The rearticulation of urban processes within China's HSR small cities: empirical observations through data-informed diachronic maps.

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Short abstract:

This paper looks to the transformations that are currently underway in those Chinese territories that are identifiable as "small cities" (Gu, Li, Han 2015), and which for a long time were excluded from the dramatic spatial and demographic expansion of China's major mega-city regions. Particularly, we focus on the small and medium-sized towns that are situated along major transportation corridors, promoted in the frame of a large scale High Speed Railways infrastructural plan, which in only one decade connected densely urbanized areas and interstitial territories.

The importance that small cities in China have recently acquired is part of a precise political development plan that aims at reducing internal demographic and social inequalities and redistributing the urban population from first and second level cities to smaller ones. There has been subsequent increase in the academic interest on urban growth in these small Chinese cities, which in many cases still reveal a complex "urban-rural binary" (Kendall 2015). However, many of these studies have focused on highlighting the tensions and contradictions in terms of social and economic restructuring, while the forms and features of these urbanization processes—particularly in terms of spatial transformations—have certainly received less attention. The analysis of this latter aspect therefore represents the main objective of this contribution.

1. Introduction

Starting from a wide georeferenced database of Chinese High Speed Railway (hereafter HSR) stations and new urban settlements developing with and around them [1], this paper focuses on small towns located in China's interior geographical areas. Until about ten years ago, small towns of the interior had remained outside the strategic national developmental interests of the country; in recent years they have started to appear in governmental plans and are now invested by a round of strong urbanization processes.

During the last four decades, China has been characterized by a fast-paced urbanization (Wu et al. 2016); according to official statistics, in 2014 the 54.77% of its population could be considered as urban (Zhang, Han 2009). Although this is still a relatively low figure compared to the average of both developed and developing countries (Chen, Zeng, Xie

1 See the paragraph on methodology, "research design," for an extensive explanation of the way the database is structured and the use we make of it.

2000), it shows a growing trend as a direct consequence of a number of institutional measures.
Many actions have been carried out by China's central government in order to further increase the amount of urban population in the country, many of which were additionally confirmed into the National New Urbanization Plan (2014-2020) released in 2014, which envisaged China's urbanization level to reach at least 60% in 2020 - meaning that about 100 Million rural population [would] become new urban residents (Zhang, Han 2009) - and at least 70% in 2025 (Johnson 2013).
In order to reduce the pressure on increasingly overcrowded large cities around which growth has long been centered in a context of accelerating urbanization (Qian 2017), these political and strategic projects aim at integrating and resettling the rural population into small towns and medium-sized cities[2]. More precisely, both the 12th and 13th national Five Year Plans, drafted respectively in 2011 and 2016, have radically changed some of the country's main lines of development, by including "small towns located in central areas as part of the 'locomotives' of the country's economic growth and destinations for both investors and migrants" (Chen, Zeng, Xie 2000; Ye & Xie, 2012). In this context, the term "cheng shi hua" (urbanization or population shift to cities) was thus replaced by the term "cheng zheng hua" (population shift to cities and towns) (Wang, 2012).
In terms of spatial and territorial planning, the critical role of small towns in the regional context was promoted by the National Urban and Rural Planning Act, which "revised the traditional city-centered planning strategies and included small towns and rural areas in the formal master planning mechanism, emphasizing the concept of city-region as a spatial context for planning" (Qian & Xue, 2017).
However, all those plans were also fostered and strongly supported by a new steadfast infrastructural plan that envisaged the development of a colossal HSR network as one of its key points. In this respect, on April 18, 2007, the CRH (China Railway High-speed) was launched for the first time in China. This new transportation route marked a breakthrough development, not only in terms of technological transfer, but also in terms of social and economic effects. In less than 10 years of development, HSR lines massively spread into the whole country (fig. 1), thus connecting many of those places which were previously considered marginal and have now been designated as strategic centers of China's internal development (Qian 2017).

[Figure 1]

During the last four decades, a huge amount of literature on urban China focused on the previously unseen urbanization of big coastal cities (Particularly the sonamed first and second tiers cities), stressing its striking numbers (Anderson, Ge 2005; Zheng, Saiz 2016),

2 Following Kendall (2015), this classification of "small city" is based on a "sophisticated" five-tier hierarchy that is based on "considerations of administrative ranking, representational power, city dynamism and citizens' self-identification" (idem: 665) In this administrative hierarchy, the threshold between small towns and medium-sized cities is 500.000 inhabitants

its quality (Zheng, Fu, Liu 2008; Zhou et al. 2015), its social effects in terms of accessibility (Li, et al. 2015) , inequality (Li 2012) and environmental sustainability (Fleisher 2015). More recently, authors have started to look at rural China and its relationship with small but expanding urban centers, directing their attention to the institutional structures and changes of these settlements (Kendall 2015), their economic or their social restructuring in terms of accessibility (Lin 2003; Ma 2002), inequality (Qian 2017) and changes in migration waves (Zhang, Han 2009). Less is known about the physical transformation of small cities, the form and the speed of their urbanization, as well as about their relations to the infrastructure that is intensifying or at least supporting this change. Further, we observe that many studies (Wang, Gu 2019; Zheng et al. 2016) employ quantitative methodologies to demonstrate the reach of the HSR phenomenon on interior areas in China, employing a macro-scale level of analysis that allows to comparatively assess the impact of infrastructuring processes - but not their form; conversely, we propose to employ qualitative methods of observation, relying on diachronic mapping at different scales, to observe actual spatial transformations that are occurring in the specific places we analyse, thus aiming at displaying different types of cause-and-effect relationship occurring between infrastructure and urban growth.

Starting from the observation that HSR infrastructurization is having a prominent role in driving and boosting a socio-economic restructuring of urban environments (also described in terms of “urban vibrancy” (Zheng et al. 2016), we ask whether this restructuring has identifiable spatial characteristics in the case of small towns; further, we ask what the most effective way is, to examine and measure such spatial characteristics in terms of dimensions of built-up area, direction and expansion of its growth, and change in its morphological structure. In this way, we set out to observe actual instances of spatial transformation - for instance, from rural grid to urban infrastructure and objects, from villages to housing estates, and so on. Finally, we aim at showing that, even though it is possible to identify comparable patterns of growth when small towns are reached by HSR, each settlement features its own specific dynamics of urbanization, and that a close observation of those specific dynamics allows to assess the role of other factors concurring to the process of spatial restructuring, thus avoiding a deterministic view of the relationship between HSR and urban growth.

The rest of the paper is organized as follows. First, we provide a methodological understanding of our work, particularly focusing on the design of our research - and showing the relationship between observed objects and scale/method of observation. In the central part of the paper, we work with three methods of representation at two scales of analysis, each attempting to unpack one specific aspect of the working hypothesis. Finally, some concluding remarks are provided.

2. Research Design:

This paper is the result of a collaboration between Politecnico di Torino and Massachusetts Institute of Technology and builds on an ongoing research carried out by the China Future City Lab at MIT around the correlation between infrastructurization and urban vibrancy in China. The research consists in the construction of a database allowing to evaluate the vibrancy of cities that have grown around HSR stations[3]. In this perspective, HSR stations are inferred to be one of the main drivers of the “new town” (Bonino et al. 2019) urbanization surrounding them, as such urbanization exists in such form as a direct consequence of the construction of HSR stations, and - more broadly - of the political intention of urban expansion which the construction of these stations is a part of.
In order to reflect on the relationship of cause and effect between HSR infrastructuring and urban growth, we focus on cities of smaller size of the interior, where the changes brought by the building of an HSR connection can be observed more easily. Therefore, from the 261 cities of the initial database we select those having around 500.000 inhabitants - identified as the threshold between “small cities and towns” and “medium-sized cities” according to the Chinese ranking of cities by size (Gu, Li, Han, 2015: 114), leaving us with 29 new small/medium cities and towns. This result allows us to identify a section of an HSR line that has the most presence of small and medium new towns responding to the criteria employed, namely the HSR line connecting Guiyang and Changsha, within the Shanghai-Kunming line, which is highly representative of governmental “go-west” policies (Sun 2016) attempting to shift the pressure of urbanisation from coastal cities to the interior. This East-West line constructs a link between two very distant and different regions: on the one hand the east coast, the most historically developed area; on the opposite side, one of the least integrated regions in national development plans, Yunnan, with its capital Kunming. This infrastructural axis connects places that up to a decade ago were considered part of "rural China" and were characterized by the preeminence of villages and "small towns” (Han 2010). Within this wider line, we select a portion connecting the capital of Hunan province and the capital of Guizhou province, Changsha - Guiyang (Figure 2). Along this section of the line, the four towns of Guiding, Kaili, Huaihua and Loudi answer to the criteria employed in our study. To these, we add the town of Xiantang, a slightly larger medium-sized city of around 1 million inhabitants, which has two HSR stations along two different lines, allowing us to observe a clear vectorial growth in two directions; and Liupanshui as a case of similarly-sized town in which no HSR station was built, but similar patterns of growth can nonetheless be observed.

3 Siqi Zheng, Carlo Ratti, Lei Dong, Rui Du, Matthew Kahn, “Can High-speed Rail Station Support a New Town? Empirical Evidence from China,” in progress.

[Figure 2]

In observing these towns, we focus on the urbanization process and the investigation of changes during time, we employ different kinds of diachronic mapping of these cities and of their pattern of growth (footprint of built-up area, direction of growth, changes in urban texture). The following cartographic and diagrammatic representations are produced using OpenStreetMap, EOC Geoservice, Axismaps, ArchGis, as well as Google Earth historical datasets, from which we retrieved the boundaries of built-up areas and its morphology in two significant moments in time: 2008, when the Ministry of Railway announced the HSR plan (Huang et al. 2018), and 2018 as the most recent available dataset - thus showing the furthest possible stage of development in terms spatial transformations.

Starting from a comparative study of selected cities, we move to a closer observation of the urban morphology of Kaili as a way to observe these changes at a closer scale. In total, two main scales and three methods of observation were adopted in order to multiply the narratives and perspectives and create a tension between different representations of changes. We assume that different scales and methods of observation allow us to verify different hypotheses and to draw on different and even overlapping results. Table 1 synthesizes the different steps of the research, displaying per each of those, the general objectives, approaches and observations that could be retrieved.

In doing this exploratory work, we aim at providing a small contribution to the way rural to urban China's binary is understood, by investigating both qualitatively and quantitatively the impact of a large infrastructure (the HSR line) on the urban growth of small cities, and the corresponding spatial restructuring.

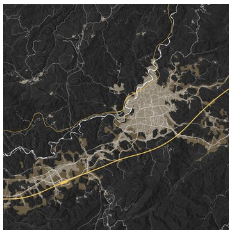
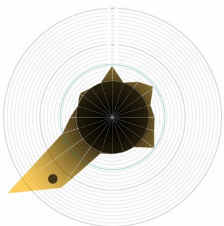
Scale	Hypothesis	Represented elements	Variables	Observations
City/territory (cartographic map) 	By observing the change in urban footprint it is possible to analyse the correlation between the building of HSR infrastructurization and urban growth	- HSR station and line - Other infrastructures - Built-up area - Topography	- Time (before and after) - Dimension (cartesian growth)	The difference in growth between HSR towns and non-HSR towns is sensible but not substantial
City (diagrammatic map) 	By quantifying the direction of growth it is possible to show the role of HSR stations as attractors of growth	- Normalization of built-up area - HSR station - Barycenter	- Time (before and after) - Direction (vectorial growth) - Presence of station	HSR stations are but one of multiple factors of growth
Portion of city (morphological map) 	By analysing the changing form of the city it is possible to reflect on the type of urban restructuring that HSR stations - among other factors - engender	- Urban objects	- Time (before and after) - Form (superimposition of urban objects)	Although not sufficient in determining its characteristics, changes in urban form suggest that the city is undergoing a rural-urban restructuring

Table 1: research design or [Table 1]

3. Mapping the spatial configuration of HSR Chinese small towns

[Figure 3]; [Figure 4]; [Figure 5]; [Figure 6]; [Figure 7]

The five maps (figures 3-7) focus on three main elements: extensions of built-up area, orographic conditions of the territory and main infrastructural lines (major roads and railway lines). This simplification of a complex space-territory allows to isolate the city's expansion in terms of built-up area as a result of - among possibly other less impacting factors - the introduction of HSR infrastructuring within specific orographic and infrastructural pre-existing conditions. This factor is also quantitatively confirmed in the following steps of the research.
Looking comparatively at the five maps, we can observe some common traits among them - namely, the location of the HSR stations and the directions of urban growth are convergent; as well as some notable differences - in some cases (e.g. Kaili and Xiangtan) there is one clear main direction of growth overlapping with the position of the station, while in others (e.g. Huaihua and Loudi) the pattern of growth is more diversified, hinting at a more complex infrastructural and orographic system. In order to measure the significance of such categories with respect to the presence of HSR infrastructure, in the following section we rely on the adoption of quantitative diagrams that allow us to compare the five HSR towns with five non-HSR towns located in the same area and featuring comparable size.

[Figure 8]

This second visualization method (Figure 8) provides an abstract representation of some selected towns and their growth during time. These schematic representations are elaborated as follows: a first circle represents a normalization of built area in 2008. All the other concentric circles indicate percentages of growth (10% per each circle). Thus, having set the reference system, the direction and amount of growth between 2008 and 2018 is indicated as a yellow bounded area. The aim of this analytical device is to provide quantitative measures of growth in three sets of towns along the chosen infrastructural line. The first two sets are comparable in terms of original (pre-infrastructuralization) size: one set of five towns that have a HSR station, and a set of towns that do not. This latter set is made of 16 Prefecture-level cities (thus, indicatively, cities between 500.000 and 1m inhabitants) across Hunan and Guizhou, of which we chose to represent the two cities with the lowest percentage of growth (Changde and Yiyang), the two cities with the highest percentage of growth (Xiangxi and Chenzhou), and the city with closest to a weighted average percentage of growth (Zhangjiajie).

The third set shows five County-level cities (below 500.000 inhabitants) dislocated along the HSR infrastructural corridor.

Looking at the first set, it is immediately possible to verify that the location of the HSR station is one of the main factors - if not the main factor - influencing the direction of growth within towns. In many of these cases, the building of the station coincides with the development of a new town. Non-HSR towns of similar dimensions (second set), on the other hand, feature a much less polarized direction of built-up area expansion. In this case the direction of growth is influenced by a broader set of elements, such as infrastructural corridors (roads, railways), topography and existing settlements. Also, it is possible to see that the average growth of non-HSR towns (second set) is quite lower than that of HSR towns (first set). Somewhat counterintuitively, though, the diagrams of the third set show that smaller non-HSR towns along the infrastructural line grow even more sensibly than the HSR towns of the first set. Although this data is biased by the different dimensions of the towns in the two sets, it may point toward the possibility that the effects of the infrastructure exceed the single urban agglomeration. For all these reasons, the HSR line cannot *a priori* be considered the main driver for the development of a small town, but rather its role as one of the multiple and overlapping factors influencing their growth in terms of built-up area is to be assessed case by case; or, conversely, we can assume that the type of transformation occurring as a result of HSR infrastruring cannot be described as merely - or only - quantitative (an expansion of built-up area), but also as qualitative (substitution of one type of texture with another). Clearly, this type of transformation cannot be observed at this scale of analysis, which does not provide any further information on the nature of the built environment, its structures, as well as its morphology and land use. All these factors, which are worth of investigation in order to better comprehend the development dynamics of China's small towns, are observed in the following section of the paper adopting a different method and scale of representation.

[Figure 9]*;* [Figure 10]

The third and last type of maps is based on specific portions of the built environment in the town of Kaili. More precisely, we select plots of land of 1 square km, a dimension that allows us to investigate the built environment at an urban scale. The single portions are selected along the axis that connect the new HSR station to the existing city center, as those most representative of a type of transformation that points to social, economic, environmental and cultural changes, and to a distinction between rural and urban categories that is still in need of redefinition. We refer to Kendall 2015 for an articulation of this issue on the specific case of Kaili, drawing on a wider debate around the need to unpack the "metanarrative" of the urban (Brenner 2016: 121), the "ordinariness" of urban agglomerations (Robinson 2006) and the "planetary" scale of urbanisation (Merrifield 2011; Brenner and Schmid 2014).
Specifically, two selected areas were mapped diachronically to show the change in texture. The first map [Figure 9] highlights the transition from an industrial site to a middle-class housing estate. New residential settlements such as this one pursue and promote a very

specific idea of urban life, shaped around those housing models that firstly appeared within first and second-tier cities during the previous period of economic and housing reforms (Zhang 2010). This transformation can be connected to the location of the site (riverside), as well as to a “nationwide shift away from industrialism” (Kendall 2015: 668) that translates into specific substitutions of urban texture that are most visible in areas close to the town center such as this one, whereas low-density productive and service areas move outwards.

The second map [Figure 10] shows a portion of land closer to the HSR station, where a rural settlement composed of villages and agricultural grids gives way to new infrastructural connections, newly built residential complexes and an amusement park. This again suggests a radical spatial transformation that can be easily connected to a broader socio-economic change occuring in the frame of rural restructuring phenomena (Hoggart, Paniagua 2001); As Qian (2017) describes it, “there are two main phases in a transition from village life to urban life: the first involved the population status change and physical form transformation, and the second, which is more fundamental, entails changes in former villagers’ values, ideology, culture, perception, behavior, employment, lifestyle, mindset, etc.” (idem: 35).

Although these two maps cannot nearly provide an exhaustive picture of a similar change, they can nonetheless point towards a possible way to observe these changes which has been up to now overlooked.

4. Concluding remarks

The main results of this exploratory research can be summarized as follows: it is possible to show that the introduction of HSR stations has contributed to the growth of small-and-medium towns of the interior as part of a political plan of development. Nonetheless, it is also possible to show that HSR stations are not the only driver of development - as many towns that do not have an HSR station show a similar order of growth. For this reason, it is necessary to carry out a qualitative observation of the transformations, by zooming in and looking at the specific changes in urban texture. In this way, it is possible to observe that the section of the town connecting the station to the previously existing urban center is the section of the town that offers the most significant types of substitutions, as for instance from heavy industry to dense urban housing, or from agricultural grids to amusement park. Although we do not yet have sufficient data to draw falsifiable conclusions from this last scale of observation, it nonetheless seems indicative of the fact that closer and more qualitative analyses are needed in order to fully understand this complex but extremely rapid reshuffling of the "urban-rural binary" (Kendall 2015) in China’s small towns.

Captions

Figure 1. Overall view of China's HSR network development between 2008 and 2018 (Elaboration by Matteo Migliaccio based on China Railway High-speed (CRH) official map - online edition - january 2019).

Figure 2. Territorial view of HSR cities with station in the Changsha - Guiyang line (elaboration of cartographic data by Matteo Migliaccio).

Figure 3. Diachronic map of Guiding built-up area growth between 2008 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 4. Diachronic map of Kaili built-up area growth between 2008 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 5. Diachronic map of Huaihua built-up area growth between 2008 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 6. Diachronic map of Loudi built-up area growth between 2008 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 7. Diachronic map of Xiangtan built-up area growth between 2008 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 8. Schematic representation/quantitative measure of built-up area growth in 5 HSR Towns and 5 non-HSR Towns between 2008 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 9. Morphological changes in Kaili built-up area between 2011 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Figure 10. Morphological changes in Kaili built-up area between 2011 and 2018 (elaboration of cartographic data by Matteo Migliaccio).

Table 1. Indication of maps at different scales in relation to hypothesis, variables and results of the research (elaboration of cartographic data by Matteo Migliaccio).

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