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# Urban Planning and Corona Spaces – Scales, Walls and COVID-19 Coincidences

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## 1 ABSTRACT

This study focuses on the role and responsibility of urban planning in mitigating the COVID-19 pandemic´s impact. The far-reaching social and economic consequences of this threat are counteracted by organisational and constructional measures to prevent lockdowns and finally illnesses and deaths. Corona spaces and voids are introduced as a consistent multi scale approach concerning the pandemics spatial implications and respective measures. These terms are operationalised for urban planning and can be used as an overarching concept to be communicated within cross-sectoral planning tasks. A comparison of Taiwan's and the USA's responses to the outbreak suggests that the coincidence at the beginning of a pandemic can be controlled by institutional precautions. On an urban scale, organisational measures (e.g. contact tracing, quarantine, and lockdown) can be supported by constructional ones concerning e.g. transport, public spaces, urban agriculture, and offices aimed at crowding reduction. If appropriate measures are applied, urban density does not seem to increase spreading the virus, whereby a regression analysis based on data of districts in Germany shows no relationship between population density and COVID-19 deaths. Lockdown prevention should be a planning goal and multifunctional approaches that integrate aspects of virus resilience should be favoured over the monothematic urban development approach (Leitbild) of a virus resilient city. Urban planning can contribute to the mitigation of future outbreaks by including pandemic preparedness in planning frameworks.

Keywords: COVID-19, urban planning, Corona spaces, pandemic preparedness, lockdown prevention

## 2 INTRODUCTION

Cities have always faced various threats and had to take appropriate measures to counter them, which were either constructional or organisational and often a mixture of both. For medieval European cities these threats were e.g. war and epidemics. War was an external threat, and city walls were constructed as protection to respond to it. The realisation of a city wall required thorough planning and considerable resources for its implementation, and the remains are still visible today as an urban structure. Epidemics, especially the plague, were also an external threat that immediately turned into an internal one as soon as it entered the city. The causes and the mode of transmission of the plague were unknown, thus initially there was only escape, as Giovanni Boccaccio described in his book “Il Decamerone”. Later on, quarantine was organised supplemented by hospitals where most of the sick died. Apart from the latter, the structural manifestations of the occurrence of plague were mainly votive churches and plague columns built after the end of an epidemic.

It has been 150 years since the world’s high-income countries achieved control of cholera, thanks to the implementation of safe piped water, sewerage systems, and basic hygiene principles, however, the world’s poorest remain at risk: at the beginning of the 21st century (WHO, 2017).

A new threat has emerged: SARS-CoV-2, a novel strain of the coronavirus family, which causes the pandemic disease COVID-19 (with 'CO' for corona, 'VI' for virus, and 'D' for disease). The most important means of controlling a virus for which there is no vaccine or therapy is to prevent or interrupt infection chains with the aim of preventing the exponential increase of the number of cases, which is expressed in the imperative “flatten the curve”. The transmission pathways of the corona virus have been elucidated by analysing the trend and mitigation measures in three epicentres, and the results show that the airborne transmission route is highly virulent and dominant for the spread of COVID-19 (Zhang, Li, Zhang, Wang, & Molina, 2020). Thus the spread of COVID-19, unlike cholera, which is spread among other things by polluted drinking water and could therefore be successfully combated through construction measures, is much more difficult to control with urban planning instruments.


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At present, there are already some statements from urban and landscape planners as well as architects and others about the role and responsibility of urban planning in mitigating the pandemic´s impact, in scientific studies as well as in popular media (cf. section 4). As an example, a review concerning the impact of COVID-19 on public space highlights the interface of COVID-19 and urban design; it is presumed that the COVID-19 crisis will fundamentally change our relationship to public space and it is mentioned that it will be critical to study and measure these changes in order to inform urban planning and design in a post-COVID-19 world (Honey-Rosés et al., 2020).

The aim of this study is (1) to introduce a consistent approach concerning the pandemics spatial implications, (2) to consider the role of coincidence in the pandemic, (3) to give a simplified overview of urban planning tools and their impacts, (4) to examine the usefulness of a pandemic resilient city as an urban development approach (Leitbild), (5) to evaluate urban density in respect to spreading the virus, and (6) to discuss post corona related urban developments such as pandemic preparedness, lockdown prevention, and some trends that may become reinforced by the pandemic. Before constructional measures on the scale of urban planning are examined, organisational measures for curtailing the pandemic are considered in this study.

## 3 CORONA SPACES AND VOIDS

In analogy to the frequently used term corona crisis, this study introduces the term corona spaces for all spaces related to the pandemic. These are (1) spaces that the virus itself occupies and in which its RNA can be detected or (2) spaces created by the social reactions of humans to the virus. The latter include empty or underused spaces, here defined as corona voids (cf. Fig. 1), which are normally populated, but which are more or less empty during a pandemic to prevent spreading the virus. Corona spaces used for isolation have boundaries which contain the virus more or less effective and which are often impassable for humans in both directions, or at least should be. Currently there are only paraphrases for corona spaces and voids. If these terms introduced here prove useful, they should be generalised so that they apply not only to coronavirus, but to all pathogens that spread through the air and can cause pandemics (e.g. airborne virus related spaces). The relevance of corona spaces for urban planning issues is discussed in section 4.

### 3.1 Scales and Walls

An epidemic occurs on a very small scale, at the level of the genome and human cells, but its effects occur on very different scales from human organs to global contexts.

SARS-CoV-2 is an RNA virus with a size of approximately 50–200 nm in diameter (N. Chen et al., 2020) and can occur almost everywhere, e.g. on clothes, the computer keyboard, and for a certain time in the air. Essential for the reproduction of the virus is the human cell, the corona space in the narrowest sense.

At the scale of the human body, a face mask helps to protect oneself and others. These “portable walls” belonging to the non-pharmaceutical interventions (NPIs) are part of the personal protective equipment (PPE) and could result in a large reduction in risk of infection (Chu et al., 2020).

Human movements are the conditio sine qua non for a pandemic outbreak, since they spread the virus both locally and globally. Concerning air traffic, a study’s findings showed the highly relevance of the number of flight routes as well as total passenger volume and identified it as a main vector for the global spread of COVID-19 (Lau et al., 2020). Cars play a dual role: on the one hand car mobility also contributes to the spread of the virus, on the other hand it serves as a sheltered mobile corona space as an alternative to public transport. It has been shown that the use of drive-through COVID-19 testing is an effective strategy for minimising patient contact and conserve personal protective equipment (PPE) (Ton, Jethwa, Waters, Speicher, & Francis, 2020).

Chains of infection are interrupted when the movement of infected persons come to rest. Contact tracing and subsequent quarantine for infected and suspects is initially the method of choice, as it can be limited to the affected persons and their rooms. These are the apartment with its borders (room walls, doors, windows), the shared accommodation e.g. for foreign workers, the single family house whose wall is a garden fence, and a block or a neighbourhood bordered by streets. It was estimated that early detection and isolation of cases prevented more infections than travel restrictions and contact reductions, but combined NPIs had the strongest and fastest effect (Lai et al., 2020).

Unlike quarantine, a lockdown refers to larger spatial units at different levels such as cities, districts, or countries. The "walls" around the lockdown spaces are temporary and usually of an organisational nature, sometimes even physical, when neighbourhoods are separated or border crossings are closed by temporary means. In these cases, the historical walls have a temporary revival: the city walls as well as the Great Wall of China. A lesson learned from the province of Bergamo is that in order to contain the epidemic, an urgent and decisive region-wide lockdown should have been implemented, as this might have limited the number of deaths in the province (Fagiuoli, Lorini, & Remuzzi, 2020).

Partial closures, such as the prohibition of mass events and the gathering of many people in a confined space, are intended to eliminate sources of infection and lead to empty football stadiums, clubs, department stores, schools and kindergartens, which are referred to here as corona voids.


Fig. 1: Corona void – empty subway station in Berlin 16/04/2020

Mandatory and voluntary quarantine increased home office and curfews mean that many people stay at home. This, together with a changed pandemic modal split due to more cycling, has led to a significant drop in public transport, e.g. with the number of journeys in Budapest decreased by 90% from 4.3 million/d to 430,000 million/d (Bucsky, 2020), thus creating many corona voids.

Four phases may distinguished when combating a potentially pandemic pathogen: Prevention (Keep the virus out of the country), control (trace the virus within the country), mitigation (containment of the virus), and recovery.[1] Each phase refers to the specific corona spaces, but the national border plays an important role in all phases, as many laws and rules apply nationwide.

## 4 COINCIDENCES

Mutations, i.e. random changes in the genome, drive the development of life on earth. Viruses mutate randomly and by chance they jump from animals to humans. Coincidences stood at the beginning of this pandemic and shape its course. Nevertheless, on the basis of coincidence emerge stable patterns. So it had long been known that a pandemic was to be expected; only the exact circumstances were unclear, thus the WHO developed a scheme for “Notifications of events that may constitute a public health emergency of international concern” (WHO, 2005).

On the level of individuals, it is random who is or is not infected by a carrier of the virus, including asymptotical cases. Hotspots of infection appear randomly on the map, often far from the epicentre of the epidemic. Now a lot depends on the decision-makers, but it is also random who is in charge at the time of the outbreak. They are responsible for the risk estimation and to manage the pandemic impact, and have to decide e.g. whether the ski circus continues in Ischgl or not[2], or whether as in Italy's virus epicentre of Lombardy, where COVID-19 patients were transferred to nursing homes by an official resolution with

[1] https://www.tellerreport.com/life/2020-03-26---corona-virus--ways-out-of-lockdown-.SJ-7vlv5I8.html
[2] https://www.politico.eu/article/the-austrian-ski-town-that-spread-coronavirus-across-the-continent/


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catastrophic consequences.[3] It is therefore important to take institutional precautions against a pandemic, as in Taiwan or South Korea, where lessons have been learned from the SARS-1 epidemic.

Example Taiwan: the "National Health Command Centre" (NHCC) is the central coordinating body, to which organisations continue to be subordinate, including the "Central Epidemic Command Centre" (CECC), newly founded on the basis of the SARS experience, and the "Command Centre for Biological Pathogens" (Wang, Ng, & Brook, 2020). The data of the National Health Insurance was compared very early on with that of the Immigration Department, the Register of Residents of Taiwanese citizens and the Foreigners Registration. This made it possible to identify and quarantine almost all persons who had been in risk areas in the past 14 days. It took NHCC a single day to establish this system. Supplemented by effective contact tracing and extensive testing, almost all suspicious cases were tracked down and the randomness was brought under control, which is reflected in low case numbers (Wang et al., 2020).

In South Korea well testing and tracking (Lee & Lee, 2020) allowed the nation to blunt the exponential spread of the disease without having to halt all internal movement and access between its cities (Park, Sun, Viboud, Grenfell, & Dushoff, 2020).

This form of institutional emergency response does not exist in the USA. The U.S. intelligence community warned in its annual “worldwide threat assessment” 2019 that the United States and the world will remain vulnerable to a large-scale outbreak of a contagious disease that could lead to massive rates of death and disability and severely affect the world economy (Coats, 2019). However, in 2018 the Trump administration closed a pandemic-response unit that the Obama administration had created after the Ebola outbreak, so no senior administration officials coordinated the efforts against the corona outbreak, Trump referred to as “an unforeseen problem,” as “something that nobody expected,” and as a crisis that “came out of nowhere”.[4] Thousands of passengers flew directly from Wuhan to the United States after Chinese officials disclosed the outbreak of the illness with health screening only beginning in mid-January.[5] The very high case numbers were countered by social distancing (Badr et al., 2020), high testing capacity and strong transmission-intervention (Chen, Li, Gao, Kang, & Shi, 2020). However, a study has estimated there may have been 36,000 fewer coronavirus-related deaths had the US entered lockdown a week earlier in March6; the Columbia University research also estimated that around 83% of deaths could have been avoided, if measures would have been taken two weeks earlier.[6]

Many other countries have also imposed a lockdown and it remains the task of future analysis and research to identify scenarios which could have been prevented that. Nevertheless, although coincidence plays a major role especially at the beginning of local infection events, it can be controlled due to the small number of cases, while the containment by a lockdown, the ultima ratio, is finally nothing but brute force against coincidence.

There are also many random elements in the development of cities, emergent processes as well as singular events. Urban planning tries to control chance; it anticipates the future, at least as far as the built environment is concerned. NB: Alexander made an attempt to understand the nature of order (Alexander, 2002) and to find ways to identify best spatial solutions in the vast "configuration space" of built environment possibilities (Alexander, 2005), however, these ideas have not yet been anticipated by planning practice.

## 5 URBAN PLANNING

Many measures related to corona spaces rely on organisational means (cf. Sect 1, cf. Sect 2) which can be implemented very quickly on all conceivable scales. On the contrary, urban development visions and plans usually only become effective in reality after a considerable time delay and new approaches such as process-oriented urban planning (Melo & Jenkins, 2019) are rarely used. Therefore, urban planning has only few options in the reaction to an acute virus outbreak. Nevertheless, the question rise what contribution urban planning can provide in preparing for the next pandemic. There are ideas on how to achieve good city form (Lynch, 1984), and there is the view that the new normality is changing cities (Salama, 2020), that that a new

[3] https://www.trtworld.com/magazine/the-massacre-of-italy-s-elderly-nursing-home-residents-35575
[4] https://www.theatlantic.com/politics/archive/2020/03/pandemic-coronavirus-united-states-trump-cdc/608215/
[5] https://www.nytimes.com/2020/04/04/us/coronavirus-china-travel-restrictions.html?auth=login-email&login=email
[6] https://www.bbc.com/news/world-us-canada-52757150

kind new urban planning is needed (Daneshpour, 2020), and there is the call for planning and design professionals with regard to the new tasks (Allam & Jones, 2020). What can urban planning achieve in terms of corona spaces?

### 5.1 Instruments and impact

A general urban development approach is the Vision (Leitbild) which lays down the broad lines of urban development. Although cities are multifunctional, the Leitbild is often monothematic: the garden city, the dense city, the car-friendly city, the smart city, and of course the climate-friendly city with its mitigation of and adaptation to climate change.

How should the Leitbild of a city look like that makes corona spaces a central design principle and thus constructively implements the virus resilient city? An important point of this Leitbild would be to solve the problem of virus resilient mass transport, either by completely new concepts for public transport or by giving preference to individual movements (walking, bicycle, car). Homelessness and informal settlements with their poor hygienic conditions should be eliminated and the lockdown of individual blocks, neighbourhoods, or districts would have to be facilitated. However, it is better to introduce health as a key principle in urban planning (Duhl & Sanchez, 1999) and to develop multifunctional solutions that integrate aspects of virus resilience in a win-win situation (Litman, 2020) than to pursue the monothematic Leitbild of a virus resilient city.

A Leitbild is concretised through concepts and plans, which are worked out for different scales. At the level of the city as a whole there is the instrument of the zoning plan, e.g. the Berlin land use planning 2020 (LUP) under the motto "thinking city ahead" that aims on considering the interrelationships of the city, making provisions for the city of tomorrow, showing development possibilities, considering many interests, and resolving usage conflicts in a transparent manner (Senatsverwaltung-für-Stadtentwicklung-und-Wohnen, 2020). It shows inter alia the activation of housing construction potentials and development areas (cf. Fig. 2).

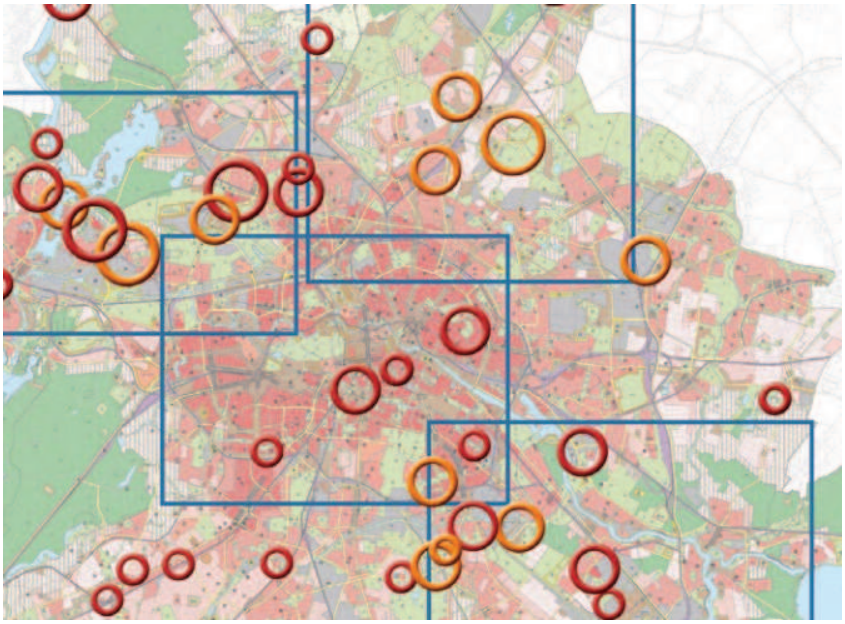

Fig. 2: Berlin LUP: Activation of housing construction potentials and development areas (Senatsverwaltung-für-Stadtentwicklung-und-Wohnen, 2020)

The LUP 2020 report deals with many topics, but the terms pandemic, epidemic, and emergency are not included. Further planning instruments, which cannot be discussed here in detail, complement or support the LUP.

Urban planning affects (1) the overall configuration of an urban area respectively the top level of the urban morphology, (2) the structure of the urban grid(s) as well as the zoning of functions which impacts the density of the built environment, and (3) the urban infrastructure, in combination with several sectoral planning instances (cf. Fig. 3). Both the driving forces of urban development and the political and legal framework play a role when planning form and function of a city.


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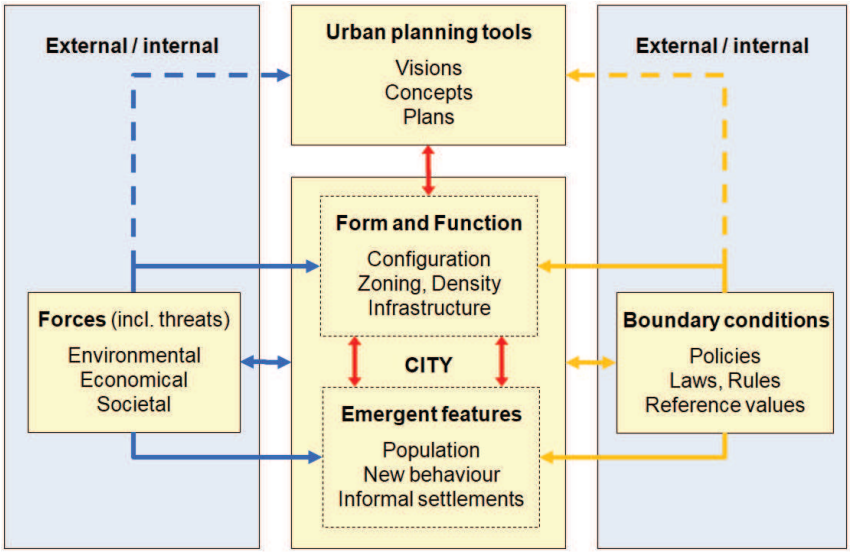


Fig. 3: Simplified representation of urban planning tools and their impact

It would go beyond the scope of this study to consider all fields of action of urban planning in detail, so it focuses on an aspect that is of particular importance regarding the pandemic context, the density.

### 5.2 Density

The very nature of the city is to bring people together and thereby create density. Among the factors that can be influenced by urban planning, building density has always played an important role. Examples are two contradictory urban Leitbilder which were developed by Howard in 1898 and Le Corbusier in 1922. Howard envisaged a system of garden cities for 32,000 to 58,000 inhabitants with large farms and new forests (Howard, 1898), while Le Corbusier proposed the "Ville Contemporaine", a city for three million inhabitants with segregated functions and 60-storey high-rise buildings in the centre (Rabaça, 2016). Both visions strive for different densities, served as a basis for the implementation of urban development projects and are still effective today.

Urban density is controversially discussed considering the spread of the virus: "Density Is New York City's Big 'Enemy' in the Coronavirus Fight"[7] versus "Urban Density Is Not the Problem"[8]. In another statement it says: "In a pandemic, busy urban centres are a big part of the problem. Without speedy and efficient public health measures to counter the infection's spread, the bigger and more well-connected a city, the faster it will travel.".[9]

With regard to the situation in Europe and Germany it was stated that, as a lessons of the corona crisis, cities need density in order to create urban space and thus promote social cohesion - although density is not a value in itself, but must be complemented by social and functional diversity and be defined in terms of urban development.[10] The opposite position emphasises the qualities of the "structured and limber city", such as the European settlement construction of the 20th century, and points out that the simultaneity and correspondence of different milieus make up the diversity and attractiveness of urban life.[11] NB: However, here the satellite settlements of the 60s and 70s which implemented "urbanity through density" (as Leitbild mentioned above) are ignored.

At least for Germany, there are no spatially high-resolution data on the corona pandemic at the level of urban structure types available that could be used to decide evidence-based whether dense development leads to a high incidence of infection. However, the Robert-Koch-Institute (RKI) provides data at the spatially much more aggregated level of German districts. The case numbers are not used here for evaluation, as it is not known who is currently infected and who was already infected. Critical gaps still remain in screening

[7] https://www.nytimes.com/2020/03/23/nyregion/coronavirus-nyc-crowds-density.html
[8] https://www.theatlantic.com/ideas/archive/2020/05/urban-density-not-problem/611752/
[9] https://www.bbc.com/future/article/20200424-how-do-you-build-a-city-for-a-pandemic
[10] https://www.faz.net/aktuell/wirtschaft/wohnen/lehren-aus-der-corona-krise-die-stadt-braucht-dichte-16762304.html
[11] https://www.faz.net/aktuell/wirtschaft/wohnen/warum-grosse-wohnsiedlungen-oft-besser-sind-als-ihr-ruf-16793967.html

asymptomatic people who are in the incubation phase of the virus, as well as in the accurate determination of live viral shedding during convalescence to inform decisions for ending isolation (Younis et al., 2020). The present study therefore uses the number of corona deaths based on RKI data (20/06/2020) instead of corona infected persons, even though it is subject to uncertainties.[12] In order to check whether there is a difference between rural and urban regions, the population density is used as an indicator for the settlement density and compared to the number of coronary deaths per 105 inhabitants.

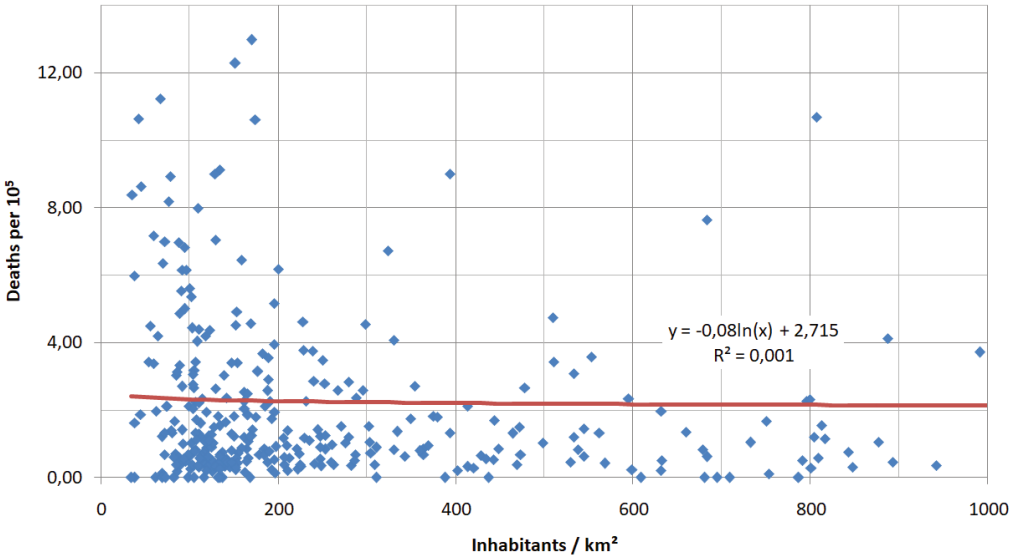


Fig. 4: Germany: relationship between population density and COVID-19 deaths on the basis of districts, extreme values not shown (own work based on RKI data 20/06/2020)

A regression analysis on the basis of districts in Germany (n=400) including the Berlin districts (n=12) yields the coefficient of determination $R^2 = 0.001$, which proves that there is no relationship between population density and COVID-19 deaths (cf. Fig. 4), at least at the level of these spatial units. This is consistent with results of a study examining SARS-CoV-2 infection rates and COVID-19 death rates in 913 metropolitan counties in the USA, which found that county density was not significantly associated with county infection rates (Hamidi, Sabouri, & Ewing, 2020).

An empirically unsupported explanatory approach states that the risk of infection does not increase with density (the number of people per unit area), but with crowding (the number of people within an enclosed space, e.g. vehicle or house): “Most infection risks are associated with specific activities – long-distance travel, worksites, stores and social gatherings – that are similar in cities, suburbs and rural areas” (Litman, 2020). This means (1) that pandemics are not an argument against dense urban structures and (2) crowding reduction (de-crowding) by social distancing or other means are a planning goal for pandemic times. However, as long as an outbreak is not detected and wherever the corona regulations[13] cannot be observed, density is still a problem.

## 6 POST CORONA

To avert similar events as the COVID-19 pandemic in the future, the prevention and control phases of containment of a potentially pandemic virus must be used efficiently. The measures in these phases are organisational and not constructional, but they could be supported by architectural means, e.g. a permanent or rapidly activated reserve of rooms for questioning, medical examination and quarantine of possibly infected arriving travellers at airports and railway stations. If these measures fail, an outbreak can no longer be prevented, but only mitigated.

### 6.1 Pandemic preparedness - lockdown prevention

Concerning urban planning pandemic preparedness should be treated as a cross sectoral planning task. The concept of corona spaces introduced in this study applies to very different spatial scales, but only a few of

[12] https://www.politico.eu/article/coronavirus-the-challenge-of-counting-covid-19-deaths/
[13] https://www.who.int/health-topics/coronavirus#tab=tab_2


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them are relevant for urban planning. In order to operationalise this term for urban planning, it must be narrowed down to areas and measurements, which will become important in the event of a pandemic. Just as flood polders are used to deliberately channel water during extreme flood events, corona spaces should be identified which need to be rapidly de-crowded and in extreme cases become corona voids. The prevention of a lockdown would be the primary planning objective and the arrangement and functionality of corona spaces can be decisive for whether a lockdown is necessary or not. Two cases can be distinguished: (1) Planning measures where pandemic preparedness is an important additional aspect and an argument when different land usages compete on the same area. (2) Planning measures that directly serve pandemic preparedness, such as hospital locations, buildings or areas for temporary reserve hospitals, or places for burial of the dead. The primary planning objective would be to do everything possible in the spatial organisation of a city to prevent a lockdown with its high follow-up costs and to keep the conditions for quarantine bearable. This lockdown prevention is especially important for populations already vulnerable as a result of occupation, class, (im)migration status, religion, gender, race, and other factors and points out that the sudden and unplanned COVID-19 lockdown in India delivered an excruciating blow to those who rely on public spaces such as the city's streets for their basic needs - food, water, shelter (Mawani, 2020).

Although a Leitbild of a pandemic resilient city will not exist, there are many suggestions on how to increase the resistance of a city to a pandemic during the mitigation phase. "The changes will be quite practical, like pop up hand washing stations, and often invisible, like tracking devices built into our sewers. If we do pandemic preparedness right, our cities might look much as they do today – just a little less crowded, with a little more local open space, and with more of the resources they need to support themselves on the doorstep."[14] NB: one component in the urban fabric is already prepared for pandemics: Gated communities are well suited for quarantine and lockdown. Using the example of Guadalajara (Western Mexico) models were developed to understand the role of urban design in disease spreading (Brizuela, García-Chan, Pulido, & Chowell, 2020), lessons can be taken from guarding a city from the COVID-19 pandemic (Xu, Shang, & Cao, 2020) and the sewage system can be mined for real-time information on contagious diseases (Snoweria, Fábio, & Carlo, 2019). The implementation of these measures will vary depending inter alia on the economic status of a city or district. Informal settlements of less economically developed cities will not be able to implement any or only a few measures, making these cities more vulnerable to pandemics. Finally, all pandemic measures, if monofunctional, will only be necessary until a vaccine is available to break the chains of infection.

### 6.2 Trends, enhanced

The pandemic may reinforce existing trends in urban development, as the following examples of transport, public spaces, urban agriculture, and offices demonstrate:

(1) Even before the corona crisis, there were efforts to reduce motorised private transport in cities. During the crisis, for example, roads were closed to car traffic in favour of bicycle traffic, e.g. Bogotá expands bike lanes to curb coronavirus spread: the Colombian Bogotá is opening 76 km of temporary bike lanes to de-crowd public transport, as well as to improve air quality, further 22 km of the new lanes were converted overnight to open on 17 March by reconfiguring car lanes.[15] Municipalities are now trying to keep some of these changes permanently in place.[16] In pandemic times, public transport is - as a permanent mass event that cannot be suspended - the Achilles heel of urban life and finding appropriate solutions to its de-crowding is a particular challenge.

(2) Open spaces such as forests, agricultural areas, and allotment gardens are of great importance during lockdown phases, as they allow recreation when public open spaces like playgrounds and baths are closed. In pandemic times, urban nature offers options for maintaining the well-being of urban populations, while enabling social distancing (Samuelsson, Barthel, Colding, Macassa, & Giusti, 2020) and thus promote de-crowding. Greener cities could be a key component of the COVID-19 recovery[17] – learning from the pandemic illustrates the potential for green roofs, walls and facades on environmental, economic and social

[14] https://www.bbc.com/future/article/20200424-how-do-you-build-a-city-for-a-pandemic
[15] https://www.smartcitiesworld.net/news/news/bogota-expands-bike-lanes-overnight-to-curb-coronavirus-spread-5127
[16] https://www.nytimes.com/2020/06/26/climate/cities-cars-traffic-congestion.html
[17] https://newsroom.unsw.edu.au/news/art-architecture-design/greener-cities-could-be-key-component-our-covid-19-recovery

benefits, including adapting cities to climate change, bringing nature back to city centres for workers and residents, and importantly, creating jobs.[18][19] Lockdown measures have limited the access of people to services and facilities outside of their local areas, whilst lowering the intensity of their usual physical activity and as a result, the green space within neighbourhoods has become more important in hosting people's outdoor activities (Ahmadpoor & Shahab, 2020).

(3) One of the factors that can increase urban resilience is urban agriculture (UA).[20] Here, food is produced in many different forms in an urban context (Lohrberg, Licka, Scazzosi, & Timpe, 2015), including aquaponics (dos Santos, 2016), whose economic viability has been demonstrated in urban applications (Baganz, Baganz, Staaks, Monsees, & Kloas, 2020) and which can make an important contribution to urban food security. UA is seen as an important component of the circular city (Skar et al., 2019), whose concept includes increasing the resilience of cities.

(4) Trends that have been considerably strengthened by the corona crisis are home office and virtual conferences. If this development continues after the crisis, albeit in a weaker form, this could have a direct impact on the development of office locations. In Hamburg's HafenCity, for example, 980,000 m² gross floor space (GFA) is earmarked for offices (35,000 office workplaces) that is 39 % of the total GFA, compared with residential use of 880,000 m² (35 %) GFA for about 7,500 units (HafenCity-Hamburg-GmbH, 2020). Here, placement on the market could become difficult. Co-Working (Manzini Ceinar, 2019) could also be affected by this development. Home office currently means in many cases the integration of an additional function into the home environment. Even if there is already a computer workstation, it is used much more intensively during the home office. So scaling up home office could lead to a further increase in living space concomitant with a reduction of office workplaces in the long term.

## 7 CONCLUSION

When the Corona pandemic is over and the "new normality" becomes the "old normality", the next pandemic could break out at any time (possibly caused by an Eurasian avian-like H1N1 swine influenza virus (Sun et al., 2020)). This study introduces corona spaces and voids to illustrate the pandemics multi scale spatial implications from the human cell to the entire globe. With the borders of corona spaces being central for the prevention, control and mitigation of the pandemics, these spaces are created by the pandemics dynamic. Coincidence plays a role here on various scales, but its impact can be neutralised by appropriate measures, especially in the prevention and control phase of the pandemic combat. If prevention and control are successful, a mitigation phase is not necessary.

Assuming that a pandemic era begins, cities must increase their resilience to a pandemic. Urban planning can help to contain outbreaks, but should not follow a monothematic Leitbild of a virus resilient city, but rather develop multifunctional approaches that integrate aspects of pandemic preparedness, e.g. measures against the climate crisis that also mitigate a virus outbreak, like inter alia bike lanes. Pandemic preparedness means reducing public health risks and should be a goal of community planning. It is a cross-sectional task that should be taken into account in as many plans as possible, comparable to the transformation towards sustainability.

Urban planning can help prepare a community for a pandemic, at least in the fields of de-crowding, well-being, and partially self-sufficiency. De-crowding is a major issue concerning lockdown prevention. Avoiding crowded public transport in pandemic times is a task, and one option for its solution is to change the modal split by significantly strengthening the cycling infrastructure. Movement reduction is another option that can be implemented by home office. Well-being of urban populations by providing green infrastructure is of particular importance during lockdown measures, as they restrict people´s access to services and facilities outside their residential areas. Partially self-sufficiency through the expansion of urban agriculture can increase resilience to food shortages that could occur as an indirect consequence of a pandemic.

[18] https://about.unimelb.edu.au/newsroom/news/2020/june/green-cities-roadmap-should-be-part-of-covid-19-recovery-stimulus,-experts-say

[19] https://cpb-ap-se2.wpmucdn.com/blogs.unimelb.edu.au/dist/c/359/files/2020/06/Roadmap-for-Green-Roofs-Walls-and-Facades-Summary.pdf

[20] https://www.resilience.org/stories/2020-05-12/urban-resilience-learnings-from-covid-19/


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Further research is needed to substantiate the findings of this study. Terms: regarding urban planning, corona space is an overarching term, as is social infrastructure or the industrial area (behind which very different realities exist), but it has to be evaluated. Another question concerning terms is whether "de-crowding" should be favoured over "crowding reduction". Scenarios: significantly better preparedness in the inter-pandemic phase is needed by using models and scenarios to clarify the social and economic impact: (1) what type of pandemic is expected, (2) how expensive will the various lockdown levels be, and (3) how expensive the measures to prevent a lockdown can be. Density: case data are needed at the level of urban structure types to further investigate whether dense development leads to a high incidence of infections. Zoning: research in the field of urban planning could demonstrate how infrastructure and zoning influence crowding, e.g. at present the separation of land use by zoning leads to traffic as a possible source of crowding. Here, the city of short distances in combination with superblocks could reduce the separation of living and working.

The last research task is a good example of integrated urban planning that also takes into account pandemic preparedness. And cities are well advised to prepare for the next pandemic, even if coincidence determines when it occurs.

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