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Perspectives on Urban Infrastructure History and the Social Sciences
Theme: The Fragile City: Creation, Expansion, Collapse and Resilience

Cold Infrastructure

Economic, Ecological and Social Implications of a Fragile Materiality of Urban Architecture and Thermal Infrastructure in Chongqing (China)

Introduction: Weathering in the City

Weather and climate are very prominent topics in people's everyday lives, even if in urbanized societies, the time residents actually spend outdoors has decreased in recent years (Hitchings 2011). Ironically, "the more weather we watch on TV the less time we spend in it" (Seabrook in Rayner 2003, 281). The creation of heated or cooled indoor microclimates alleviates the harshness of the outdoors (Roesler and Kobi 2018). Dwelling as a form of place-making is one of the most important parts of weathering practices:

> To weather is an active, reflexive, practical disposition to endure, sense, struggle, manipulate, mature, change, and grow in processes that, over time, implicate the place-making of one's dwelling. To weather, in short, is to dwell. […] In its most basic denotation to dwell refers to inhabiting, to organizing space, and to cultivating a relationship with place. (Vannini et al. 2012, 362–63)

In urban areas, dwelling is happening mainly in multi-story (high-rise) buildings, where indoor climate control is not regulated by passive means of climate control—as documented for detached rural and vernacular housing (Rapoport 1969; Fathy 1986)—but where regulation of microclimates is related to the built infrastructure. Heating and cooling practices for maintaining a homogeneity of indoor climates are far from being simple biophysical processes that regulate the temperature of the individual body. Rather, these practices are related to the existing heating infrastructure, to social and cultural forms of regulating the thermal environment and to the availability of energy and natural resources. In short, warming and cooling practices are part of a broader urban political ecology.

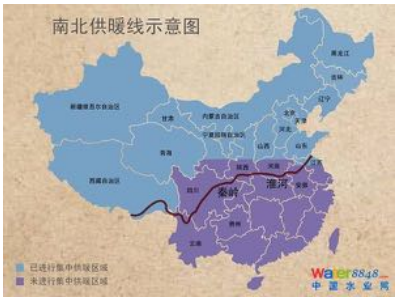
This ethnographically-grounded paper engages with thermal-material practices in the winter season of Chongqing, a city in southwest China. With regards to the conference theme of the

fragile city, it inquires into the economic, ecological and social responses of urban residents to the non-existent heating system and a generally fragile housing infrastructure.

Geographical and Climatic Context of Chongqing

Chongqing has a population of roughly 8 million inhabitants and a densely populated inner city area dominated by high-rise buildings. The local subtropical climate allows for pleasant autumn and spring season, but demands adaptations of residential practices in summer and winter. Chongqing's summer months July and August are extremely hot with average temperatures around 35°C; its winters are comparably mild with temperatures on the coldest days ranging between 5 and 10°C. Further, Chongqing has few sunshine days in winter (only 1 out of 7 days) and a very high humidity of around 80% all year round.

Weathering practices in Chongqing are related to the particularity that Chongqing is located south of China's Heating Demarcation Line (Ch: *zhongguo gongnuan fenjiexian*) and lacks of an official (district or central) heating infrastructure. This government policy was introduced in the 1950s in times of resource scarcity. Almost half of China's population lives in the non-heated zone, although the more south you get, the milder winters are. Of particular interest with regards to a lacking heating infrastructure is the northern part of the south, the so-called "hot summer and cold winter zone" (*xiare dongleng diqu*), where several mega-cities like Shanghai, Wuhan, Chengdu or Chongqing are located. In terms of thermal indoor regulation, north and south of China are clearly separated and the political separation has implications on the thermal management of indoor spaces.



Map of China's climate zones and China's Heating Demarcation Line (*zhongguo gongnuan fenjiexian*). (Fig. 1: Liu, Meyer and Hogan 2010; Fig. 2: http://www.iepz.cc/New/View.aspx?ID=6389)

The data for this paper stems from four months of ethnographic fieldwork in Chongqing conducted in August/September 2017 and in December/January 2017/2018. The main research methods included "*Reading the façades*" (a kind of mobile ethnography where I assess the built environment through walking and seeing different neighbourhoods for sensing the materiality of today's architecture); semi-structured interviews and visit of interlocutors' apartments for inquiring into the thermal-related practices; and expert interviews with architects, engineers and others involved in the construction industry.

Fragile Materiality of Urban Architecture and Thermal Infrastructure

When using the term "fragile materiality of urban architecture" in the context of Chongqing's housing stock, I do not mean "fragile" in the sense that the buildings are about to collapse in a literal sense, but they are fragile and "cold" with regards to their thermal properties. Fragile infrastructure can challenge citizen-state relationships in different ways. Chu (2014, 361), for example, reminds us that shifting atmospheres in to-be demolished neighbourhoods in Shanghai can be felt in infrastructural ways, "[…] through the leaky roofs, punctured walls, and other breakdowns of home insulation, as people found themselves increasingly exposed to such elements […]." Or Laszczkowski (2015) analysed the potential of scrappiness and material decay in the Post-Soviet context to form new citizen-state relationships in a neoliberal period.

In Chongqing, the fragility of urban infrastructures is an inherent feature of the political economy. Since the 1990s and a decentralizing land management, leasing land to the construction industry became a major field for municipal governments to generate financial incomes. The construction of fragile buildings is desired as they nourish the capitalist-oriented real estate and national economy. According to Qian (2010), every year about 40% of the urban construction area is being created through demolition. And Liu, Meyer and Hogan (2010, 98) mention that in 2030, 40% of the building stock in China will be

constructed after 2010. This results in a planned architectural obsolescence (Abramson 2016) which guarantees continuous working possibilities for construction companies. Chongqing's urban architectural history reaches back to the 19th Century and the establishment of an urban centre around the port. Shortly after, a number of foreign embassies in colonial-style architecture were being built. Urban residential architecture in the 20th century was dominated by stilted houses (*diaojiaolou,* lit. "hanging feet building") along the hilly terrain of Chongqing. They regulated indoor climate conditions mainly through passive means, e.g. facilitating ventilation, combating humidity through breathing bamboo walls (*hui huxi de qiang*), and minimizing the summer sun radiation through the attached building structure (see, e.g. Tian and Zhou 2015, 155-58). Those houses have, however, not included ways to deal with the mild, but still cold winter season.

Stilt houses in Chongqing. (Fig. 3: Tian and Zhou 2015, 155; Fig. 4: Luo 2011)

Between the 1960s and the 1980s, a new housing typology emerged: the characteristic socialist six-storey buildings, often arranged in work unit compounds (*danwei*). Historical data shows that in the 1960s, house fundaments were often built out of locally available slabstone (*pianshi*) or rubble (*maoshi*); walls were made out of earth (*tuqiang*), stones (*shitou*) or bricks (*zhuan*) (CSCJGW and CSJGJ 1997, 130). In 1985, still 33% of the urban housing stock was built with bricks and wood compared to 50% built of steel, concrete or mixed constructions (CSCJGW and CSJGJ 1997, 87). In Chongqing, houses from the 1960s and 1970s had very thick walls (about 60-70 cm) providing a relatively good insulation, but buildings that were constructed in the post-reform period lack this insulation capacity.

Characteristic six-storey socialist houses in Chongqing (Photos M. Kobi).

Since the 1990s, and the popularization of elevators, more and more high-rise constructions have appeared. Due to their lack of insulation materials in the outdoor walls, an effective (and energy-efficient) cooling or warming of indoor spaces through passive means is impeded. Several problems exist with regards to the sealing of the outside walls (in both high-rise and six-storey buildings): insulation has only become mandatory in recent years,[i] windows are still often single-glazed, and there are air-leaking spots in the façade, e.g. where split-unit air-conditioners are installed. This results in a "[…] poor performance of these buildings" (Fernandez 2006, 54). The long neglect of insulation as energy-efficient measure is not unique for China, but also in other subtropical contexts, insulation regulations were only introduced recently, e.g. in Australia in 2006 (Hitchings et al. 2015, 164). Nevertheless, a close observation of adapted facades of buildings built before the 1980s reveals today's importance of sealed indoor spaces: in many cases, former openings are being bricked in or plugged with cloth to seal rooms for an effective use of the air-conditioning system. The first buildings in Chongqing with a controlled indoor climate (temperature, humidity, air quality) were being constructed in the 1960s (CSCJGW and CSJGJ 1997, 164), but the popularization of this technology is rather a trend of the last two decades.

The guidelines for insulation that became mandatory in recent years are complemented by various national and local standards under the umbrella term of "energy efficiency", such as *Green Building Evaluation Standard* (GB 50378-2006), the Chongqing-related *Design Standards on Public Building Energy Saving (Green Buildings)*, (DBJ50-052-2016) or the

Design Standard on Residential Building Energy Saving 65% (Green Building) (DBJ50-071-2016). Some prestigious building projects can afford to certify their constructions with international standards such as LEED (Leadership in Energy and Environmental Design). These measures are part of a larger framework for promoting Co2-low and sustainable urban developments in China.

However, the implementation of sustainable development goals in the urban building industry seems more difficult than its proclamation: while designs may meet the codes, there is little control of the actual construction project. In particular, Romano (2014, 238) mentions the lack of financial returns as one of the hindering reasons for construction companies and building owners to invest in insulation materials. In general, we find a lack of trust towards construction companies because "if something can be done with cheap materials, construction companies will do it, even if more ecological-friendly materials such as triple-glass windows are now available," as an architect from Chongqing commented, adding that house owners in general care little about green architecture because they cannot trust companies that those really include insulation materials: "Basically, anything can be in the wall interior as residents cannot verify the materials."[ii]

This urban housing market where inhabitants are not directly involved in the construction of their homes and constructors are not interested in inhabiting the houses they build, leads to a classical "principal-agent problem" well-known in energy studies: the construction of a more energy-efficient house costs more than building a fragile house and does not rise the price of an apartment. So constructors (as "principals") choose to invest less as best option for them. The owners (the "agents") search for inexpensive ways to heat or cool their apartments, documented for example by Sahakian (2014, 153, 157) for the case of the Philippines.

Residents' Responses to Missing Heating Infrastructure

Due to the lack of insulation materials in the walls of new buildings and the lack of a heating infrastructure, most buildings in Chongqing fail to provide warm indoor spaces in winter. In

winter, without the intervention of residents, indoor and outdoor temperatures are basically the same. In order to weather in their apartments, residents compensate the construction deficiencies of the walls with an own "system of thermal-material culture" (Shove, Walker, and Brown 2014, 118). It is in and through a large diversity of objects and devices that residents cope with the "cold infrastructure" that results from the political and economic context. In the words of Shove, Walker and Brown, "[i]n technical terms, indoor climates are outcomes of dynamic processes of heat transfer through and between air, people, furniture, fans, heaters, walls, objects, etc. and the components and molecules of which these are made" (Shove, Walker, and Brown 2014, 115). The main objects used to mitigate winter cold in Chongqing include air-conditioning,[iii] heating blankets (*dianre tan*), small electronic heating devices (*nuanqi pian*, *qunuanqi* or *xiao taiyang*), electric underfloor heating (*dinuan*), hand heaters to carry in the pocket of your jacket, special indoor underwear, electric shoe-warmers, heating plasters (*nuan baobao*), quilted pyjamas and so on. Due to the nonexistent insulation, people insulate themselves, for example with quilted pyjamas which are an inexpensive way to stay warm.

Despite an outdoor temperature of 5-10°C, weathering practices include the opening of windows and balcony doors permanently as this combats the high humidity and levels temperatures. When the windows are closed, indoor temperatures are often cooler than outdoor temperatures without the intervention of heating systems. Even in that case, it is difficult to guarantee a steadily warmed environment and a comfortable warmth depends on many factors as a heating engineer from Shanghai commented: "[…] it makes a difference whether we use a heating radiator, an underfloor heating or an air-conditioning unit. If we use the air-conditioning in the heating mode, we only produce hot air. It might be comfortable to sit in front of the unit where the hot air is coming out, but the heat is only temporary. The walls remain cold and so does the room."[iv]

Recently, middle class residents also consider the installation of electrical underfloor heating. In comparison to the north of China, where underfloor heating runs with hot water and where

heating is state-subsidized, in Chongqing the financial means of a family decide whether they are capable and willing to pay for the installation and the later running of an underfloor heating.[v] The use or non-use of a device heavily depends on the available economic means. This is not a particular feature of developing economies such as China. Also in other mild winter places we find a similar situation. Cupples, Guyatt and Pearce (2007, 2889) analysed heating practices among residents in Christchurch (New Zealand) and found out that both socio-cultural and economic reasons determine people's heating practices. Some devices such as "central heating, double glazing, or insulation were 'way too expensive' and were [considered] an unnecessary and excessive luxury" (Cupples, Guyatt, and Pearce 2007, 2889). In Chongqing, buying a quilted pyjama is a rather cheap option as it needs no maintenance costs. On the contrary, using a heating radiator for a few hours in the evening means an extra electricity cost per day. Many lower middle-class people deem the costs for using the air-conditioning system in winter as too expensive.

Besides such cultural and personal preferences for certain heating devices, we also encounter a difference between age groups. Elderly residents in Chongqing often make use of traditional, thermal methods for getting warm, like the foot bath (*paojiao/tangjiao*). It used to be a custom in the evening to put feet into a warm-water bath which stimulates blood circulation of the whole body. The conventional method involves a bucket and some warm water, but today, there also exist electronically-driven warm-water tubs – sometimes even with integrated foot massage function.

Thermal Infrastructure, Citizen-State Relationship and Biopolitics

Within three decades, residential life in Chinese cities such as Chongqing has changed drastically. The thermal-material culture transformed along with urbanization, the verticalization of living spaces, and a liberalization of the energy and housing market. More passive means of climate control through architecture were superseded by a thermally fragile architecture and a diversity of energy-dependent devices indoors. With regards to the very

hot summer temperatures and the winters without heating installations, policy-makers, architects and engineers have shifted the thermal responsibility to the inhabitants. The provided ethnographic accounts outline that weathering practices as a response to the "cold infrastructure" depend on economic means, age, native place, thermal experiences and cultural notions of thermal comfort.

As Gupta (2015, 563) outlines, energy politics are closely related to biopolitics. While in northern China, the state warms the bodies of its citizens through the provision of heating and attaches these regions closer to the nation state, people in the southern part are themselves responsible for the heating of their bodies. Because houses are built with thermally poor materials, Chongqing residents heavily depend on electricity for their devices to warm their apartments. This concerns small objects such as heaters and electric sleeping blankets, but also the emerging trend to install underfloor heating. However, the growing energy supply for heating in winter is a smaller problem than the energy consumption of almost permanently running air-conditioning units in summer.[vi]

So far, the Chinese state managed to stifle dissent caused by people living in the non-heated zone through the subsidy of the electricity infrastructure so that electricity is cheaper than gas. Energy prices are lower than their actual production costs (Glicksman, Norford, and Greden 2006, 16), so heating solutions in the urbanizing context of Chongqing mainly depend on the use of electricity. One of the interviewed architects from Chongqing clearly stated that "the problem is not architecture, but energy sources; it would be better to search for renewable energies to solve the problem of high energy consumption."[vii] Not only in Chongqing, but with regards of energy futures worldwide "[g]enerating and using more electricity is taken as a foregone conclusion: the question is merely how to do it with the least impact on the environment" (Gupta 2015, 564).

An analysis of thermal indoor regulation in winterly Chongqing show that if we want to understand climate-responsiveness of architecture in an urban context, it is not sufficient to study the built structure of the individual house. Inevitably, the materiality of the house is only

one part of the “thermal-material culture” which also includes the uses and choices of technologies and objects by residents. Weathering and dwelling—which includes the thermal control of indoor spaces—far from being detached individual practices are embedded in citizen-state relationships and also in broader questions of energy provision and urban ecology.

Conclusion and Outlook

For an urban future utopia where less electricity is consumed for heating and cooling indoor spaces, it would be crucial to revive the thermal knowledge about passive forms of climate control. In the 20th century, a clear separation between indoor and outdoor areas has become normality in the engineering of buildings. In order to combat this bipolar thermal concept, passively-controlled urban settings would not only decrease energy consumption but offer an incremental connection between indoors and outdoors and thermally more diverse spaces (Roesler and Kobi 2018). For Chongqing, this could mean to reconsider older forms of passive climate control such as ventilation or sun radiation, and combine those with newer technologies and materials such as high-tech insulation. In addition, the well-known positive impact of implementing buffer zones could be considered for urban high-rise architecture. Due to their long-term exposure to non-heated spaces, Chongqing residents (especially an elder generation) are quite resilient to deal with the subtropical winter cold. When asked about how my informants cope with winter in Chongqing, one of the most frequently given answers was: “Yes, it is cold, but Chongqing people are accustomed to the winter climate.”

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[i] According to a local businessman in the heating sector, a mandatory insulation of 10 cm is now integrated in walls of buildings in Chongqing while an architect mentions 20 cm as average insulation layer.

[ii] Fieldwork conversation, September 2017.

[iii] There are different price ranges and types of air-conditioning machines in Chongqing: mobile units (*yidong kongtiao*), window air conditioners (*chuangji*), split units (*bigua shi*), standing machines (*guiji*) or systems integrated into the wall structure (*jiayong zhongyang kongtiao*).

[iv] Fieldwork conversation, December 2017.

[v] The installation of an electric underfloor heating covering 50 m^2 of a new apartment costs around 13'000 RMB. According to my informants' guess, this new heating will cause an additional 500 RMB electricity cost per month which they can bear and is apparently less than running the airconditioning unit would cost them. Research shows that the underfloor heating is indeed more energy-efficient than the air-conditioning unit when permanently used. However, for a sporadic use, the airconditioning unit is more energy-efficient.

[vi] Statistical data from Shanghai, another non-heating zone, shows that when people feel hot in summer, 73% of residents would turn on their airconditioning unit. When they feel cold in winter, only 48% would turn on the airconditioning sometimes and 37% would not use it at all during the entire winter season (Long 2013, 46).

[vii] Fieldwork conversation, December 2017.