



Understanding rural–urban transitions in the Global South through peri-urban turbulence

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Much previous research has problematized the use of a binary urban–rural distinction to describe human settlement patterns in and around cities. Peri-urban zones, on the edge of urban settlements, are important both in the sheer magnitude of human population and in terms of being home to vulnerable populations with high rates of poverty. This Perspective presents a framework that conceptualizes rural–urban transition through the prism of shifts in natural, engineered and institutional infrastructure to explain the processes of rapid change and the dip in service provision often found in peri-urban areas in the Global South. We draw on examples related to the provision of water and sanitation to illustrate the theory and discuss its implications for future research on the peri-urban. A research agenda is set out that emphasizes the importance of studying early warning signs of service dips using systems theory concepts such as flickering and critical slowing down. Through such approaches, research can better predict and explain what we call peri-urban turbulence and inform the development of mitigation strategies to reduce the vulnerabilities that peri-urban residents too often face during periods of rural–urban transition.

For much of this century, the world’s urban population will continue to grow, leading to an increasingly urbanized planet¹. A significant consequence of this demographic change is urban expansion, as cities extend outwards incorporating land around them. This expansion of cities is evidenced in high-income countries^{1,2}, where urban population growth is modest, but the trend in developing countries in Asia and Africa is especially rapid^{1,3}. This creates ever larger areas of interface between the urban and rural. Depending on the definition, approximately 1 billion people were living in peri-urban areas in 2015, with the proportion of peri-urban inhabitants particularly high in low- and middle-income countries⁴. The size of the population living in these areas challenges the usefulness of a dichotomous categorization of urban and rural areas and reaffirms the importance of further theoretical and conceptual development of the peri-urban interface^{5–7}.

Peri-urban areas are by nature complex, multifaceted regions, and so the literature on these areas is spread across numerous disciplines. For example, there is significant scholarship on environmental and ecological conditions⁸ as well as literature on changing patterns of land use⁹. Research has been emerging on ‘cityness’¹⁰, ‘urban’ activities in rural spaces (such as wage employment¹¹), ‘rural’ activities such as agriculture in urban spaces¹², middle-class colonization of rural areas¹³, understanding the interdependence between these two realms⁷ and, finally, the livelihoods and resource-management issues at the interface between the urban and the rural^{3,14}.

There is therefore a need to bring these disparate themes together in an examination of the peri-urban, what Allen describes³ as:

“a lumpy rural–urban continuum that challenges conventional distinctions between the urban and the rural ... where cities’ appropriation and transformation of nature’s nutrient cycle manifests most intensely”

Allen³ goes on to argue that peri-urbanization is a process that sees tensions between the imperatives of economic growth and natural productivity. The result is a zone of intensely heterogeneous activities in space, time and nature that frequently include subsistence and peasant farmers, abattoirs, squatter settlements, reservoirs, factories and mining activities, side-by-side. This raises important questions about the provision of infrastructure and services, about the ability of peri-urban interfaces to provide “inclusive, safe, resilient and sustainable” settlement as envisioned in the Sustainable Development Goal 11 on sustainable human settlements¹.

Previous conceptualizations of the challenge of sustainable human settlement involve comparisons and contrasts between urban and rural that lead to a partial understanding of lack of services. There are approaches that theorize the urban and rural as areas that are in competition over resources and services¹⁵. For example, Lynch⁵ highlights the relationship between the city and countryside that can be generic—complementary trade in agricultural goods and natural resources such as food, fuelwood and water—in exchange for finance, manufactured goods and services. However, this relationship can also be exploitative, drawing more value from the rural to the city, with limited return trade. A number of studies indicate that urban demand places pressure on rural woodfuel sources, but research suggests that the pressure is mediated by ‘institutional scarcity’^{16,17}. There are also examples of competing economic values applied to peri-urban land—direct use value, indirect use value and non-use value—or the benefits from not using natural resources, such as protection of wildlife, green space for leisure, or wildlife conservation¹⁸. In this Perspective, we focus on the transformations that occur at the frontier of urbanization and examine how the systems that underpin basic service provision, such as water and sanitation, and enable the management

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Box 1 | Key definitions for a theory of peri-urban turbulence in cities of the Global South, drawing on environmental and urban studies literature

- Urban: the territorial area of a city typically characterized by high population density, a substantial built infrastructure endowment and municipal governance mechanisms.
- Peri-urban: the territorial area on the edge of an urban settlement typically characterized by rapid growth in population; mixed land use between agriculture, industry and housing; and fragmented governance systems. Some densely populated rural areas may display similar characteristics.
- Rural: the territorial area beyond peri-urban and urban areas, typically characterized by lower population density, substantial agricultural land use and greater prominence of community-based institutions.
- Natural infrastructure: defined as ecosystem services, which are the benefits humans derive from nature (also known as nature's contributions to people).
- Engineered infrastructure: the endowment of built structures and facilities that enable the provision of infrastructural services, such as water and electricity.
- Proximate institutional infrastructure: the formal and informal institutions that are concentrated within communities, such as community groups or local service providers, which manage public goods and deliver services.
- Distant institutional infrastructure: the formal and informal institutions that are dispersed across communities, such as municipal councils and public utilities, which manage public goods and deliver services.

of public goods, such as the land or green space, shift during rural-urban transition. We combine literature and theories from urban studies and ecology to form a framework that explains a peri-urban dip in service provision and process of rapid change that we characterize as 'peri-urban turbulence' (PUT).

The theory of PUT presented in this paper is based on the concept of shifts in the balance and magnitude of natural and engineered infrastructure and local and distant institutional systems during transition, primarily in fast-growing urban areas of the Global South (Box 1). We characterize natural infrastructure through the prism of ecosystem services—the benefits people derive from nature—especially those associated with regulating services whereby we recognize the role of the environment in purifying water and processing wastes. Engineered infrastructure includes the endowment of built structures and facilities that enable the provision of services, such as reservoirs, pumps, treatment plants and piped distribution networks that can form a water distribution system. The distinction between proximate and distant institutional infrastructure reflects partly the relative scale of institutional systems that underpin basic service provision. Here, we account for the unit of service management between local models of household (self-supply) and community-scale provision against more distant forms of municipal or large-scale market provision. However, it also reflects a distinction between the prominence of more localized institutions in broader areas of rural life, such as community groups, and the more dispersed, impersonal institutional systems that fulfill similar roles in urban life, such as municipal councils. We believe that conceptualizing the shifts in the balance of natural, engineered and institutional infrastructure can help explain the varied mechanisms through which citizens meet their needs and communities manage public goods across rural, peri-urban and urban areas.

Building on this introduction to the constituent parts of the PUT theory, the next section reviews literature on the peri-urban condition and assesses evidence on the reported distribution of engineered, natural and institutional infrastructure across urban, peri-urban and rural areas. It draws on examples from the water and sanitation sector to illustrate similarities and differences across these zones. We then unpack and explain the PUT theory in more detail, discuss its implications on future research on the peri-urban and provide concluding remarks.

The peri-urban condition

The expansion of peri-urban areas and the growing evidence of their relative neglect highlight their importance in addressing global poverty, however what we know about these areas is obscured by demographic statistics that distinguish between urban and rural populations, thus splitting the peri-urban between these categories¹⁹. Recent work has sought to better characterize the peri-urban condition. One study into child health in East Africa found that it was lowest in the peri-urban interface between the city and rural areas²⁰, and a study in South Africa found that around two thirds of urban and rural citizens report that their quality of life had improved over the last five years, but only half of respondents reported such improvement in peri-urban zones²¹. The literature is clear that peri-urban environments can amplify health inequalities^{22–24}. Rapid urbanization can overwhelm local water supply and sanitation systems, and coupled with high levels of animal ownership, this leads to higher infectious disease burdens²². Weiss and McMichael²² argue that these peri-urban dynamics are contributing to a “major transition in the human–microbe relationship” that is contributing to an unprecedented era in terms of the emergence and spread of pathogens, from the re-emergence of cholera to new infectious diseases such as severe acute respiratory syndrome (SARS) and COVID-19. In this view, the transitional status of some peri-urban areas represents not only localized welfare issues but also global health security risks. This is further compounded as peri-urban populations are also likely to be exposed to ‘urban’ co-morbidities linked to issues such as air pollution or lower levels of physical activity²³.

Assessing the endowment of engineered infrastructure in peri-urban areas is complicated by the structure of most global datasets not using this classification. Those datasets clearly show that urban populations are more likely to have access to infrastructural services such as water supply and electricity than rural populations^{25,26}. It is hypothesized that in peri-urban areas, such infrastructure is likely to sit between the urban and rural levels. However, in interpreting this distribution of infrastructure, it is important to recognize that the welfare costs associated with a lack of access are likely to be higher in peri-urban areas than rural areas. This is because in rural areas ecosystems can fill gaps in infrastructure service provision²⁷ or reduce the risks associated with low levels of infrastructure by absorbing wastes that leak into the environment before they affect human health²⁸. Based on this logic, we would hypothesize that peri-urban populations are often faced with middling access to engineered infrastructure but the highest exposure to risks associated with inadequate access.

Similarly, the flow of ecosystem services to inhabitants of peri-urban areas is poorly understood. Provisioning services (for example fuel, food, and water) might be most accessible near the ecosystems that produce them and in areas where they can be transported easily (for example, via value chains²⁹), potentially resulting in a shortage in peri-urban areas where local ecosystems are degraded but transport networks are not fully established. Regulating services (for example, maintaining the quality of air and soil, providing flood control)—by their very nature—are often not transportable, as they prevent, moderate or structure natural processes. Thus, regulating services might be best noticed by their absence. In rural areas, healthy ecosystems help maintain habitable environments,

but increased pressure from higher population densities can disrupt these processes leading to increased flooding, droughts, soil erosion and disease³⁰. Where established, engineered and institutional infrastructure can mitigate some of the disruption resulting from a loss of regulating services (for example, paving slopes where vegetation has been lost reduces the probability of landslides). Furthermore, people living in rural areas may have more direct access to cultural ecosystem services (for example, the ability to develop our mental, physical and spiritual well-being, providing space for recreation, spiritual and aesthetic appreciation of nature) than those who live in urban areas, as they are often physically closer³¹, although good city planning can preserve access to these services by maintaining urban green space, as well as providing good transport links to natural areas³².

Focusing on the differences and similarities in the institutions that underpin the delivery of services and the management of public goods, it is common that the urban and rural categorization is used as an organizing logic for distinguishing between different institutional environments. For example, across much of South Asia, the Panchayat raj (village council) system of local government reflects a form of direct local government that has historical roots back to pre-colonial periods³³. In rural areas, large-scale infrastructure development is overseen by state-level agencies, but many households and communities manage basic services such as water supply and sanitation, themselves or via community-based management mechanisms. In this context, service provision is best described as being coproduced between household, community and government³⁴. We conceptualize such arrangements in this paper as proximate institutions, which we formally define as the formal and informal institutions that are concentrated within communities, such as community groups or local service providers, which manage public goods and deliver services in those areas.

This compares to urban institutional environments whereby entities such as municipal corporations take direct control or supervise specialist city-wide institutions such as metropolitan water boards to develop and run infrastructure to deliver services. In such cases, citizens and communities have a much more passive and distant role. These formal urban service delivery systems often exclude many citizens, and therefore an ecology of formal and informal private sector providers, such as water tankers and vendors³⁵, also have a role. However, the ultimate 'fallback' option of self-supply is greatly diminished compared with rural areas. In this paper, we conceptualize this environment as reflecting distant institutions, which we define as the formal and informal institutions that are dispersed across neighbourhoods, such as municipal councils and public utilities, which manage public goods and deliver services.

In peri-urban areas there is even greater heterogeneity as the rural based models become degraded by growing and dynamic populations, eroding the potential for community-based models, and reducing space for self-supply, while the urban service delivery models are yet to mature^{36,37}. This process creates a series of poorly recognized institutional tensions in peri-urban regions. For example, in many neighbourhoods long-established households rely on pre-existing infrastructure, either at the household or community level, and can be resistant to shift to new management paradigms that may require paying for services at higher levels than before³⁷. Similarly, there are often tensions in governance, as rural authorities are hesitant to accept processes of municipalization that will see the power of local political leaders being subsumed into larger governance units³⁸. In parallel, municipal authorities are often hesitant to expand their authority to include peri-urban areas where the management of public services and goods is challenging³⁸. These institutional dynamics mirror the infrastructure and ecological transition that unfolds within the peri-urban sphere.

In summary, the peri-urban is a transitional site where the relative capacity of natural infrastructure to support populations is reduced

compared to rural areas, while the endowment of engineered infrastructure is not yet materialized. Communities are often mixed, with some residents well-embedded in proximate institutional networks, yet community-based management approaches and other similar proximate models become stressed by much higher populations. The expansion of more distant institutional systems, such as those characterized by municipal governance, often lags behind the change in settlement character towards urban-like conditions and can be fragmented across peri-urban regions, resulting in a patchwork of institutional forms³.

The peri-urban turbulence framework

To help explain why these processes unfold as they do, we propose a theoretical model for rural–urban transitions that argues that changes in natural, engineered infrastructure and distant and proximate institutions represent important markers of rural-to-urban transition, especially in the Global South. The high-level logic of the PUT framework is derived from four (or more) semi-independent transitions: (1) high levels of natural infrastructure (for example, ecosystem services) are associated with rural contexts with these being low in urban areas, whereas (2) engineered infrastructure follows the reverse pattern. Similarly, (3) an inverse relationship exists between proximate institutions (high in rural areas and low in urban areas) and (4) distant institutions. In this view, as cities grow, nearby settlements experience deep-rooted transitions as their character shifts from rural to urban, but this includes an intermediate period of poorly delineated and defined peri-urban existence that can last decades, characterized by rapid spatial and temporal change and uncertainty. The peri-urban character reflects the instability between the two systems with higher flux in land use, livelihoods, resource use and services; a transition that we label as PUT (Fig. 1), with PUT suggesting a lower level of natural, engineered, proximate institutional and distant institutional infrastructure in peri-urban areas.

Developing this theory, we draw analogies—with key differences—to the red-loop and green-loop theory of rural and urban systems^{39,40}. Red-loop and green-loop theory describes how local natural infrastructure declines during urbanization and how engineered, social and institutional infrastructure may fill this gap. In a green-loop system, the overarching pattern is one of direct use of local natural resources⁴⁰. By contrast, in urban areas there is an increased reliance on socioeconomic infrastructure across larger spatial scales⁴⁰ (for example, regional). A wide variety of evidence supports this theory across a range of ecosystem services, from food production (for example, subsistence agriculture in rural areas versus transport chains for urban supply⁴¹) to fuel use²⁹. However, there are notable exceptions—for example, in both rural and urban areas, proximity and access play a role in how much time people spend in green space. Living nearby an urban green space does not necessarily mean people spent time there⁴², as there is a need for some level of connection to nature for people to want to spend time there and gain the associated benefits⁴³.

The peri-urban character reflects the instability between the two systems, whereby there is higher flux in land use, livelihoods, resource use and services. This transition, which we refer to as PUT, resembles a hysteresis loop and can move in either direction, but with a service gap in the peri-urban space between rural and urban dynamic equilibrium states (illustrated in Fig. 2). Historically, urbanization is the dominant trend, but examples of ruralization also exist⁴⁴. Although for the purpose of PUT we emphasize instability of the peri-urban, we recognize that some may conceptualize rural, peri-urban and urban areas as three related complex adaptive systems that each cycle between phases of stability and change within the larger system of how humans organize the biosphere^{5,6}.

When establishing red-loop and green-loop theory, Cumming et al.⁴⁰ suggest a transitional state whereby both local natural

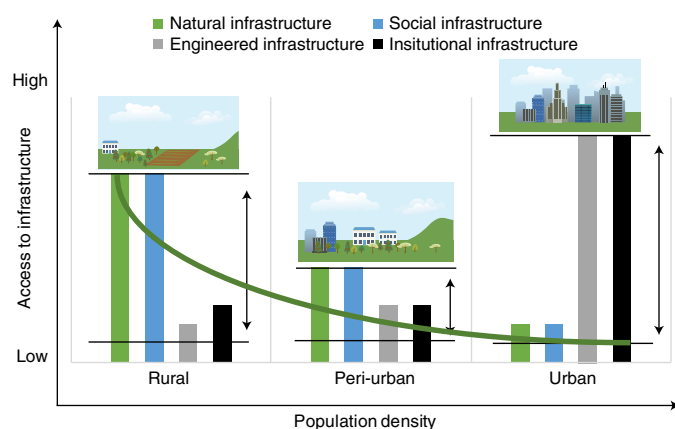


Fig. 1 | Levels of infrastructure vary across rural, peri-urban and urban areas. Access to services varies across individuals within each area (arrows), and nature may act as a safety net in many areas across the Global South (green line).

infrastructure and distant socioeconomic infrastructure are benefited from simultaneously, but distant services predominate, as urbanization progresses. We suggest that this transition is not always perfect, leading to a hiatus between services. As a result, peri-urban areas may not experience the best of both worlds (as might be inferred from red-loop and green-loop theory) but instead go through a temporary void until infrastructure is able to provide access to distant services. In other words, PUT probably results in both reduced local ecosystem services and a dearth of engineered infrastructure that might enable these benefits to be supplemented from distant natural infrastructure. These gaps are of high social and political importance when the loss of services results in a large reduction in well-being (for example, sanitation services).

We hypothesize that both the rate of ecosystem degradation and the cost of establishing engineered infrastructure are major drivers in determining the dearth of services in peri-urban areas. For example, when the cost of supplying the service is high for the environment, then nature can support only low population densities. Similarly, when the cost of building infrastructure is also high, then it is only economically viable at high population densities. In a situation such as this, the green-loop system is likely to degrade before the red-loop system is fully established. For example, in low population densities, pit latrines can be used safely, relying on natural processes within the soil to make the waste safe²⁸. However, since establishing sewerage and sewage treatment plants is expensive, it is only viable to develop this infrastructure when the economies of scale enable it. Thus, medium population densities in peri-urban areas are likely to experience unsafe sanitation—where nature's services are overwhelmed but engineered alternatives are not yet established. The likelihood of such a gap in infrastructure is increased as the institutional environment is also in a state of flux and therefore is unable to create viable solutions.

This type of negative spiral in peri-urban areas is greater for some services than others, and varies across geographic areas. For example, food production occurs predominantly in rural locations, but can continue within urban areas⁴⁵. Even without urban agriculture, food can be transported within cities with relative ease via transport infrastructure⁴⁶ (which is relatively cheap compared to other forms of engineered infrastructure, such as sewage). Similarly, an imperfect transition between natural and engineered infrastructure can be avoided through good governance and strong land tenure. For example, some natural infrastructure can be conserved throughout urbanization through good city planning enforcing protection of green space despite heightened pressure for building

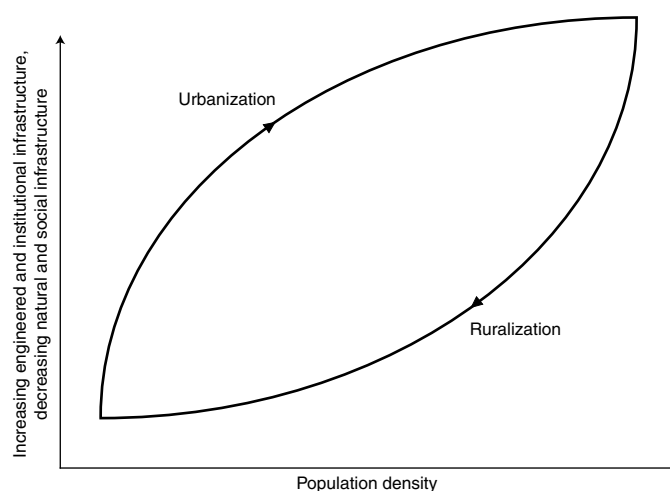


Fig. 2 | Conceptual model of the relationship between the processes of urbanization and ruralization. The relationship is illustrated as a graph with a vertical axis for transition from natural and social infrastructure to engineered infrastructure and a horizontal axis showing population density.

developments. As well as this, large-scale distant institutions, such as municipal water utilities, can subsidize the provision of services to increase viability at lower population density (for example, provision of water supply is cross-subsidized from metropolitan areas to small towns and neighbouring rural areas in Uganda⁴⁷). We therefore anticipate PUT to be stronger in areas where these forms of cross-subsidies do not exist and the transition in peri-urban areas proceeds unsupported.

Although we hypothesize that peri-urban areas have the worst overall turbulence, there are likely to be significant differences between groups living in each context. For example, higher-income households and communities living in peri-urban areas will cover the relatively high costs of developing engineered infrastructure and therefore overcome the dearth of services. This manifests most visibly in the phenomena of suburban gated-communities that are now common in major cities of Africa and South Asia⁶. High-income households can also invest in facilities, such as generators, private boreholes and septic tanks to overcome a lack of some services. Low-income peri-urban residents are less able to overcome this lack of engineered infrastructure and their options for using natural infrastructure systems is reduced or constrained, compared with rural citizens. This magnifies inequality as a lack of local natural infrastructure (that is, as red-loop systems develop⁴⁰) decreases the resilience of households, particularly as more vulnerable households are often the most dependent on local natural infrastructure (either directly or indirectly⁴⁰), both for their livelihoods⁴⁸ and as a coping strategy for buffering shocks⁴⁹. Thus, the ability to rely on natural infrastructure as a safety net is reduced during urbanization, potentially resulting in large reductions in well-being for those unable to access alternative services, or when these services fail as a result of a shock. For this reason, peri-urban areas face the starkest inequality, with citizens who are not well served or integrated into the urban institutional systems or who have access to engineered infrastructure facing limited alternative options. In this case, they are excluded from the institutional safety nets of the state and nature.

Peri-urban turbulence as a research agenda

PUT points to the importance of improving our understanding of the peri-urban condition and dynamics. We believe what happens in these settings will determine global society's ability to meet many

of the critical challenges of the next decades. As we have argued, under current paradigmatic approaches, the necessary expansion of core services such as water and sanitation will be most difficult in these regions and the populations living in such environments will be limited in their ability to overcome this gap in provision. This not only represents an issue of immediate human need, but creates a series of broader risks and opportunities. This includes environments in which it is more likely that emerging infectious disease can arise and spread²³, but these settings are also where people are resetting a pattern of living that will determine their future ecological footprints. Here we see significant opportunities in viewing the peri-urban as a site for creating more sustainable futures as well as a site for monitoring and responding to local and global risks. Red-loop and green-loop theory emphasizes the danger of urban populations having consumption levels so high that they over-exploit distant ecosystems⁴⁰ and we should be wary of responding to PUT by simply accelerating the rate at which populations move towards these types of unsustainable consumption levels, thereby heightening global environmental risks. We believe that further research is required to understand whether the peri-urban is an opportunity to create more sustainable urban models that allow the meeting of human needs within acceptable ecological boundaries⁵⁰. Some localized and sector-specific efforts on issues such as travel⁵¹ and urban agriculture⁴⁵ may hold promise, but there needs to be further examination of the challenge of peri-urban governance and service delivery to accelerate and scale up such work.

We argue that PUT may occur through the interaction of numerous tipping points, resulting in a perfect storm of poor infrastructure (for example, natural, engineered, institutional, and so on; Fig. 1). The critical thresholds at which each system will tip (for example, the population density at which household-based onsite sanitation is no longer safe and sewerage or supported faecal sludge management is required²⁸) are notoriously difficult to identify, but more research can help unlock important insights on when such thresholds might be realized and the multiple pathways to avoid them. We see value in bringing together conventional urban studies literature^{3,5} with contemporary work on studying systems change from rural perspectives^{34,41,52} and other disciplines^{53–56}. For example, this integration could inform urban and rural planners, designers and architects to build into their practice wider systemic perspectives that take account of the peri-urban⁵⁷. There is a need to develop pathways based on work such as this to address the services deficiencies in the peri-urban in ways that are sustainable in the long term.

The systems change literature provides conceptual frames and methods for studying early warning signals in system change, such as ‘flickering’ and ‘critical slowing down’ that have been used to predict when a system might collapse⁵³. Thus, taking the example of sanitation provision, as the critical threshold population density is approached, the onsite sanitation system of latrines might be safe for most of the year but ‘flicker’ to an unsafe state during points of stress, such as high precipitation when flooding latrines may cause problems in densifying neighbourhoods. Similarly, the proximity to the tipping point is closer, as the ability of the system to recover from these high rainfall periods slows down (that is, from becoming safe a few days after heavy rainfall, to taking substantially longer). Such patterns have been identified in a wide range of systems, from shifts in freshwater lake systems⁵³ to critical transitions in financial markets⁵⁵.

Methodologically, these early warning signals are difficult to identify in advance, often being observed only with hindsight—although cutting-edge methods are being developed to address this⁵⁴. Here we draw analogies between deforestation (reduction in forest areas) and urbanization (expansion of urban areas). Studies comparatively investigating rural and urban areas are well suited to identifying many of the impacts of urbanization (akin to analyses

comparing pristine forests with agricultural fields to understand the effects of deforestation). However, to identify the proximate and underlying drivers of these processes, it is necessary to study the frontier⁵⁸. Ecologists produce high-resolution annual maps of deforestation to track this frontier⁵⁹. Such maps can be used to (1) identify the drivers behind the expansion of the frontier, including down to individual-level motivations⁵², and (2) anticipate the future expansion of the frontier⁶⁰. Applying similar methods to peri-urban areas could lead to a step change in urbanization research, for example, with annual, high-resolution maps of frontiers of urbanization highlighting key locations for in-depth investigation to follow the process as it occurs. Given the far-reaching consequences for sustainable development, enhancing our understanding of PUT is an important goal for future research.

The way forward

In proposing this framework of PUT as a route for new research, we are aware that any systems-level analysis of rural–urban transition is necessarily abstract and therefore does not account for the varied experiences of individuals living within such systems. There are many rural communities and households that will be rich in infrastructure and linked into distant institutions, and many urban ones that are comparatively poorer across these markers. However, we believe that the meso level of analysis that we adopt in the framework is still useful, as it allows us to conceptualize rural–urban change in a way that provides an explanatory account for frequently found deficiencies in peri-urban services and well-being. This is a generalizable challenge, and this framework provides a robust foundation for building a research agenda that can help address it. We accept that this work is largely conceptual in nature and the next stage will be to validate the framework using comparative datasets and case studies of rural–urban change, but we note evidence presented throughout this paper from the literature that reflects the patterns of outcomes that we have discussed and that we believe supports the central tenor of our argument. Moving forward, we believe it is imperative to focus on responding to PUT and to answer questions on when and how authorities can respond to rural–urban transition to ensure that services and public goods are best maintained in a socially and ecologically sustainable way. This may create tensions for urban administrators over their responsibility to provide services for the dwellers in these regions: at what point should they extend their boundaries to incorporate new urban areas? At what point do city authorities include in-migrants? Responding to this dynamic process has implications for a city’s ability to meet the needs of its residents and therefore its key performance indicators. Future research in this area should be directed towards supporting such policy challenges and developing pathways to address these concerns. This Perspective develops PUT as an analytical framework to reveal the deficiencies in services experienced by those living in the peri-urban and the implications for both the urban and the rural. There are multiple potential pathways shaped by the specifics of context, rate of change, institutional capacity at various scales and degree of disparity (or sharpness of the boundaries) between the rural and urban, among others. The numerous possible combinations of these few variables result in a large number of possible pathways. We believe that system-based approaches for studying rural–urban transition can be used to better anticipate, predict and explain systemic change thresholds and therefore the basis for pathways to better futures.

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Competing interests

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