Vulnerable or resilient? The response of informal settlements to COVID-19: The case of urban village communities in Beijing

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Abstract

The COVID-19 pandemic has brought topics of the impact, response and adaptation of cities in emergencies to the forefront. When compared with formal settlements, the problems faced by informal settlements are more prominent. We propose the framework of an actor-network theory, substantiated by an empirical study of three typical informal settlements in Haidian District, Beijing, in which the process, characteristics and internal mechanism of the spatial reconstruction of the informal settlements in response to COVID-19 are closely scrutinised. Human actors such as local governments, community volunteers, landlords, tenants and non-human actors all participated in the response to COVID-19 according to their goal vision and political logic, with the local government as the core driving force, forming an integrated actor network. Rooted in the special locality of informal settlements, the actor network was both hierarchical and flexible, and its inherent dynamism has proven to be efficient during COVID-19, resulting in social adaptation and spatial reconstruction. This study contributes to the cautiously optimistic estimate of similar urban community resilience in terms of global epidemics and enriches the understanding of their interlacing dynamics from the perspective of spatial reconstruction.

Keywords

COVID-19, informal settlements, urban villages, actor-network theory, community resilience

Introduction

The COVID-19 pandemic which began in December 2019 has been a major global public health issue,¹ with nearly 543 million confirmed cases of COVID-19, including 6,329,275 deaths, being reported at the end of June 2022.² As a typical urban public health emergency, the unforeseeable, nonlinear, urgent and fuzzy³ outbreak of COVID-19 has aroused widespread interest in the characteristics and mechanisms of the virus’ transmission and the impact on and response of communities.⁴,⁵ Higher population densities and greater mobility rates are conducing to the prevalence of COVID-19 in a city,⁶ which means that high economic level cities were more seriously affected by the crisis,⁷ but with a better health care infrastructure that is better prepared to respond to pandemics, these cities may be affected to a lesser degree.⁸ However, health disparities within cities are of concern,⁹ and informal settlements such as denser urban areas,¹⁰ slums¹¹ and urban kampungs¹² are considered to be the ‘most vulnerable areas’.¹³ Informal settlements are those that allow a group of residents to build their own houses on land without formal land tenure to solve temporary housing problems.¹⁴ This type of settlement is often observed in developing

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countries. In many countries, informal settlements are associated with low-income, marginalised groups, high population density, inadequate housing, limited accessibility to health care and serious public health problems. In the Chinese context, informal settlements refer to ‘urban villages’ or ‘shantytowns’, which are often considered to be demolished and renovated as they have an adverse impact on property values. In 2005, the Beijing Urban Master Plan (2004–2020) was released, which proposed a variety of measures to rectify ‘urban villages’ to decentralise the population of the central city and thereby improve the urban environment. Since 2015, the Beijing Government has issued annual mandates for the remediation of the shantytowns and promotion of the environment.

In the context of COVID-19, the vulnerability and effectiveness of prevention measures of informal settlements became a focus of attention. The response in informal settlements is not different from that in formal settlements, which includes a range of measures such as raising the COVID-19 alert level, the access control of the residential communities, close contact tracing, self-isolation and vaccination. These measures are considered to be particularly important for areas having very low per capita hospital resources and vulnerable groups. However, failing to address the following concerns can cause control measures to backfire. For example, informal urban settlements in Kenya lack access to clean, modern and affordable sources of household energy. In these areas, food is more commonly purchased from small-scale owner-operated businesses, and lockdown deprives them of the opportunity to purchase food from street vendors. Residents of most informal settlements live hand-to-mouth with very limited savings or capacity to save, and restrictions on mobility ignore their most basic needs (e.g. livelihoods). This exacerbates existing social and spatial inequalities and increases deaths unrelated to COVID-19 due to a lack of basic healthcare.

In general, informal settlements are more severely affected by epidemics than formal settlements, but research shows that informal settlements themselves vary to different degrees in terms of their resilience and adaptability. On the one hand, different material conditions, socioeconomic factors and occupational structures contribute to the vulnerability to COVID-19; on the other hand, it is the level of interaction and consolidation between the local government and the local organisations that determines the response capacity related to COVID-19 of each of the informal neighbourhoods and the ability to recover socio-economically after the epidemic. In addition, collaborating with local residents would enable effective control measures and enhance community resilience. The unique morphologies, evolutionary patterns and self-organisational practices of informal settlements have received considerable interest from the research community. Their unsurpassed knowledge, diverse socio-ecological values and their contribution to urban vitality are also being increasingly valued. The spread of COVID-19 in the built environment occurs via the interaction of a range of synergistic factors. The epidemic context allows us to better understand the interplay between artificial and natural systems. The response of residents to COVID-19, the influence of the community environment and the changes in the built environment all could influence the process and effectiveness of epidemic prevention, which in turn influence the behaviour of residents in the community.

In this study, we investigated the emergency response and healthy community construction of informal settlements, focussing not only on the importance of the local government, the involvement of community volunteers and the underlying wisdom of the dwellers, but also on the epidemic response and interaction process of informal settlements, which have received less attention in previous research. In particular, we aimed to investigate the following: (1) How are the different participants in informal settlements, such as the local government, community committees and tenants, affected by COVID-19? (2) How do informal settlements construct a governance framework that combines top-down and bottom-up approaches in response to COVID-19? (3) Embedding of social networks in the built environment and their dynamic changes in informal settlements, and the resulting spatial reconstruction and community adaptation.

Study design

Subjects of the research. This study focuses on the informal settlements in Haidian District, Beijing (Figure 1(a)), as Haidian District ranks as one of the most economically developed districts in Beijing, with excellent mobility, and is significantly affected by COVID-19. From February 2020 to May 2021, we observed and conducted research in three informal settlements over a period of 15 months, with the Sijie Community in Qinghe Street as the primary focus of the study (Figure 1(c)), complemented by the Shuimo Community and Fuyuanmen Community on Qinglongqiao Street (Figure 1(b)). During this process, the Shuimo Community was demolished in May 2020, and a demolition compensation plan for the Fuyuanmen Community was launched by the end of the study. However, infrastructure in the Sijie Community was gradually improved and there were no signs of demolition. The spatial texture, social interaction and management modes in the Sijie community are relatively stable, and can better represent other informal communities.

Semi-structured in-depth interviews were conducted to assess the mobility and irregular working hours of urban village residents. A total of 17 people were interviewed, including residents, committee members, housing managers,
property managers, security guards, landlords and tenants (Table 1). Each interview lasted approximately 30 min. The detailed interview contents are listed in the Table Appendix 1 appendix. In addition to face-to-face communication, textual data were organised via WeChat and participatory observations, and image data were collected by taking photographs of the inner and outer spaces of the urban village. A qualitative strategy was adopted in this study, using actor-network theory (ANT) theoretical and methodological tools to reinforce the analysis. We used key concepts in ANT, such as actors, translation and networks, to describe the spatial reconstruction process of impact-response-adaptation in informal settlements during COVID-19.

### Basic characteristics of the informal settlements

The Sijie community is a typical informal settlement with the following basic characteristics:

* **Time.** Established in 1954, the Sijie community developed gradually from a naturally formed village, despite the rapid urbanisation of the surrounding area. The community grew continuously, gradually and spontaneously (*‘These are homesteads, they used to be bungalows, but now they are all buildings. They are spread out from their former walls and from the roadside to become buildings now, as one can change the land in front of his door at his own command.’* [B06]). This slow, unstructured development was brought under the framework of rigorous urban control amid rapidly increasing cases of COVID-19. From March 2020, the community initiated lockdown measures; including home segregation, closing all entrances with only two in the south and north, which required registration and a certificate for entry and exit, being left open and the closure of the community activity centre. In May 2020, more volunteers were mobilised in the community to supplement the shortage of staff and regular temperature and nucleic acid testing was started. In June 2020, an outbreak of

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**Figure 1.** Location of the research communities. (a) Macro location of the research communities in Haidian District. (b) Three informal settlements and their surrounding environments. (c) Sijie Community on Qinghe Street.

**Table 1.** Interviewees and their basic information.

| No.  | Place of residence   | Hometown | Years of residence | Interviewee description                        |
|------|----------------------|----------|--------------------|-----------------------------------------------|
| A01  | Sijie Community      | Beijing  | 20+                | Local landlord, female, 60+                   |
| A02  | Sijie Community      | Beijing  |                    | Residents committee, female, 40+              |
| B01  | Sijie Community      | Hebei    | 5+                 | Beautician, female, 30+                       |
| B02  | Sijie Community      | Henan    | 10+                | Ice rink attendant, female, 50+               |
| B03  | Sijie Community      | Yunnan   | 5+                 | Supermarket salesperson, female, 45+          |
| B04  | Sijie Community      | Shandong |                    | Mobile greengrocer, male, 50+                 |
| B05  | Sijie Community      | Gansu    | 3+                 | Waiter, female, 30+                           |
| B06  | Sijie Community      | Hebei    | 20+                | Lingerie saleswoman, female, 50+              |
| B07  | Sijie Community      | Shanxi   | 4+                 | Full-time mother, female, 30+                 |
| B08  | Sijie Community      | Anhui    |                    | Owner-operated hawkers, female, 50+           |
| B09  | Sijie Community      | Hebei    | 7+                 | Programming teaching staff, male, 33+         |
| C01  | Other                | Other    |                    | Soy product vendor, female, 50+               |
| C02  | Other                | Other    |                    | Vegetable station owner, male, 45+            |
| C03  | Other                | Other    |                    | Sijie Community security, male, 50+           |
| C04  | Other                | Other    |                    | Sijie Community, property manager, male, 40+   |
| D01  | Fuyuanmen Community  | Jilin     | 4+                 | White collar, female, 30+                     |
| D02  | Shuimo Community     | North East| 8+                | Housing manager, male, 55+                    |
COVID-19 in Xinfadi, a vegetable supermarket in Beijing, which is the source of vegetables for many vegetable vendors in the Sijie Community, led to a spike in prices at vegetable stations (‘At that time, food was very expensive. Now it’s a little bit cheaper, but it’s not as cheap as before.’ [B06]). In July 2020, shelves were set up in front of the community, and mobile vendors began to appear at community boundaries (‘The government said they were stimulating the economy and now they’re allowed to set up stalls.’ [D02]). In August 2020, some tenants returned to the Sijie community from their hometowns (‘I came over at the end of August, and at that time, the impact of COVID-19 was almost under control and our life was back to a normal state.’ [B09]). In March 2021, a property management company was hired to patrol, guard entrances and deal with emergencies (‘I’m at post no.4, mainly responsible for dealing with the irregular car parking in this community, as well as checking entry and exit certificates.’ [C04]). In May 2021, the domestic epidemic was largely under control; the community-organised vaccinations for residents, the barbed wire fences previously put up along with closure measures were destroyed by residents, and some tenants returned to their hometowns due to a significant reduction in income (‘Not working during the epidemic definitely affected income.’ [B09]).

Space. As with many urban villages, the Sijie Community is located in the prosperous ‘crack’ of the city, where the core area of the technology and innovation centre of Beijing is located, and within the service radius of higher education institutions and commercial centres. The rent is relatively low compared to that in surrounding areas, making it a magnet for students, white-collar workers and traders (‘Next to Yuanmingyuan, the Summer Palace, Tsinghua and Peking Universities and Zhongguancun Street, it’s convenient to walk around for eating and shopping. And I’m not willing to spend a lot of time on commuting.’ [D01]). The Sijie Community preserved historical residential households and after approval by the local government, villagers can apply for homesteads to expand their houses in accordance with certain per capita standards. In this process, the contractors played an important role by bricking a block of buildings divided into 5–8 square metres without advanced design, all based on personal experience (‘We report upwards for farmers’ homesteads until approved, and there are limitations on the area for each person. For example, I’m approved for a total of 130 square meters, and building houses exceeding this number is not permitted... there’s no design, but a vague estimation of ten square meters per room, and that is how it is calculated.’ [A01]). This ‘one building, one owner’s’ tenure also enabled landlords to play an important role in the fight against COVID-19. Owing to strict government control of the height of buildings, urban villages were dominated by 2–3 storeyed houses (‘This house was built in 2009, and in 2010 two-storey buildings were no longer allowed by the administration.’ [A01]). Therefore, the community is dominated by residential land use, with a relatively homogeneous function, high building density and little public space.

Population. There are 1212 households in the Sijie Community, with approximately 12,000 residents. More than 80% of them are transients, that is, ‘Beijing drifters’ without a household registration (‘I think the houses were built ten or twenty years ago, how could they have imagined that so many people would want to live in his house now?’ [B07]) (‘I’ve been living here for more than 20 years, but when checking my hukou (registered permanent residence), I’m nothing.’ [B06]). Most of them have entered society or work in the service industry with a very low income. The most important factor in choosing to live in informal settlements is the low rent (‘Nowadays, young drifter people in Beijing are basically living in urban villages or at the city edge.’ [D02]). According to previous research, rent in the Sijie Community only costs RMB 1500–2200 per month (‘We’ve lived here for ten years, and the rent was just over 800 yuan at the beginning, with a token increase of 40 or 50 yuan every year.’ [B02]), while in the formal community just across the road from the Sijie Community, the same rent is only enough to share a room with someone else, and the cost of a full rental ranges from to RMB 10,000–23,000 depending on the area. The Sijie Community is therefore seen as a ‘paradise’ by many migrants and has gradually developed a mixed agglomeration of students, white-collar, skilled immigrants and traders. Although the residents have adapted to the daily life of the informal community, they still feel that they do not belong here and regard it only as a temporary residence. Even if they have lived here for more than ten years, they may choose to leave because of marriage or for their children’s education (‘If my daughter becomes the civil servant, we’ll go back.’ [B02]) (‘When my children go to kindergarten, I may not be here anymore.’ [B07]). Informal settlements are difficult to integrate into the mainstream because of the high mobility and heterogeneity of the population, which made their management during the COVID-19 pandemic extremely difficult.

Theoretical framework

Based on the emphasis on the interaction between different participants in informal settlements and the process and mechanism of spatial reconstruction, we built a research framework based on the actor-network theory (ANT). The ANT was first proposed by M. Callon, J. Law and B. Latour in the mid to the late 1980s. It involves breaking the traditional dichotomy between subject and object, nature and society, combining macro-structure and micro-behaviour, focussing on the interpretation of processes and mechanisms, and the revelation of complex social connections. It has been applied in research on tourism
development, public health interventions, sustainability-oriented innovations, rural development and other interdisciplinary fields.

The three key concepts of the ANT theory are actors, translators and networks. Actors include both human and non-human actors. Heterogeneous actors face different goals and obstacles driven by their respective interests, however, the direction of the actor-network depends on the goals and directions of the key actors, and the obligatory passage point (OPP) is set based on the achievement of this goal. Translation is the crucial driving mechanism for the formation of actor-network and consists of five stages: Problematisation, Interessement, Enrolment, Mobilisation and Dissidence. The stability of an actor-network depends on the continuous translation of interests of various actors. This study constructed an analytical framework of response and spatial reconstruction of informal settlements based on the ANT (Figure 2), focussing on the interaction between managers, landlords and tenants, emphasising goal management, power relations and value exchanges in the connection of the actor-network. Additionally, this study provides a reference for local governors to assure public health and respond to major disaster events for resource allocation and joint mechanisms.

Results

The composition of actors in informal settlements in COVID-19

The nature of the informal settlement’s response and reaction to COVID-19 is a dynamic process of the creation, renewal and change of the heterogeneous networks constituted by heterogeneous actors, which are present in the community space. Different spatial representations and community adaptations occurred during the pre-COVID-19 period.

Actors. For informal settlements, human actors in the fight against COVID-19 include tenants, landlords, vendors, community volunteers, community committees and local governments such as the Qinghe Street Office, and non-human actors include land, houses, roads, open spaces and community boundaries. The actors in the actor network with the greatest demand for solutions to their own problems are the most likely to be the key actors to lead the establishment of the actor network. The investigation revealed that before the epidemic, the links between the heterogeneous actors were loose and the presence of the Qinghe Street Office and community committee was weak. However, during the COVID-19 epidemic, ‘prevention and control of the epidemic’ became a common demand, in which governmental forces led the development of the community based on epidemic prevention policies and goals; community forces changed in response to the governmental forces, as well as disseminated instructions to landlords and tenants. For the tenants, their individual needs were often hidden beneath the anti-epidemic objectives. It can be said that the informal settlement’s response and reaction to COVID-19 were largely organised and driven by the Qinghe Street Office. This means that during the epidemic, the Qinghe Street Office and the administrative force took the lead as key actors and controlled the process of construction and translation of the network.

Objectives and obstacles. The objective of tenants is to protect public health, and keep their lives and work untouched (‘The domestic control of COVID-19 is very good and I’m not particularly worried about it’ [B05]). The obstacles are high mobility, low-end jobs and low-income levels (‘Who will live here if they earn more in the future?’ [B02]). Landlords put the goal of making money second during COVID-19, and the primary demand was regarding physical and mental health (‘Once demolished, the rent is not as profitable as now... however, I’d like to hang around and have fun. Now I appreciate health as the most important thing.’ [A01]). The obstacles lie in irregular operations and management (‘Some landlords charge tenants for rubbish disposal, that’s what the landlords collect themselves, and

Figure 2. Analysis framework of this study.
they don’t give it to the community committee.’ [A02]). The goal of community committees is to strictly implement prevention policies, take various preventive measures, and ensure the safety of the community. The obstacles are the lack of grassroots organisations in informal settlements and the difficulty in managing buildings which did not undergo a formal approval process (‘There are no houses in the community where you can open a restaurant, it’s not legal. But they are open secretly and have been ordered to shut down several times.’ [A02]). The Qinghe Street Office wants to promote epidemic prevention policies and ensure that the community is safe and sound, and the obstacles lie in inadequate communication channels and limited awareness of policies (‘All the people on the election committee are native citizens.’ [A01]). Non-human actors, such as land, houses, access, open spaces and boundaries of informal settlements, are characterised by a lack of function, low quality, confined spaces and lack of public facilities and activities (‘The current environment of Qinghe Street, although much improved than before, is still dirty and disorderly due to the large population of migrants.’ [A01]). All these actors’ obstacles and objectives imply problematisation and interesserent in the early phases of translation.

**Obligatory passage point (OPP).** The objectives of the key actors, namely the Qinghe Street Office, also represent the overall objectives of the entire network of actors, which are ‘to maintain community safety and prevent the spread of COVID-19’. The objectives and obstacles of all actors must be completed/overcome in order to pass through the OPP to achieve a unified output before proceeding to the next stage of network construction. The formation of an OPP is a prerequisite for heterogeneous actors to form a solid alliance of interests (Figure 3).

![Figure 3. Heterogeneous actors and obligatory passage points in informal settlements.](image)

In the process of translation, the actor network can only be formed and remain stable if the interests of all heterogeneous actors are met to varying degrees. In this circumstance, key actors must adopt various intervention strategies and measures to enable heterogeneous actors to play their assigned roles in the alliance of interests. In the OPP on ‘epidemic prevention and control’, the Qinghe Street Office adopted four main approaches to enrol and mobilise in response to the human actors (Figure 4) and non-human actors.

**Administrative Enrolment/Mobilisation.** The ability of informal settlements to organise emergency management teams and programmes with great efficiency could not have been achieved without the coordination and management of government departments at all levels. Backed by strong administrative power, the Qinghe Street Office quickly joined the network of actors and took a series of top-down emergency management measures, such as keeping open only two main entrances of the community, setting up tents at the entrance to register incoming and outgoing vehicles 24 h a day, setting up additional shelves at the entrance as a ‘buffer zone’ for non-contact distribution of goods, tracing and recording the track of outsiders through big data, setting up a WeChat group to send out notices of epidemic prevention, monitoring and reporting body temperatures, requiring people returning from their hometowns be quarantined at home and applying for an access card to get in and out of the community at the community committee after safe two-week isolation (‘Passes are always required for entry and exit during COVID-19.’ [D01]), and free vaccinations.

**Volunteer Enrolment/Mobilisation.** Although informal communities are experimenting with formal management tentatively, by introducing property management companies to improve the dirty and messy physical
environment (‘We are hired by the street. We work on two shifts a day, one from 7:00 a.m. to 7:00 p.m. and the other from 7:00 p.m. to 7:00 a.m. the next day.’ [C03]). However, the emergency management staff in informal settlements were not exclusively hired but were part-time members of the community committees. Under the call of the OPP ‘epidemic prevention and control, the actors of community committees changed their identities from ordinary community servants to fighters against COVID-19 voluntarily.

At the beginning of the outbreak, there was a shortage of staff in the interference team in urban villages, which gradually improved with the participation of civil servants and other volunteers.

‘Middleman’ Enrolment/Mobilisation. The study found that landlords are a very distinct and important actor in the network of informal settlements when compared to formal communities. The owner of the house transformed into a social point of the junction through the acknowledged OPP, which bonded the informal settlement in three ways: transferring the daily information (‘Usually, the landlord informs me of important things.’ [B09]), proving the identity of the tenant (‘Usually the landlord helps to provide basic information.’ [B07]) (‘I’ve managed it all these years and I get several calls every day.’ [A01]) and providing basic supplies to tenants during the two-week quarantine period (‘During the quarantine period, I was in charge of buying things for him.’ [A01]). Under the organised and centralised management of the local government and committee, the landlord of each self-built building subconsciously ‘manages’ their tenants, balancing the rigid top-down constraints with a flexible and moderate strategy (‘Some landlords are particularly humane.’ [B07]).

Spatial Enrolment/Mobilisation. The once highly active and interactive informal settlements were subjected to closed-off management during the COVID-19 pandemic. The disadvantage of social isolation in informal settlements, as we discussed before in this paper, was transformed into a relative advantage of spatial isolation from potential virus transmission-ecological green spaces, rivers and highways acting as natural and artificial barriers. The Qing River and Xiaoeye River adjacent to the community became recreational areas for residents to walk, exercise and fish, and the small green space to the east of the community also served as a place for dancing. Despite the high density of buildings in informal settlements, the limited public space, light and ventilation, the monotonous and confined spatial layout of a seeming dormitory created conditions for centralised community management and home isolation as communication between residents on the same floor only occurred in the communal water closets, toilets or bathrooms and this communication was otherwise confined to their own rooms, with little contact with others (‘I usually leave early and come home late and I don’t interact much with my neighbours.’ [B05]).

‘Dissidence and its exclusion’ in the informal settlement during COVID-19

The dynamic transition and spatial reconstruction of the entrances and boundaries of the Sijie Community reflect the
process of the actor network from enrolment to mobilisation to dissent and finally exclusion (Figure 5). To reach the common goal of the actor network, key actors try to attract and convince other actors of the roles proposed for them. Dissent arises when heterogeneous actors deviate from the collective interests of the actor network based on their own interests. Dissidence and its exclusion are essential parts of the actor-network translation process.

There used to be more than 20 entrances to the Sijie Community, but due to the OPP of ‘epidemic control’, only two main entrances, one to the south and one to the north, were retained. The others were installed with retractable gates and additional barbed wire, which led to a reduction in the connectivity of the community. Over time, shelves for deliveries and takeaways were set up near the main entrance, and several itinerant vendors began to set up stalls along the street. People’s daily activities were gradually concentrated at highly integrated and connected community boundaries, which evolved into important places for the exchange of internal and external information and resources. ('I used to have a shop in another community, and I was doing well, but I couldn’t go out because of the lockdown measure, so I had to set up a stall here.’ [C01]) ('I live in the community, I have an entry and exit permit, and the vegetables I sell are wholesale from the Xinfadi supermarket.’ [B04]). Due to COVID-19, the establishment of temporary supply and demand gradually nurtured a diversity of businesses such as waste collection, mobile hairdressing stalls and mobile fruit stalls, which formed an economic balance around the community and created a positive experience of the external world in the community boundary zones. In the case of the Sijie Community, we can see that space is the ‘field’ where different powers and interests are interrelated and competed, with key actors trying to conciliate other actors to follow their commands and reach an OPP by benefit promise, while heterogeneous actors are also carrying out space occupation, transformation and practice by their interests. The spatial collision of mainstream and marginal forces has led to the evolution of dynamic characteristics and the reconstruction of informal settlement boundaries.

There were two distinct characteristics of the informal settlement’s response during COVID-19. 

Cascaded management inclination, creates an actor-network with distinct hierarchy. The management of the
Sijie Community pre-epidemic was only slightly better than being completely unfunctional, with the community committee mainly dealing with day-to-day chores, and the street office barely showing any presence (‘The community committee is in charge of eating and drinking, which means its work is trivial and all-embracing.’ [A01]) (‘The property management company also consults with the community committee on how to manage major incidents well.’ [C04]). There is no avenue or platform in informal settlements where news can be released uniformly to all residents in the community (‘Only residents in the community can join the owners’ WeChat group, while tenants cannot.’ [A02]). As a result, the social capital between different residents is uneven, tenants are in a disadvantaged position in terms of receiving and feeding back information, and they can only hear about information through referrals from landlords or neighbours, or announcements, banners and broadcasts scattered around the community (‘Community broadcasts usually start at three or four in the afternoon, and end at their (the staff of the community committee) off-duty time, so only those who are not working during the daytime can hear it often.’ [B09]). In the context of COVID-19, however, the informal settlements mobilised resources through a hierarchical network to cascade and implement the political intentions of key actors. In practice, the Sijie Community once received a tenant from Hubei Province, which was severely affected by the epidemic at the beginning of the outbreak (‘he was supposed to go to a centralised quarantine location.’ [A01]) and had to choose home isolation in the community because a centralised quarantine location was not available that day. Key actors enrolled and mobilised other actors to pay the same attention as they did through the hierarchy of actor networks in terms of different escort levels, sealing measures and activity ranges (Figure 6). In the context of fighting COVID-19, this hierarchical framework creates an efficient transmission mechanism between different levels, with key goals delivered from the top down.

Landlords in informal settlements play an important role at an intermediate level in the actor-network. The landlords themselves have greater freedom and flexibility in terms of how to follow orders from superiors and whether to manage them strictly (‘Last year, I knew of landlords who didn’t charge rent and some who cut it in half.’ [B07]). To put it in a metaphor, like the arteries and capillaries of the human body, the street office, the community committee and the landlord jointly deposited the official requirements into the daily lives of the tenants with both quick collective responses and appropriate individual actions, while also shaping the resilience and flexibility of the informal settlement actor-network (‘The important thing is that the community gates are tightly controlled, but we don’t have much control inside the building.’ [B01]) (‘You can go out of the building, but you can’t go out of the community gates.’ [B06]).

The informal settlement built up a stable, efficient and strong actor network during COVID-19, a process driven by two main mechanisms.

Exclusivity and control of the actor-network itself. The targeting intentions of the actor network, and often the intentions of the key actors, decide that the actors they enrol in need to act obediently or be excluded from the actor network. People returning to the community from their hometowns experience a rapid ‘identity deprivation’—no matter who they are, how long they have lived here previously, and whether they are healthy or not, they are turned into QR codes with different risk levels tracked by big data, coordinate points defined by the time and space visited, and a series of numbers of the building, unit and room number in the WeChat group (‘You are not allowed to enter unless you have special proof, such as an entry and exit certificate.’ [C04]). The two-week ‘home isolation’ was subsequently followed by ‘community reintegration’, which meant they could leave the WeChat group, regained their identity, credentials and freedom to enter the community. ‘Quarantine’ does not only mean spatial closure and isolation, but also a metaphor for enrolment and mobilisation, as the association of tenants and actor-network experienced a dynamic process from strong (before the outbreak) to weak (during quarantine) and to strong (after quarantine) in succession.

The concentration of power of key actors over heterogeneous actors. The spatial reconstruction of a community under the leadership of the local government generally follows political logic based on grand objectives. As a key actor, the street office brings together for the first time such a large number of mobile populations on online platforms for management, with the enrolment of community security and volunteers. On the one hand, a large WeChat group was set up for all those who had recently returned to Beijing so that notices could be issued promptly. On the other hand, small WeChat groups were subdivided by street to report tenants’ temperature every day during the quarantine period. In addition to the Home Quarantine Commitment signed with the tenants, Qinghe Street also signed a responsibility letter with the landlord, who was responsible for ensuring daily necessities and tracking the health of the tenants during the quarantine period. At the end of segregation, the landlord needs to provide relevant materials for the tenant’s temporary residence permit and entry certificate. Thus, informal settlements form a joint network in which street offices, community committees, landlords and tenants are hierarchically nested, closely linked and interactively adapted (Figure 7).

Discussion
In the process of rapid urban development, informal settlements are considered to be lagging in terms of modern
development and are excluded from formal management. However, in the perspective of ANT, the informal settlement is no longer a low-end living area in dire need of remediation and assistance, but a network space of heterogeneous actors and their interactions, with certain power relations and dynamic changes, transforming the community into a ‘quarantine cocoon’ or ‘the health unit of the city’. The informal settlements are not paralysed by the epidemic, but rather show their dynamism and resilience instead. Through the obligatory passage point, heterogeneous actors interacted passively or actively, in short, and in close proximity, reshaping the social networks and neighbourhoods of informal settlements. The multiplicity of mobile vendors at the boundaries of the community supported the daily functioning and self-sufficiency of the community, providing convenience without increasing living expenses, and also fulfilled the need for epidemic control to reduce contact with people from outside the community.

This study found that, as the largest number of heterogeneous actors in the informal settlement, migrants play a passive role, whether it was the itinerant vendors who had difficulty continuing to operate the business after the clean-up policy of the Qinghe area due to Beijing’s remediation action (‘Business used to flourish when there was no patrolman, but now it’s a bit of a setback.’ [B08]), or ordinary residents who have had to put up with rising prices and inconvenient living conditions (‘The vegetables from that vegetable shop at the entrance are more expensive than those from the big supermarkets. Because two years ago there was a rectification action and these vendors were not allowed to sell in the community, and the shops on the street had to seal their windows, which is not convenient at all.’ [B06]), they seemed to be isolated and marginalised. They were also kept away from the inner circle of power when compared to other actors. This confirms the description beforehand regarding their weak sense of belonging and their perception of the community as a ‘temporary home’. Although they succumbed to the Enrolment and Mobilisation for the OPP of ‘epidemic control’, it did not enhance their social capital and anti-risk ability (‘Of course, it (COVID-19) has an impact, as things don’t sell well, we consequently don’t get a commission and earn less money.’ [B06]). Ultimately, they had to leave (‘After the COVID-19, many of my neighbours had moved out, five or six of them.’ [B09]). In the long run, this perception of informal settlements as ‘temporary or transitory settlements’ with a lack of long-term commitment poses a significant threat to the stability of the actor network created.

This study has documented how the most vulnerable are managing and coping with epidemics from a new perspective of spatial reconstruction, in which heterogeneous actors in the community jointly construct a dynamic network through power concentration and interest reallocation, thus resulting in continuous social adaptation and spatial reconstruction. In terms of comprehensive governance, to strengthen the mobilisation of heterogeneous actors, especially tenants, and build a more mature and resilient actor network, this study proposes the following recommendations: (1) improve the physical conditions, enrich basic education, medical care, recreation and commercial functions, and increase the amount of small green spaces and public space around informal settlements. (2) Improving community emergency approaches,
including basic emergency evacuation routes, emergency shelters and assistance programs against epidemics. (3) Focus on cooperation between the government and different groups and establish a unified platform where information can be shared among all tenants. (4) Provide sustainable community support services, especially recruitment information and vocational skills training.

This study aimed to improve the social, economic and physical well-being of the urban poor and contribute to the cautiously optimistic estimate of other similar urban communities in regard to their resilience in terms of global epidemics. We believe that a city is resilient only when the most vulnerable people can withstand and recover from disasters. As a case study, the generalisability of the findings to different geographic areas and types of informal settlement needs to be further explored.

**Conclusion**

In regard to geography, the formation and transformation of space are one of the most important scientific topics. The actor-network theory effectively links the agency of multiple actors, spatial processes and complicated networks, providing a new perspective for explaining spatial reconstruction. Based on the context of the COVID-19 epidemic, this study adopted an ANT analysis framework, taking informal settlements in Haidian District, Beijing, as a case study. The following conclusions were drawn: (1) The Sijie Community transformed from an ordinary urban village community with mainly residential functions to the main battlefield with multi-functional functions such as information exchange, daily shopping, leisure and fitness, and epidemic prevention and management, implicating an actor network dominated by the Qinghe Street Office as the key actor and incorporating multiple heterogeneous actors, both human and non-human. Human actors, such as the local government, community committees, landlords and tenants, and non-human actors, such as land, houses, roads, open spaces and boundaries, all played an important role in the actor network. (2) The key actor, the local government, defined the target intention of ‘epidemic prevention and control’ as an obligatory passage point for the other heterogeneous actors. Heterogeneous actors with their own interests and logic were enrolled, mobilised and expressed their dissidence in various ways, thus making the overall framework of the actor network both hierarchical and flexible. (3) The actor network established by the informal settlement in response to COVID-19 was mainly driven and constructed by administrative power and political logic, resulting in the centralisation of power and a hierarchical management pattern, thus changing the structure of interests and power accordingly. Social-spatial reconstruction of informal settlements was also a continuous process of (re)ordering and co-evolution, as the actor network consisted of a dynamic juncture of conflicting goals, competing interests, dissent and negotiation.
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Ying Dong, Shunyi Wang and Aiping Lin collected and analyzed all data and wrote the paper. Fang Wang was responsible for guiding the construction of the theoretical framework and organised the entire research process.

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### Appendix 1

| Category                  | Examples of questions                                                                 |
|---------------------------|---------------------------------------------------------------------------------------|
| Basic features            | 'How long have you been living in this community?’                                  |
|                           | 'What means of transportation do you usually take to work?’                          |
|                           | 'Does the building you live in have a private bathroom?’                              |
|                           | 'Who are your frequent contacts in this community?’                                   |
|                           | 'How is your relationship with your neighbours?’                                      |
|                           | 'How do you obtain information on the management and activities of the community, and how do you generally obtain information relevant to your own interests?’ |
|                           | 'Are there any volunteer activities in the community, and have you been involved in them?’ |
|                           | 'Are you in the WeChat group of the community or the rental block?’                   |
| Impact and response       | 'How has the pandemic affected your life?’                                             |
|                           | 'During the epidemic, who was responsible for the daily management of the building you live in?’ |
|                           | 'During the epidemic, what anti-epidemic measures have you taken for yourself and the building you live in?’ |
|                           | 'During the epidemic, have you experienced home isolation, and what inconveniences have you encountered during this period?’ |
|                           | 'How did you manage your diet during the 14 days in quarantine?’                      |
|                           | 'During the quarantine period, who was your main communication partner?’               |
|                           | 'How was the change of tenants in your building during the outbreak?’                  |
|                           | 'What kind of help did you receive from the community during the outbreak?’           |
|                           | 'Was there a rent reduction for the house you rented during the outbreak?’             |
|                           | 'How did you spend your day in general, before and after the pandemic?’               |
|                           | 'Did you worry about the living environment of urban villages, before and after the epidemic?’ |
|                           | 'Did you have a sense of security and belonging in your community, before and after the pandemic?’ |