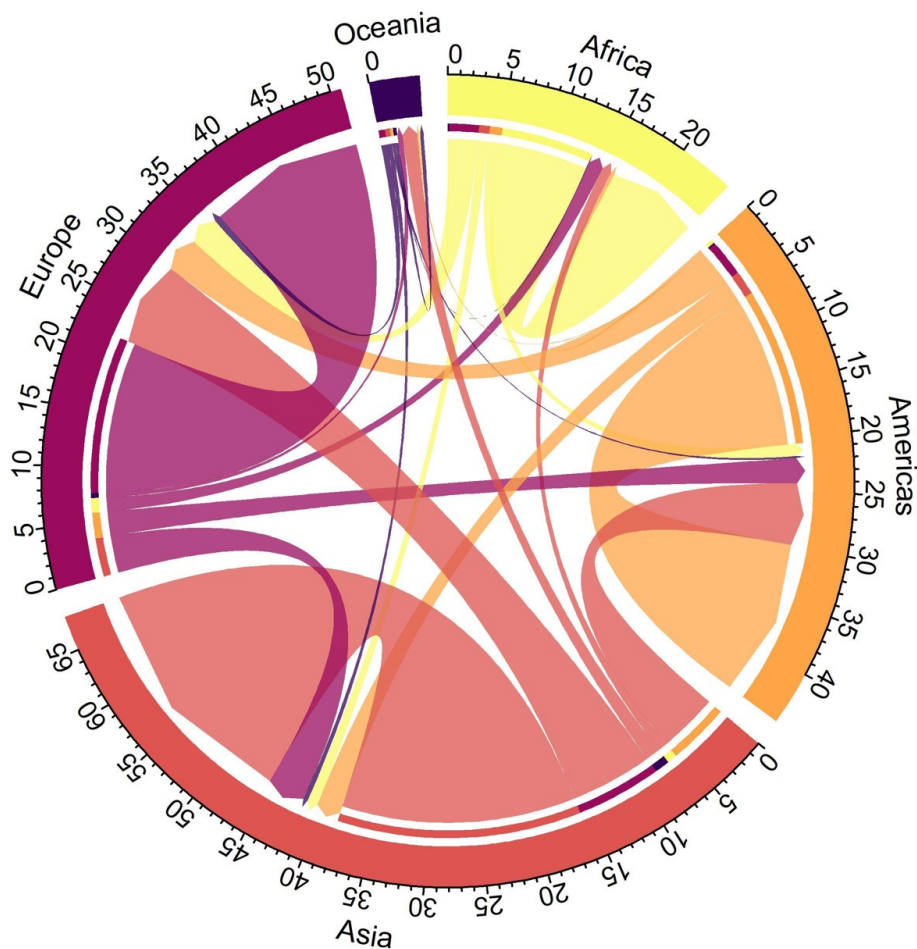


Figure 3: International mobility flows for 2015, based on Abel and Cohen (2019)

Note: The flows in this figure represent an estimated total of 95.8 million international migrants. Units are in millions of people. Arrows are coloured based on the continent of origin and point toward the destination continent. Arrow heads correspond to the volume of movement. This figure emphasizes that most migrations take place within continents and that for inter-continental movement, Asia was the source for most migrations, and Europe the destination.

KEY MESSAGES



1. The mediating role of resources in migration policy

The idea of “environmental mobility” as a result of natural disasters (“rapid change” events) and/or more gradual environmental perturbations (“slow onset” changes) is becoming increasingly familiar within policymaking circles and in the popular imagination. When considered without nuance, observed or predicted environmental changes have been used to create some alarmist projections about the potential scale of movement of people, typically from poorer to richer parts of the globe (see Chapter 2). This can feed into (often negative) broader civic and political discussions around migration. There has been an emergence of more in-depth appreciation of how environmental changes and resource pressures might influence migration since the turn of the millennium. However, the depletion and degradation of various resources and ecosystem services across the world are nonetheless expected to influence migration trends even more significantly in the coming century.

According to this survey of the existing research and data from a review of contemporary literature, geospatial and modeling data and a systems presentation of mobility

influences based on ethnographic data, connections between climate change, resource degradation and movement of people are far from linear. In other words, more change does not necessarily equate to more movement. Messages that make simplistic assumptions tend to subvert the growing body of empirical studies that point to both the multi-causal nature of migration and the indirect, “messier” link between environmental changes and the motivation for and levels of mobility. The dynamics - forms, drivers, processes and impacts - surrounding migration and resources are extremely multifaceted. Unsurprisingly, the relationships between them are also extremely complex.

Such complex and interconnected relationships certainly influence the different “types” of mobility/ migration, including whether people move permanently or temporarily, internally or internationally, and whether this mobility is “chosen” or “forced”. There can also be outcomes that seem counterintuitive at first glance, such as the rejection of migration by the citizens of environmentally threatened Small Island Developing States (SIDS), low mobility from other environmentally vulnerable regions as populations become “trapped” or the ability of migration to actually improve resources in areas of both outwards and inwards migration.

The dynamics - forms, drivers, processes and impacts - surrounding migration and resources are extremely multifaceted. Unsurprisingly, the relationships between them are also extremely complex



© Sntes/Shutterstock.com

2. Refugee camps and resource dynamics

By the end of 2020, 82.4 million people had been forcibly displaced by conflict, war and persecution, the highest recorded number since 1990.⁴ While approximately 78% of the world's refugees live in urban areas; the remaining 22% live in camps managed by the host country in conjunction with the Office of the United Nations High Commissioner for Refugees (UNHCR). Camps provide humanitarian relief, critical aid and essentials of food, water and shelter for refugees fleeing violence in their home countries, and such camps expand rapidly with refugee arrivals. On average, refugee camps are established in sparsely populated regions within 50 km of the international border crossed by refugees (Van Den Hoek et al., 2018). As of 2018, the median period of residence within refugee camps was five years. Although they are designed to be temporary solutions, many refugee camps operate in a state of “permanent temporariness”, populated for years on end but still considered a short-term solution to forced displacement caused by violence and persecution.

⁴ UNHCR Global Trends Report, 2021, <https://www.unhcr.org/flagship-reports/globaltrends/>.

Refugee camps in Bangladesh, Uganda, Jordan and Colombia were the subject of case studies for this document. These four countries have received large and recent refugee inflows driven by humanitarian and sociopolitical crises in neighbouring countries of Myanmar, South Sudan, Syria and Venezuela, respectively. These countries were the origin (source) countries for two-thirds (13.6 million) of the global refugee population under UNHCR protection at the end of 2019.⁵ For each refugee-hosting country, place-specific environmental changes during periods of high refugee inflow were explored, contextualized in country-specific land-use policies, and then short- and long-term land cover changes around selected refugee camps were analysed. Open satellite data, UNHCR-designated camp locations, years of camp establishment and occupation, encamped refugee populations and camp planning boundaries were used to characterize the environmental impact of each camp. The range of camp sites and their form of resource delivery are highly varied. The 2018 Global Compact on Refugees (GCR) sought to support countries hosting many refugees through a call for international and equitable responsibility-sharing. However, the top-down approach of global migration governance like the GCR can be restricted by State governments and local social contracts, which may evolve to address natural resource use and access. Instead, a data-driven ad hoc approach may be more adaptable to specific situations, such that policy can be targeted at the rapidity and specificity of response rather than generalized implementation templates.

⁵ UNHCR, 2020. *Mid-year Trends*.

Refugee camps in Bangladesh, Uganda, Jordan and Colombia were the subject of case studies for this document. These four countries have received large and recent refugee inflows driven by humanitarian and sociopolitical crises in neighbouring countries of Myanmar, South Sudan, Syria and Venezuela, respectively.



3. Addressing “resource rushes”

Mineral occurrences can be a major attractive force for migrant labour. There is a long history of mining towns and cycles of affluence followed by rapid decline when the resource is depleted. Policies such as Fly-in-Fly-out (FIFO) have attempted to mitigate boom and bust cycles for large-scale mining. However, many of the remaining policy challenges of the migrant-resource nexus relate to artisanal and small-scale mining (ASM) in developing countries.

Although estimates vary, there are thought to be 100 million people directly and indirectly engaged in ASM globally in over 80 countries. Most of these countries are low-income nations in Sub-Saharan Africa, South America, Oceania and Asia. In many of these countries, ASM is a long-established craft that predates European contact and colonialism. In the Akan region of Ghana, for instance, traditional gold mining was used for the kingdom of Akan. Today, ASM has been estimated to account for 80% of global sapphire, 20% of gold mining and up to 20% of diamond extraction. Such practices have become linked to global mineral commodity

markets. The practices of ASM are heavily criticized for environmental degradation, linkages to smuggling, labour trafficking, money laundering and intensifying negative social and ecological externalities. Despite this, ASM has been established as a poverty-driven livelihood strategy that attracts a labour force willing to work under hazardous conditions to supplement low incomes. In developing countries, diminishing agricultural productivity and poverty have been identified as drivers pushing the rural labour force into ASM.

Some empirical literature suggests that abundance of natural resources may fail to improve living standards, or even hinder economic performance, especially in the presence of weak institutions. Most of the evidence, however, comes from aggregate data at the country level and offers little guidance about the local economic effects of resource abundance. In some settings, however, mineral resources might provide income in times where agricultural yields dwindle. There is therefore an internal migratory impact of minerals in the short term. Spatial econometric analysis within a data cell found positive effects of mineral resource presence on sensitivity to changes in the Standardized Precipitation Evapotranspiration Index (SPEI). That is, adverse drought effects are reduced by the presence of mineral resources, probably due to the possibility of accessing an alternative source of income.

Some empirical literature suggests that abundance of natural resources may fail to improve living standards, or even hinder economic performance, especially in the presence of weak institutions



4. Droughts and migration

Using episodes of drought as an indirect indicator of land resource stress, internal migration throughout Africa is found to increase with natural resource stress. For the richer countries, drought is associated with increased international migration. For the poorer countries, drought is associated with decreased international migration, indicating liquidity constraints on this type of mobility (in other words, immobility or “trapped” populations).

The impact of drought on migration through an effect on agricultural productivity was investigated to test the hypothesis that communities experiencing greater environmental stress may have suffered declining agricultural productivity leading to mobility. This phenomenon, which probably affects mainly rural populations, has differential consequences on emigration rates depending on the income level of potential migrants. In very poor countries, where the main obstacle to migration is the unaffordability of emigration costs, warming and lower rural incomes may result in lower levels of emigration. In countries where income is not as low, however, reduced agricultural productivity will

increase the incentive to migrate to cities or abroad. In accordance with this theoretical framework, drought episodes are found to be associated with decreased human mobility in low-income environments.

In addition, the presence of alternative sources of income is found to greatly improve drought resilience at the national and subnational levels. By combining international and subnational models, previous findings on drought resilience can be extended by shedding light on the importance of local sources of income other than the drought-sensitive agricultural sector. Furthermore, droughts seem to be mostly related to decisions on subnational migration as opposed to international migration. As international migration is more expensive, droughts, through their adverse effects on agricultural productivity, cause poverty traps at the national level. Given worsening climate conditions and increased incidence of drought in the future, investment in and development of alternative sources of income seem paramount in alleviating natural-resource-related climate stresses in severely affected communities.

Droughts seem to be mostly related to decisions on subnational migration as opposed to international migration. As international migration is more expensive, droughts, through their adverse effects on agricultural productivity, cause poverty traps at the national level.



5. Hydropower and migration

Globally, the top 200 recent hydropower developments (2000-2018) are estimated to have displaced between 900,000 and 2 million people and induced substantial land-use change since the start of the century. According to geospatial data, international migrant flows seem to be linked with natural resource use. On a regional level, these connections can often be seen much more directly. Refugee camp establishment is associated with rapid changes in resources and land use that are positive (subsistence farming and negative deforestation).

After selecting 279 hydroelectric dams constructed between 2000 and 2018 from the Global Reservoir and Dam database version 1.3 (2019), all dam points were combined with associated reservoirs, land cover maps and population datasets to estimate environmental and human population changes following dam construction and reservoir filling. The population at risk of displacement was estimated by using the reservoir size to calculate the total population residing in the area at the time.

There was a 35% increase in the size of water bodies at dam locations between 2000 and 2018, which is probably attributable to reservoir filling for electricity generation. During the same time period, an 18% decrease in tree cover was estimated, probably due to reservoir clearance and filling. China's Three Gorges Dam, Brazil's Luis Eduardo dam and Ethiopia's Gilgel Gibe III dam stand out, with visible population changes around dam reservoirs between 2000 and 2020. However, only the Three Gorges dam showed a decrease in population. The dam has a capacity of 22,500 MW and was completed in 2009. It has displaced more than 1 million people, with some estimates for the final total number reaching above 5 million people, citing official Chinese government sources.

In 2000, the World Commission on Dams estimated the number of people displaced by dams at 40 to 80 million people globally, based on secondary data from government sources and academic research. China and India are major dam-building nations and they alone accounted for between 26 million and 58 million people within the global figure (1950-1990), with dam-induced displacement representing 34% of all development-induced displacement in China in that period (including displacement due to urban construction). Policymakers concerned about the migration-resource nexus should consider more migrant-friendly siting and design of dam reservoirs as a priority. Where displacement is inevitable, resettlement locations need to consider resource assessments

In 2000, the World Commission on Dams estimated the number of people displaced by dams at 40 to 80 million people globally, based on secondary data from government sources and academic research. China and India are major dam-building nations and they alone accounted for between 26 million and 58 million people within the global figure



6. Soil carbon as an indicator of migration?

Detailed analysis of agricultural pathways to migration highlighted the mechanism of deteriorating land resources due to drought. In particular, the statistical relationship between the Standardized Precipitation Evapotranspiration Index (SPEI) and international migration flows and subnational population densities (and thus internal migration flows) were explored. The SPEI is a measure of drought and, by extension, an indicator of stressed land resources in terms of productivity. This examination of land resource degradation was extended to consider the influence of soil carbon on migration flows.

This examination of land resource degradation was extended to consider the influence of soil carbon on migration flows.

The focus was on the African continent for more refined analysis related to agricultural productivity in highly vulnerable farming communities. For locations with low income levels, drought conditions are statistically related to increased internal migration from the drought areas. However, at the international level the effect was reversed for these countries, with drought associated with decreased international migration. The magnitude of this drought effect is smaller at the international level than the subnational level. The strength of the drought effect was found to increase in proportion with the length of time for which the location is affected. However, with regards to soil degradation, reductions in soil carbon are not found to be significantly related to migration flows. Lastly, the presence of mineral resources is found to reduce the influence of drought on migration. The reason why soil carbon is not significantly related to mobility flows deserves further research investigation. It may be due to the variable replenishment effects of inorganic and organic sources of carbon entering the soil reservoir. Human charcoal usage and fire ecology can also have confounding influences on soil carbon.

The magnitude of this drought effect is smaller at the international level than the subnational level. The strength of the drought effect was found to increase in proportion with the length of time for which the location is affected



© Adriana Mahdaviya/Shutterstock.com

7. Systems mapping as a policy tool

When analysing the linkage between natural resources and migration, three main framings are often used. The first is when people are considered to be forced to move because of an individual, household or society being detrimentally affected by a degradation or reduction of natural resources available. The second framing is where the process of migration is seen as an adaptation to the loss or potential loss of natural resources. The migration process may not only reduce exposure to resource loss and degradation but may also provide income and skills that can be used to build resilience to shocks and stresses. In both of these framings, natural resources

can be seen as conduits of climate stress and shocks. However, resource degradation and loss can also be a result of non-climatic reasons including poor resource governance. The third framing is where migration is seen as a response to the perceived opportunity of natural resources, such as resource mining. Clearly these framings are not mutually exclusive, and people can be forced to move and the process of migration can help them adapt. Likewise, populations may choose to migrate to cities for reasons totally unrelated to resource loss, but then be exposed to new risks that are a symptom of resource degradation. One example is depicted in Figure 4, which shows the myriad interconnections between migration and resource influences in the Sahel region. Such system maps help policymakers identify nodes of influence for intervention and also recognize the multiple causes behind particular impacts.



© Prasit mehmet al poyraz/Shutterstock.com

8. Preventing forced migration and promoting safe, adaptive and lawful mobility

A complex systems approach to migration policy formulation requires a consideration of dynamic “push” and “pull” factors alongside adaptive capacities. This is illustrated by the ethnographic testimonies from environmentally vulnerable localities – Bangladesh, the Philippines and the Sahel region. These were used as a basis for systems diagrams of how resources and (im) mobility interact on an individual, familial and group level. Here, the links between resources and migration are mediated by a wide variety of sociopsychological, political, economic and demographic factors, alongside environmental ones. In contrast to policymaking on climate change and socioeconomic development targets within sustainability agendas and frameworks, approaches and mechanisms to quantify and manage resources are relatively underdeveloped (as are the associated data points). Accordingly, there are only a handful of existing examples of policies that broach the link between resources and migration (see Appendix A). Many of these are, however, embedded in separate approaches to climate change, sustainability and migration, rather than consisting of a holistic policy framework.

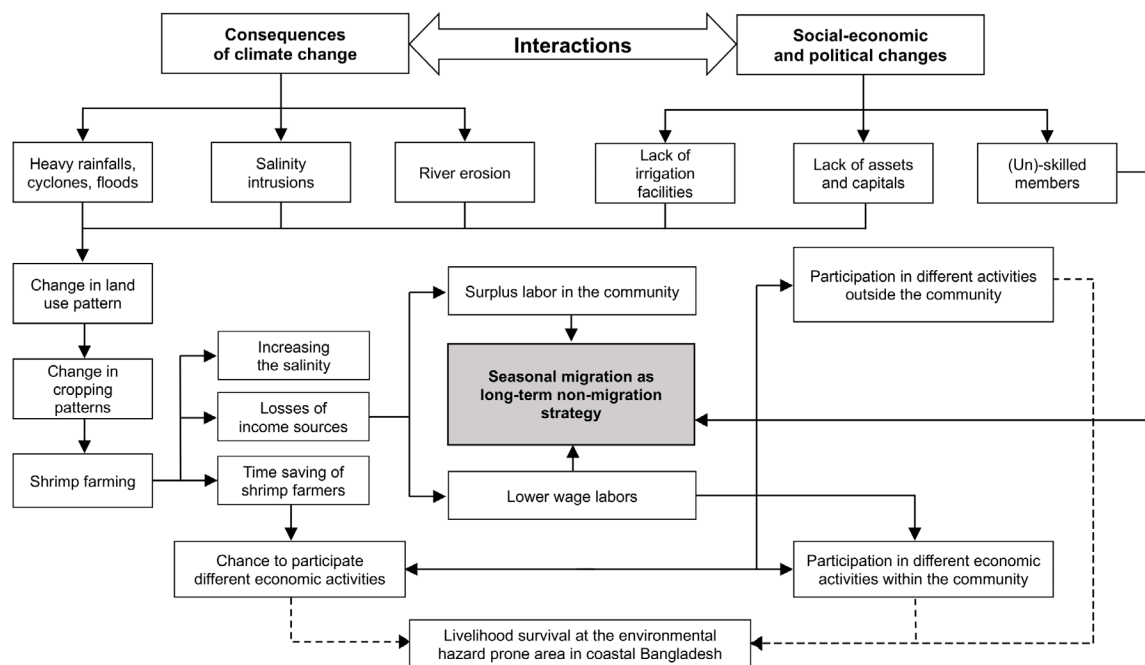


Figure 5: Nodes of potential policy intervention in diversification of income in coastal Bangladesh shrimp-farming communities.⁶

This analysis of policy approaches and interventions that could contribute to a practical application linking resources and migration is split into three areas: preventative policies to address resource constraints at points of origin that can prompt emigration: policies that allow for mobility flow in situations where populations may be trapped due to resource constraints or disasters: and policies that facilitate adaptation at destination points following immigration spurred by resource

drivers.⁶

⁶ Adapted from: Biswas, B., & Mallick, B. (2021). Livelihood diversification as key to long-term non-migration: Evidence from coastal Bangladesh. *Environment, Development and Sustainability*, 23(6), 8924–8948. <https://doi.org/10.1007/s10668-020-01005-4>.



© Andre Silva Pinto/Shutterstock.com

© Andre Silva Pinto/Shutterstock.com

9. The impact of land ownership

Property rights to resources can create resilience for populations in times of natural systems stress and may prevent involuntary migration. However, such tenure can also provide opportunity for greater mobility and hybrid livelihood situations where one family member may move temporarily for supplemental income. Policy approaches related to land tenure and access should focus on the following key areas of impact:

- **Strengthening the vitality and sustainability of the resource base.** Approaches that protect and (where possible) restore resources have the potential to stimulate improvements in socioeconomic resilience, especially in areas with livelihoods that are strongly tied to natural resources (such as agriculture or fisheries). Resource inventories, combined with land classification and zoning systems, such as those that have been undertaken in the United States, could represent valuable ways of quantifying and managing local and regional resources, alongside more traditional conservation and restoration approaches.

- **Ensuring local communities have rights of ownership and tenure over resources.** Encouraging security and “buy in” to resource bases has the capacity to create a greater vested interest in protecting them. This has been observed in parts of rural China and is beginning to take root in parts of Africa (such as Kenya). Effective and equitable implementation of common property approaches, such as “markets” for water resources, can be used in combination with more general land reforms to make livelihoods tied to natural resources more secure.
- **Foster livelihoods that are less directly reliant upon resources.** Diversification of income or livelihood sources can alleviate pressure on resource stocks and reduce population vulnerability to changes in those stocks. Hybrid incomes should be facilitated for families whose primary income sources may be seasonal or vulnerable to commodity price fluctuations (such as extractive industries) or security concerns (such as tourism).

Diversification of income or livelihood sources can alleviate pressure on resource stocks and reduce population vulnerability to changes in those stocks.



10. Migrant remittances as a policy tool

The economic value of migrant remittances to vulnerable resource-stressed countries can be an important mechanism for promoting policy innovations such as “green remittance bonds”. A systems approach to the positive feedback loops of migration is a good example of such interventions. Remittances have repeatedly demonstrated a high degree of stability in most countries where they are significant in supporting families back home. Initiatives that match incoming remittances are likely to be effective in reducing vulnerability for people left behind (or “trapped”), while also alleviating pressures on local resources. It is also possible to match remittances on the basis of investment in sustainable resource-use initiatives.

Integrative lessons

Focusing on the role of natural resources in (im)mobility decisions and outcomes makes it easier to identify targeted regional, national and local policy intervention points, compared with simply considering the link between factors like climate change and (im)mobility.

First, there is the idea that (im)mobility should be based on a rights approach, with people having the right⁷ to stay or move to/within their country, and not being discriminated against for being migrants or deciding to stay in an environmentally risky area. Second, the sustainable management of resources provides the platform for people to enjoy this rights-based approach. In a sense, the aim of such policies is to decouple the degradation of natural resources from (im)mobility. Third, the aim is to integrate migrants and the process of migration into achieving the sustainable management of resources. In order to identify the entry points for policies that would achieve these aims, a systems approach is used to illustrate the many processes linking (im)mobility and natural resources. In particular, the analysis delves into the many sociopsychological, political, economic, environmental and demographic (SPEED) factors identified, and explores the relationship between resource degradation and human mobility.

Extreme environmental events and their aftermath can dramatically disrupt resources of various kinds and heighten the vulnerability of many people in the affected area. Often, relief efforts are ad hoc (which results in delays in administering assistance) and aimed at alleviating immediate human concerns rather than livelihoods over the longer term. Bolstering dedicated internationally mandated funds for natural disasters (like the International Disaster Assistance account), and national and regional “insurance policies” (like the

African Risk Capacity fund), is likely to significantly reduce the number of people “trapped” in areas of scarce resources and allow movement away from those areas if appropriate.

In cases where involuntary migration is unavoidable due to natural and anthropogenic factors, a proactive approach to the resettlement process is essential. Population migration because of declining resources such as land (for agricultural and residential use) and drinking water has already begun in some Small Island Developing States (SIDS).

⁷ Article 13 of the Universal Declaration of Human Rights states that, (1) Everyone has the right to freedom of movement and residence within the borders of each state, and (2) Everyone has the right to leave any country, including his own, and to return to his country (UDHR 1948). For further details, see <https://www.un.org/en/about-us/universal-declaration-of-human-rights>

In cases where involuntary migration is unavoidable due to natural and anthropogenic factors, a proactive approach to the resettlement process is essential. Population migration because of declining resources such as land (for agricultural and residential use) and drinking water has already begun in some Small Island Developing States (SIDS). Such policies will probably need to be extended to other contexts of diminishing resources, whether this is a “managed retreat” of populations from environmentally vulnerable areas within countries or tactfully managed initiatives for relocation regionally or internationally. Planning for such eventualities requires policies that are deeply embedded in dynamic data about resource availability and ecological resilience.

The resource-mobility nexus challenges conventional approaches to policymaking because of its inherent properties as a complex adaptive system. The IRP has approached this topic at many levels where resource drivers and impacts of human mobility are seen as part of a connected system of feedback loops. Since migration can be an adaptive strategy for resource constraints and, in some cases, an inability to migrate can itself cause greater resource stress, linear models and causal theories for policy impact are elusive. An adaptive planning framework is needed with continuous monitoring of a range of data and thresholds. Policymakers need to be flexible in their decision-making approaches and be informed by some of the planning frameworks from the computational field of operations research. The policy planning process in a complex adaptive system is therefore inherently iterative. Appendix A provides some specific examples of policy actions that could be developed in this regard. The goal

in the context of the resource nexus with mobility can be measured in terms of efficient resource delivery for a specific target of human well-being, which could be measured through a variety of quality-of-life indices. The most ecologically efficient resource consumption patterns that are informed by a separate set of policy decisions can then be mapped to those indicators.

Policymakers need to be flexible in their decision-making approaches and be informed by some of the planning frameworks from the computational field of operations research

APPENDIX A
EXAMPLES OF POLICY
RESPONSES TO
MIGRATION FROM REPORT
CONSULTATIONS

Policy	Impact	Obstacles	Scale	Examples
Microcredit Schemes	Ability to obtain assets and capabilities needed to become less susceptible to shocks and stresses and/or cope with their impacts	Repayments can further trap people in place. Limited availability. Often resources do not reach poorest of the poor.	Usually local	Self Employed Women's Association (India) Bangladesh Unemployed Rehabilitation Organisation
Natural hazard related financial support	Access rapid and predictable financing when disaster strikes for food security and livelihoods	Usually currently served on an ad hoc basis, meaning delays. Often linked to formalized (exc. informal) economy	Regional to international	
Insurance Policies	Expanding the financial resilience of the population to disasters and shocks	Affordability issues, large transaction costs for small portfolios, weak institutions, lack of trust	Local to national	Turkish Catastrophe Insurance Pool (TCIP). Mongolian Livestock Insurance Pool African Risk Capacity
Resettlement and assisted migration schemes	Allows orderly and managed movement of people away from already affected or vulnerable areas	Often stringent and arbitrary terms attached to eligibility. Does not reach poorest sections of society. Many may not wish to move.	Local to national	Viet Nam - GOV and UNFCCC linked planned relocation schemes to support mobility away from risky locations SIDS - Facilitation of movement to US, NZ through labor schemes and passport and visa support
Remittance schemes that support sustainable resource management "back home"	Adds to already significant revenues from remittances sent home by diaspora	Reliance upon external resources may limit indigenous development and cause "brain drain"	International	Pakistan - money invested by migrants matched by gov.

Policy	Impact	Obstacles	Scale	Examples
Policies to discourage land conversion	Evaluates propensity of soil to be eroded and other soil qualities Easy to interpret	Lack of baseline data in many country contexts	Local to country scale	USA's Land capability classification system: No subsidies provided for land conversions within certain classes where land degradation is likely
Land use planning: Common property approach	Gives communities agency over resource use decisions	Corruption: local "land grabbing" for onward sale Gender: if only men inherit land based on cultural norms	Country-specific. Need to identify culturally appropriate policies	Bolivia's land reforms: communities needed to organize and given land tenure. Can then decide locally how to utilize land
Resource inventories	Discourage migration to areas of resource vulnerability or scarcity	Lack of baseline data in many country contexts	Local to country scale	USDA's National Resource Inventory: collects and produces information on the status and trends of land, soil, water, and related resources
Land restoration efforts	Inform decisions about where to invest in restoration	Currently largely conceptual Restoring areas that are likely to be (re)degraded	Local to regional	Africa's Green Wall Pakistan's "Tree Tsunami" Mexico's Forestry Commission
Water markets	Compensate users (farmers) for the use of finite water resources	Sufficiently factoring in "externalities" into market dynamics	Regional to country	USA Australia Chile China

ABOUT THE INTERNATIONAL RESOURCE PANEL

Aim of the Panel

The International Resource Panel was established to provide independent, coherent and authoritative scientific assessments on the use of natural resources and their environmental impacts over the full life cycle. The Panel aims to contribute to a better understanding of how to decouple economic growth from environmental degradation while enhancing well-being.

Benefiting from the broad support of governments and scientific communities, the Panel is constituted of eminent scientists and experts from all parts of the world, bringing their multidisciplinary expertise to address resource management issues.

The information contained in the International Resource Panel's reports is intended to:

- be evidence based and policy relevant,
- inform policy framing and development, and
- support evaluation and monitoring of policy effectiveness.

Outputs of the Panel

Since the International Resource Panel's launch in 2007, more than 33 assessments have been published. The assessments of the Panel to date demonstrate the numerous opportunities for governments, businesses and wider society to work together to create and implement policies that ultimately lead to sustainable resource management, including through better planning, technological innovation and strategic incentives and investments.

Following its establishment, the Panel first devoted much of its research to issues related to the use, stocks and scarcities of individual resources, as well as to the development and application of the perspective of 'decoupling' economic growth from natural resource use and environmental degradation. These reports include resource-specific studies on biofuels, water and the use and recycling of metal stocks in society.

Building upon this knowledge base, the Panel moved into examining systematic approaches to resource use. These include looking into the direct and indirect impacts of trade on natural resource use; issues of sustainable land and food system management; priority economic sectors and materials for sustainable resource management; benefits, risks and trade-offs of low-carbon technologies; city-level decoupling; and the untapped potential for decoupling resource use and related environmental impacts from economic growth.

Upcoming work

In the forthcoming months, the International Resource Panel will focus on status, trends, outlook, and solutions for sustainable resource management, the socioeconomic implications of resource efficiency and the circular economy, the connections between finance and sustainable resource use and circular economy in consumer electronic products, among others.

More information about the Panel and its research can be found at:

Website: www.resourcepanel.org

Twitter: <https://twitter.com/UNEPIRP>

LinkedIn: <https://www.linkedin.com/company/resourcepanel>

Contact: unep-irpsecretariat@un.org

Human Migration and Natural Resources: Global assessment of an adaptive complex system

Resources such as minerals, land, water and energy are key drivers of human mobility. Policymakers should recognize the complexity of the resource-migration nexus and the need to monitor resource-scarce areas, particularly those with vulnerable human populations. Current crises in Ukraine, Venezuela (Bolivarian Republic of), Afghanistan, amongst others have led to a focus on forced displacement. While such tragic episodes can have a resource nexus as well, they are part of a much wider range of human mobility phenomena that impacts human development. The availability or scarcity of natural resources impacts patterns of migration. Resource abundance can attract immigration; resource scarcity can either “trap” populations or lead to emigration (where that is possible).

This report opens a discussion about the natural resource nexus with human mobility, using an integrative approach that considers multiple causalities and networks of interaction. This report finds that natural resources have a significant impact on human mobility, but that the relationships are not linear. Based on scientific findings, the report advocates for a complex adaptive systems approach to policy interventions. These should consider sociopsychological, financial and demographic factors that mediate natural resource-(im)mobility pathways. The report further identifies efficient policies within the resource-mobility nexus such as: land ownership and tenure rights and migrant remittances (including “green remittance bonds”) as a way to manage the resource-mobility nexus more effectively for better ecological and socio-economic outcomes.

For more information: