

Environment, Health and Migration

Towards a More Integrated Analysis

Jennifer Holdaway

Migration and Health in China

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UNRISD, Palais des Nations, 1211 Geneva 10, Switzerland; Tel: +41 (0)22 9173020; Fax: +41 (0)22 9170650; info@unrisd.org; www.unrisd.org



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Sun Yat-sen Center for Migrant Health Policy, Sun Yat-sen University, #74, Zhongshan Road II, Guangzhou City 510080, P.R. China; Tel: +86 20 8733 5524; Fax: +86 20 8733 5524; cmhp@mail.sysu.edu.cn; <http://cmhp.sysu.edu.cn/>

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Introduction to Working Papers on Migration and Health in China

This paper is part of a series of outputs from the research project on [Migration and Health in China](#).

China is confronted by major challenges posed by the massive population movement over the past three decades. In 2009, approximately 230 million rural inhabitants moved temporarily or permanently to cities in search of employment and better livelihoods. Such large-scale mobility has huge implications for the pattern and transmission of diseases; for China's health care system and related policies; and for health of the Chinese population in both receiving and sending areas. The health and social issues associated with population movement on such an unprecedented scale have been inadequately addressed by public policy and largely neglected by researchers. Based on interdisciplinary research across the health, social science and policy fields, this project constitutes a major effort to fill research and policy gaps. Collectively, the papers and commentaries in this series aim to provide a comprehensive assessment of the health and public policy implications of rural to urban migration in China, to inform policy and to identify future research directions.

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Abstract

Many of the health risks faced by rural-urban migrants in China relate to environmental factors, including exposure to occupational hazards, unhealthy living conditions and environmental pollution. This commentary reviews some of the major trends in recent research on migration, environment and health, and discusses some of its limitations and challenges. It argues that, while a focus on the health problems facing existing migrants remains important, it is also necessary to consider the interaction between environment, health and migration in the context of long-term processes of urbanization, agricultural intensification and industrialization. These processes have generated very particular patterns of migration and also of environmental impacts and health risks, and they will continue to do so as China enters a new period in which rapid urbanization is accompanied by industrial restructuring. Situating analysis within this broader context has the potential to provide the basis for more forward-looking and locally appropriate health and environmental protection policy.

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Jennifer Holdaway is Program Director, China Environment and Health Initiative at the Social Science Research Council (SSRC), United States.

Introduction

This commentary is part of a series of papers that considers the challenges that rural-urban migration in China presents for health policy. Several of the contributions begin with a listing of the factors that put migrants' health at risk and many of these relate to "the environment." They include exposure to a range of physical, chemical or biological hazards in the home and workplace as well as psychological stresses related to the social environment. The first part of this paper discusses the ways in which environmental factors can affect health, reviews the main trends in research on this topic in the China context and discusses some of its limitations and challenges. In particular, it points to the fact that to date most research has focused on assessing existing health outcomes and risks, and has paid little attention to their drivers. This severely limits the usefulness of these studies in anticipating future shifts in the burden of disease and informing policies to address them.

The second part of the paper expands the frame of the analysis and argues more broadly for grounding research on environment, migration and health in analysis of the spatial distribution of economic activities and population which shape locally specific constellations of environment and health problems. This broader perspective is especially necessary at a time when industrial restructuring, agricultural intensification and urbanization are redefining China's physical and social landscapes.

Framing Environment, Health and Migration Interactions

Environment, migration and health can each be defined in a number of ways that open up different lines of enquiry. Some of the analysis below could also be extended to changes in social environments and their implications for health, to psychological as well as physical health impacts, and also to other types of migration. This paper, however, is concerned primarily with the physical environment, both natural and man-made, with physical health, and with labour migration across administrative boundaries that have implications for access to employment opportunities and to public goods and services.¹

Interactions between these phenomena have been approached from a number of different directions. In addition to research that investigates the role of environmental factors in determining health discussed below, a largely separate literature considers the impact of migration on the environment and its implications for human and ecosystem health. A third and growing body of work is concerned with the role of environmental degradation and related health risks as a driver of migration.² Given the focus of this collection, this paper is concerned primarily with the first of these clusters of research, but I suggest that the broader framing has the potential for integrating the other two dimensions in contexts where they are relevant.

Even with this limited focus, analysis of environmental impacts on health is not a simple matter, as these can be direct or indirect, localized or broad in scope, and immediate or delayed, as well as acting independently or in complex interaction with

¹ This discussion refers to domestic jurisdictions, but the analysis could also be applied to the growing numbers of African and other international migrants to China.

² A review of this literature is beyond the scope of the commentary. Hugo 2011, 2008; and White 2008 provide introductions.

genetic and behavioural factors. However, there is a growing consensus among both public health and development experts that understanding and addressing environmental determinants is crucial to advancing public health and well-being. This emphasis is apparent in the Health Synthesis of the Millennium Ecosystems Assessment (WHO 2005), the International Development Research Centre's EcoHealth Program (Forget and Lebel 2001) the One Health Program (Kaplan et al. 2009), the GeoHealth Program (UNEP 2009), and the Urbanization, Environment and Health program of the International Council for Science (ICSU 2011) among others (OECD 2007; Prüss-Üstün and Corvalán 2006). Realizing the potential of this approach will entail understanding the different ways in which environmental factors affect health in particular locations and the way in which they interact with other dimensions of social change to influence the burden of disease and needs for health care. In China, the massive scale of rural-urban migration and its crucial role in development in the post-reform period clearly make this an important issue for consideration.

Research on Migrants' Environmental Health in China: Scope and Limitations

The largest body of literature on environment, health and migration interactions in China, and that to which this series of papers contributes, is part of the broader research on migrants' health. This research considers the factors that affect the health in particular of low-skilled labour migrants during the period in which they are treated as temporary residents of urban areas because of their rural household registration status (*hukou*). It also considers the implications of migration for the provision of healthcare services.³ A smaller body of work looks at the health of migrants returning to rural areas and at the economic burden of occupational injury and disease,⁴ or at the health of the children of migrants and of elderly parents left in the countryside (for example, Ye 2008).

In disciplinary terms this research has been conducted predominantly by three groups of scholars. Epidemiologists and public health experts are concerned with migrants because it is assumed that they are at high risk and/or potential vectors of communicable diseases such as SARS, avian flu, HIV/AIDS and tuberculosis.⁵ Migrants also draw the attention of health policy experts because their mobility itself presents challenges for the provision of health care services in the Chinese system which has for many decades provided separate and unequal services to rural and urban populations.⁶ In addition, social scientists—primarily demographers, economists, sociologists and anthropologists specializing in migration and in social stratification more generally—are interested in migrants' health and related policy because these are important and challenging aspects of migrants' broader economic and social inclusion.⁷

Environmental health is not the only issue of concern in this literature—infectious diseases, reproductive health and, more recently, psychological health also receive attention—but environmental factors loom large among the factors considered to place

³ See relevant articles in this series, as well as Niu and Zheng 2011; Holdaway 2008; Zheng and Lian 2005; Xiang 2004; Hansen 2001.

⁴ Chen et al. 2014; Chen et al. 2011; Hu et al. 2008.

⁵ For example, Kraemer et al. forthcoming; Shen et al. 2009; Jia et al. 2008; M. Wang et al. 2008; Yang 2008.

⁶ For example, Zhu and Ngok, forthcoming; Mou et al. 2009; Hesketh et al. 2008; Duckett 2007; Barnighausen et al. 2007.

⁷ For example, Niu and Zheng 2011; Du et al. 2006; Cook 2007; Wang and Cai 2006.

migrants at risk. At the same time, the aspects of the environment examined in this research are also quite limited, usually being restricted to migrants' immediate living and working conditions, along with their social networks, and the effect of these on physical and mental health. Research thus focuses on occupational injury and disease, and on health problems associated with inadequate sanitation, over-crowding, and lack of adequate access to affordable healthcare services.⁸ Analysis of the impact on migrants' health of water and outdoor air quality, of exposure to environment-related health risks through food and of longer-term impacts through climate change is much more limited, although there have been some studies of extreme weather events. Within occupational health, most research has addressed conditions in industry, mining and construction.⁹ Although the modernization of agriculture, aquaculture and animal husbandry is generating a population of migrant farm workers and research on international migration suggests that related occupational health risks can be high, these have yet to receive attention in research on China.¹⁰

Research on migration and health in China, which is thoroughly reviewed in this series, includes epidemiological and public health studies, generally of particular populations in specific worksites and survey-based social science research on large populations, as well as case studies and ethnographies. However, due to the different units of analysis and scale, these studies do not "fit" well together. In the case of occupational risks in particular, efforts to assess the scale of these problems, the economic and social costs, and the implications for healthcare services are hampered either by reliance on small samples, or, in the case of some social science research, their dependence on self-reported or general health data that do not provide sufficient detail to assess environmental impacts on health. Because different occupations expose migrants to very different kinds of hazards, many migrants change jobs numerous times over the course of their working lives, and those who are seriously ill often return home, attempting to establish cause-effect relationships for individual or groups of migrants is extremely hard.

A more serious challenge is that, because it focuses on deaths and illnesses that have already occurred, this research has an inherently reactive quality. Many environmentally related diseases have long latency periods, and the rapid pace of urbanization and industrialization in China means that studies are often out of date by the time they are completed because enterprises, people and sometimes also policy have moved on. So although it can provide useful information about immediate healthcare needs, and draw attention to the more general necessity for monitoring and regulation of occupational health in industries where conditions are particularly harmful to health, this research can rarely inform preventive policy or targeted allocation of resources.

To do this would entail analysis not only of health outcomes, but also of patterns and trends in their determinants. This requires a reframing of the issue to look not only at rural-urban migrants as a *population* but at migration as a *process*, which interacts with enduring aspects of the physical environment and climate and with changes in production and consumption activities to produce different constellations of environmental impacts and health risks in different locations.

⁸ Robinson et al. forthcoming; Gransow et al. 2014; Holdaway and Marshall 2010; Zheng and Lian 2005; Xiang 2004; Hansen 2001.

⁹ Gransow et al. 2014; Li 2005; Xia 2006; Ngai 2005; Wright 2004; Su et al. 2000.

¹⁰ I am obliged to Fang Jing of Kunming Medical University for pointing out the need for research on this emerging trend.

Environmental Impacts on Health in China: Rural and Urban Meet and Flow

In China, dizzyingly rapid but uneven economic development and social change, combined with the underlying diversity of natural terrain and climate, means that the country faces a particularly complicated set of environment and health challenges. China continues to grapple with “traditional” environmental impacts on health associated with poverty and agricultural livelihoods at the same time that “diseases of affluence,” associated with richer diets and a more sedentary lifestyle are on the rise.¹¹ Meanwhile, the urbanization, industrialization and intensification of agriculture that are driving China’s rapid economic growth have also led to the rapid rise of “transitional diseases” caused by exposure to air, water and soil pollution and contaminated food, as well as new infectious diseases and zoonoses.¹² Although the impact of environmental pollution on health is hard to isolate or quantify because it often contributes to chronic, non-communicable diseases in which genetic and behavioural factors also play a role, it is increasingly becoming both a focus of public concern and a cause of social conflict (Holdaway 2013; Ministry of Environmental Protection 2011).

How, then, does migration relate to this complex burden of disease? On one level, the massive movement of people that has occurred in the last 35 years has churned up the former spatial and demographic distribution of environmental health risks. In the pre-reform period, when populations were less mobile, environmental impacts on disease could be fairly easily predicted on the basis of an understanding of local climate and terrain, level of economic development and the risks associated with a fairly stable set of livelihoods and lifestyles. In general, rural people were more likely than urban residents to be affected by environmental health problems related to poverty, including endemic diseases resulting from the absence or excess of certain elements in the soil or water; lack of access to water or its contamination by bacteria due to inadequate sanitation; indoor pollution from burning solid fuels in cold areas, traditional zoonoses from living in close quarters with animals, and occupational illnesses related to agricultural work. These problems were exacerbated by lower levels of education, poorer nutrition and inferior access to health services. Urban populations were more likely to be exposed to air pollution from industry and coal burning and to occupational diseases related to industrial work, but they generally had much better sanitation and access to water and health services than people in rural areas (Banister 1998).

The distribution of environmental health risks is much more complicated now, partly because the influx of migrants into cities in the absence of adequate infrastructure and services has brought the environmental health problems of poverty with it. Once the necessary infrastructure and human resources are in place, the concentration of the population in cities makes it easier to control certain environmental health threats by making the provision of piped water, sewage treatment, garbage collection and other public health-related services easier and more cost effective. It also potentially improves access to health and other public services. For these reasons, urbanization has generally been associated with improvement in public health in less developed countries (Brady et al. 2007). But many Chinese cities have expanded so quickly that infrastructure development cannot keep up with demand. A high percentage of sewage goes untreated, the disposal of solid waste is an issue of growing concern, and outlying areas of many cities do not have safe water supplies (Wang et al. 2010; Wang and Krafft 2008). Hardware is not the only problem. Many of the facilities involved—water

¹¹ Gong et al. 2012; Van de Poel et al. 2012; Wang et al. 2010.

¹² Holdaway 2013; Holdaway and Marshall 2010; Smith and Ezzati 2005.

treatment plants and incinerators, for example—require skilled personnel to operate and monitor them effectively, but few people are yet trained for these new occupations. Large cities like Shanghai have the resources and skilled personnel to address these issues, but those with fewer financial and human resources do not (Zhou 2010). Small cities and urban peripheries in particular often experience a serious lag between rapidly expanding needs and infrastructure (Wang et al. 2010).

Urban residents, especially the poor and those living in neighbourhoods with limited infrastructure, are potentially affected by these new health risks. But migrant workers are particularly vulnerable and also less likely to have access to medical services. From a combination of necessity and the desire to save money, migrants frequently live in conditions very different from their urban neighbours. They are more densely concentrated, and often live in old or peripheral areas of cities where there is limited access to drinking water, heat, waste disposal and other services needed to maintain a healthy environment (Yang and Liu forthcoming). Some migrants run small workshops out of their homes or keep chickens, rabbits and other animals. All this adds to the potential for diseases to spread among both migrant and non-migrant populations. The coexistence of basic environmental health problems with those common to established urban areas complicates the work of public health monitoring and the provision of medical services. As the early industrializing cities expand and redevelop former industrial and older residential areas, migrants are increasingly being pushed out into more peripheral areas with even weaker infrastructure.¹³

Although it is known that migrants are concentrated in employment sectors that are dangerous from an occupational health perspective, the division between researchers who work on occupational health and those who work on environmental pollution means that we know much less about migrants' exposure to pollution outside the workplace. However, recent work in Jiangsu and Henan has found that townships with higher percentages of migrants were more likely to be close to pollution sources, even when controlling for occupation (Schoolman and Ma 2012; Ma 2010), confirming the intuition that migrants are more likely than other urban residents to live in contaminated areas. Other recent studies have found that migrants have stronger perceptions of exposure to pollution than other urban residents (Chen et al. 2013) and see it as a serious problem in their lives (Knight and Gunatilaka 2010).

The relationship between migration, environment and health in rural areas has received less attention but is also significant. Although it is still common to talk about rural and urban China as if they were very different economic and social worlds, and discrimination against those without an urban *hukou* remains a barrier for migrants in terms of access to social protection (Chan and Buckingham 2008), “urban” occupations and lifestyles, and the diseases associated with them, are not restricted to large cities. As the article by Chen Chuanbo and colleagues in this series shows, as the first generation of migrants leaves the labour force, rural areas are now seeing growing numbers of people suffering from diseases resulting from their previous employment in factories and construction sites in urban areas; diseases that rural insurance and medical care are not equipped to handle (Chen et al. 2014; see also Hu et al. 2008). Children and parents of migrants who remain in rural areas also have needs for care that are not adequately covered by existing schemes, as do ageing migrants.

¹³ This is another issue that has yet to be fully researched, partly because it is hard to follow migrants as they move out of urban neighborhoods.

The implications of industrialization and urbanization for disease monitoring and health care provision in China's countryside go beyond migrants and their immediate families. As discussed in more detail below, although they have not travelled far enough to be termed migrants, tens of millions of other rural people have left farming to work in industry or service sectors in county towns and even villages, becoming exposed to health hazards usually associated with “urban” areas. As of 2006, 85 million people were working in industrial town and village enterprises (TVEs) alone (Bramall 2008), not counting construction and the service sector. The financial and “social” remittances (Levitt 1998) associated with migration have also contributed, both positively and negatively, to changes in rural diets and lifestyles (Démurger and Xu 2011), with implications for health.

This means that the environmental drivers of disease are complex and overlapping, and they interact dynamically across urban and rural spaces. This is reflected in the fact that the top five causes of death in China are already strikingly similar in both rural and urban areas, with cancer, heart disease, cerebrovascular disease, respiratory diseases, and injury and poisoning accounting for the vast majority of deaths. Problems such as obesity that were formerly associated with urban life are also on the rise in the countryside (Ministry of Health 2012). Researchers who work on non-communicable diseases are therefore finding that measures of urbanicity that include only standard demographic variables and rural-urban residence status are insufficient to explain changes in the burden of disease, and that indicators which cut across traditional rural-urban categories, such as occupation, sources of food and energy, opportunities for exercise, and exposure to media and information are necessary.¹⁴ Such analyses begin to challenge the habit of considering health outcomes and needs for services in terms of two populations—rural and urban—with migrants as a third category. They also challenge the common use of the terms “urban” and “rural” as shorthand for socioeconomic status, lifestyles and values.

The need for more nuanced analysis of the distribution of environmental health risks across populations and places will intensify with the formal or de facto settlement of many migrants and their children in cities, the introduction of policies that seek to reduce the gap in rural-urban social protection schemes, and the implementation in at least some migrant destinations of housing, health and welfare policies designed to integrate migrants into urban life as long-term residents—even if not offering the same standard of provisioning available to long-standing city dwellers (Zhang 2012; Wang 2012). Changes in rights to rural land and housing could also have far-reaching implications for rural-urban migration.

Reframing the Analysis

But although the rural-urban dichotomy may have less analytical purchase than in the past, there is still a strong argument for spatially differentiated analysis of environmental health outcomes and their drivers that incorporates migration as a key variable. This is because environmental impacts and related health risks are determined not only by level of development, but also by concentrations of population and the specific production and consumption activities in which people are engaged. In China these vary considerably across both cities and rural areas, producing localized constellations of environment and health problems.

¹⁴ Jones-Smith and Popkin 2010; Allender et al. 2008; Dahly and Adair 2006.

To consider cities first, research suggests that China's rapid post-1979 urbanization has been driven by different economic and policy factors at different time periods and in different regions (see Yeh et al. 2011, for a summary). There has also been some analysis of the implications of city size for economic and environmental sustainability and the trade-offs between them (for example, McGranahan and Tacoli 2006) as well as the contradiction between policies designed to promote migration to smaller municipalities and the overriding pull of opportunities and resources in the coastal mega-cities. But less attention has been paid to the ways in which particular combinations of urban economic activity trigger particular types of migration, and of the implications of these different population flows for environmental impacts and for health. Although studies reveal different age, gender and occupational profiles of migrants in various cities (for example, Niu and Zheng's (2011) analysis of Shenzhen and Beijing), the drivers and implications of these different profiles are usually beyond the scope of the analysis. In fact, as in the Niu and Zheng study, demographic variables are sometimes controlled in order to examine the impact of policy towards migrants, when these differences are in fact key in shaping migration flows and related needs for services.

Recently, however, new initiatives in economic geography offer the potential for exploring these connections in more detail. For example, Wang Jinfeng and colleagues (2012) of the Chinese Academy of Sciences (CAS) have developed a tool for tracing different pathways of urban development in China. On the basis of employment in various sectors and other indicators of economic structure, their "ecological city tree" clusters 253 cities into different functional types including manufacturing cities, mining cities, cities dominated by industry and business, commerce-oriented cities, tourism-oriented cities, and those with no strong orientation, and further differentiates them by level of development. The model was developed in order to understand the drivers of urban expansion and has been used to predict changes in land cover in cities with different sectoral concentrations. However, the typology provides a more nuanced understanding of the drivers of urban development and potentially might enable researchers to anticipate trends of in- and out-migration associated with different phases and types of development. The same methodology could be adapted and expanded to consider the implications of these changes for environmental impacts and for health, including needs for monitoring of pollutants and other environmental hazards specific to certain cities, and for housing and general health services related to different types and degrees of urban expansion.

Grouping cities in terms of their key economic/administrative functions and their possible development trajectories could also enable more systematic selection of sites for in depth research, greater capacity to predict changes in environmental impacts and the burden of disease, and more learning across jurisdictions with similar profiles. It would thus provide a valuable backdrop to research not only on health but also on many other policy issues. Although the data challenges are greater, a similar analysis could be conducted at the county level to analyse trends in rural development and their implications for environment and health, and determine priorities for monitoring, regulation and service provision in rural areas.

Spatial Analysis of Economic Drivers, Population Movement and Environmental and Health Impacts

A retrospective consideration of shifts in the distribution and composition of economic activities and populations since 1949 makes clear the implications for environmental

impacts and the burden of disease. Clear patterns in the distribution of economic activity and population that had implications for environmental pollution and health risks were already evident in the Mao era with the concentration of industry in the Northeast and Shanghai regions, along with clusters of Third Front facilities in hinterland locations.¹⁵ In the reform period, the promotion of manufacturing zones along China's east coast led to a massive geographical transfer of labour as millions of rural people left their homes to find work in major urban centres. To a considerable extent, this concentrated pollution and occupational diseases in those areas. But at the same time, this physical movement went hand in hand with policies that supported the broader transfer of labour out of agriculture and the establishment in many rural areas of TVEs. Particularly in rural areas with natural resources or close to manufacturing centres, these local enterprises provided jobs in mines or factories without the need for long-distance migration, and in some cases these counties later became urban centres (Bramall 2008, 2007, 2003; Wang 2004).

TVEs and small rural industries have also been the source of both serious occupational and labour safety problems and of rural environmental pollution.¹⁶ Many of the most severe mining and work safety-related incidents have occurred in these small rural industries and mining operations (Wright 2004). In some cases, workers are local to the area, but other enterprises recruit migrant labour. Although their working and living conditions are not always worse than those of locals, particularly if employed in the state sector, migrants' temporary and informal status often leaves them more vulnerable to occupational health risks and less likely to complain about pollution (Lora-Wainwright et al. 2012; Tilt 2006). Rural industry also has broader environmental impacts that affect health in direct and indirect ways. It is responsible for more than half the emissions of dust, air pollution and waste water (Wang et al. 2010) and its pollution of ground water and soil has particularly long-lasting effects on drinking water and food safety. Although the full extent of the problem is not known, some estimates suggest that as much as a tenth of China's agricultural land may be contaminated with heavy metal pollution (Zhongguo huanjingbao 2011), largely as the result of the co-existence of agricultural activities and industrial production or mining.

Since the 1990s a number of factors have contributed to further waves of industrial development and relocation, which have led both to new migration flows and the redistribution of environmental and health risks. The dismantling of state-owned enterprises (SOEs) in the 1990s led to the deindustrialization or industrial upgrading of many cities in China's Northeast and, more recently, a similar process is underway in Guangdong and other coastal provinces as wage costs, tighter environmental regulation, and land-zoning policies are prompting the transfer of industry to the hinterland. For example, analysis of 2010 census data shows that although Guangdong is still the largest single migrant destination, it also saw the highest increase in the rate of out-migration during 2000–2010 (Zheng and Ge 2013; Wanget al. 2012) and its share of in-migration also fell in relation to that of the Yangtze River Delta and the Beijing-Tianjin area, suggesting a shift in the economic opportunities available (Wanget al. 2012).

In terms of environmental and occupational health, the early industrializing cities are seeing a reduction in locally generated environmental health risks from industry, although regional pollution continues to be a problem for some, as is legacy pollution which will be difficult and expensive to remediate. Pollution from vehicles and an increase in household waste resulting from higher levels of consumption are also a

¹⁵ Bramall 2008; Wang 2004; Banister 1998.

¹⁶ Tilt 2009; Wang, M. et al. 2008; Han and Lei 2006.

growing problem (CCICED 2012a, 2010; World Bank 2010). Although the rezoning of peri-urban areas to residential use and policies encouraging the construction of low-income housing will continue to support construction for some time to come, industrial upgrading/de-industrialization will mean that some low-skilled migrants will probably leave these cities, following factory jobs to their new locations, while those who stay will be exposed to different kinds of occupational health risk associated with service and high technology sectors. As these cities have considerable resources to invest in infrastructure and housing, environmental health risks related to poor sanitation and living conditions are likely to be addressed fairly rapidly. But if measures are not taken to prevent it, there are concerns that environmental and occupational health risks associated with rapid industrialization and urbanization may be transferred to cities in the interior and west that are growing fast but have weaker governance capacity (CCICED 2012a, 2012b).

De-industrialization or changes in industrial structure are also occurring in many rural areas of China. The clampdown on small-scale polluting industries that has been in (intermittent) progress since the mid-1990s has led to the closure of many former TVEs and small workshops. Some areas with good transportation and a relatively educated workforce are able to attract large industries transferring out of coastal regions and are increasingly concentrating these, along with existing enterprises, in industrial parks where pollution and occupational safety can be more easily monitored and addressed. An example is Shenqiu County in Henan, a county in which rural industry drove economic growth in the 1990s causing serious water pollution that resulted in high rates of cancer (Yang and Zhuang 2013). Many of the most polluting industries have now been shut down and the area is attracting food processing and other industries transferring from the east coast, with many former migrants returning to work in them (Wang, W. et al. 2012).

Other areas are less able to attract cleaner industries, or are prevented by zoning policies from doing so. For them, out-migration may be the only choice as smaller polluting enterprises increasingly come under the control of stricter environmental policies. In some places, mining and industry have already caused serious damage to the environment, threatening the safety of drinking water supplies and food, as well as the long-term viability of agricultural livelihoods. Pollution is sometimes a driver of migration as people concerned about their health or that of their children leave, either to seek work elsewhere or, if they can, to be absentee landlords or employers (Lora-Wainwright et al. 2012; Chen and Cheng 2011). Where pollution is very serious, planned migration may be the only option, while in other areas, there is an urgent need to consider what kinds of ecological renovation, alternative food and water supplies, and public health education and services might be needed to enable rural populations to remain. The elderly, women and children, who are most likely to be left behind, are also usually the most vulnerable to environmental health risks.

So far this discussion has emphasized the importance of considering patterns of industrial location and industry type in understanding the relationship between migration, the environment and health. But a more comprehensive analysis could also include changes in the nature and location of agricultural production, the role of migration and the implications for environment and health. The suitability of different areas for particular types of agricultural production, combined with the impact of policies that designate certain areas as key zones for agricultural production, industrial development, or ecological preservation (Liu 2011) are also contributing to changes in patterns of labour force participation. For example, in areas where agricultural incomes

cannot compete with the wages in urban areas, the out-migration of healthy adults means that farming is now the responsibility of women with young children and the elderly, or is conducted in short bursts when migrants return for planting or harvesting. Although only one factor among many, the lack of full time adult farm labour contributes to the use of labour-saving fertilizer and pesticides, which can present a direct health risk to those who use them and contaminate food sold to urban populations. Over the long term, the excessive use of farm chemicals also contributes to the deterioration of soil quality and undermines the long term viability of land for agriculture (SAIN 2012; CCICED 2010). Rural-rural migration is also increasing as some areas become centres of intensive agriculture, while in others people are being pushed off the land by urbanization or becoming day labourers for large producers. Although research has yet to focus on these workers, international experience suggests that they may have little control over inputs and little incentive to engage in safe or sustainable cultivation practices. Informal employment arrangements also provide little basis for protecting their rights as workers or raising concerns about pollution.

Conclusion

Low-skilled rural-urban migrants have so far been the focus of most research on health, environment and migration. They will continue to be a population of concern for disease monitoring and health care provisioning for some time to come as the result of their greater exposure to environmental health risks in the home and workplace, and their potential role as vectors of communicable diseases. However, the scope of existing research is limited and there is a need for studies that include a broader range of occupations (for example, agriculture and high technology industries).

More importantly, research on migrants' environmental health has generally been reactive in focusing on health outcomes or risks that already exist. While this is important in order to understand the consequences of failing to address migrants' health needs, anticipating and reducing environmental and health risks requires analysing their drivers. These lie in industrial restructuring, urbanization and the modernization of agriculture that are changing the spatial distribution of economic activity in relation to that of the population. In disciplinary terms understanding these changes and their implications means more collaboration between economic geography, demography, and the environmental and health sciences. In terms of policy research, it suggests the need to supplement investigation of the way in which cities are providing for existing migrants with more analysis of development, land use and tenure, and other policies that are shaping the landscape of economic opportunities, migrant flows, and potential environmental and health risks in different contexts.

In considering the way in which migration interacts with economic and environmental change, it is important to consider both the scale and also the composition of migrant flows because the movement of specific demographic and occupational groups in and out of particular locations has different implications for the environment and for human health. The profiles of migrants in different cities vary considerably, and these differences need to be taken into consideration in assessing environmental impacts and health risks and needs for disease monitoring and control. Migrants are of course not only workers, and their lifestyles and consumption behaviour will also have environmental implications. While low-income labour migrants may be associated with an increase in problems related to inadequate sanitation and over-crowding, high-income migrants are more likely to exacerbate problems associated with higher car ownership, energy use and household waste. Understanding local migration profiles will

enable a better assessment of the “costs” of urbanization in different contexts because needs for housing and education as well as environmental management and health services will vary. The cost of not urbanizing also needs to be considered if this means providing expensive infrastructure and services to scattered rural populations, which may also have environmental and health implications.

Although urbanization is a key organizing concept in studying economic, social and environmental change in China, in researching the interaction between environment, health and migration it is increasingly important to avoid a simple distinction between “rural” and “urban” contexts and populations that is based only on residence registration or measures of population density. Other factors, including occupation, income, and environmental and health awareness may be at least as important in understanding vulnerabilities and needs for public services. Although rural-urban migrants have been the focus of most attention due to their potential vulnerability, when considering the environmental impacts of migration, and their long-term implications for sustainability, it is important to consider also rural-rural and urban-urban migration.

While individual studies will focus on particular scales, dimensions, populations and regions, situating research on interactions between migration, health and environment interactions within this broader framework should help to enable more forward-looking analysis that can help policy makers and communities understand and respond more effectively to the challenges of balancing economic development with human well-being and environmental protection.

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