

About being in the middle: Conceptions, models and theories of centrality in urban studies.

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Abstract

The (dis)advantages accrued by centrality, by being in the middle, is a pivotal causal mechanism explaining the existence of cities and inter-city relations. This chapter introduces classical theories of centrality and elaborates some of the theoretical controversies surrounding them. Four theories are discussed: The von Thünen-Alonso land use theory, Christaller's variety of central place theory, developmental and critical renderings of centre-periphery theory, and urban networks theory. Although antecedents are often much older, these foundational theories developed strongly in the 1950 and 1960s as abstract models in relative space characteristic to that era. Such theories travel easily, but only provide crude pictures of the underlying geographic detail. Although abstract models have long been out of fashion in geography, this chapter argues that they can still make important contributions to contemporary urban thinking. As the different centrality theories have often got tangled up and hybridised over time, their differences need to be disentangled first.

Keywords: centrality, central place theory, location theory, centre-periphery theory, central flow theory.

Introduction

A commonly encountered perspective in textbooks explains the existence of cities as function of being in the middle of something. Cities are centres of political, cultural, economic and/or religious life, explaining the large religious buildings, stock exchanges or pantheons in the city. According to many (for instance Bird 1977: 1; Friedmann 1968: 236; Lefebvre, 1991[1974]: 331-314), the associated notion of centrality amounts to a key building block of what the city is about. This chapter surveys these urban theories that try to understand the benefits, the side effects and the desires associated with being in the middle.

Urban centrality's core idea is that being in the middle exerts spatial effects. The middle can induce a desire to be there, a centripetal tendency. Authors (e.g. Bobek 1927) emphasize the 'magnetic attraction' of urban places, invoking images of being pulled to 'bright lights, big city'. Alternatively, being in the middle can be something one is pulled away from, a centrifugal tendency, for instance when the middle is too expensive, too crowded or too dirty. These centripetal and centrifugal tendencies were first theorized as urban phenomena by Schlüter (1899 cited in Müller-Wille 1978: 50) in Germany and by H. G. Wells (1902 cited in

Bird 1977: 104) in the Anglophone world and were further elaborated in the subsequent century. Colby (1933) provides an overview of what these tendencies entail in early twentieth century cities. The balance between countervailing centripetal and centrifugal tendencies generates distinctive divisions of labour and zonal patterns of urban fabric within a particular technological conjuncture. Colby (1933) notes how new technological possibilities, transportation modalities, and changing economic fortunes continuously upset these equilibriums and change centralities (Van Meeteren et al. 2016a).

From this abstract perspective of centrifugal and centripetal tendencies, all location theory is theory about being in the middle. However, it is easy to complicate the matter by unpacking the question. *What* is the theory about? Being in the middle of a landfill will surely exert a different balance of centrifugal and centripetal tendencies than being in the middle of a sun-bathed park. Secondly, how do we conceive of *'the middle'*? As a point in the middle of a plane, region, or in the middle of a network or (social) structure? There might be several middles to be considered. Third, *who or what* is desiring to be in the middle and how strongly is it desired? A car demolition company might offer less to be in the middle than the headquarter of a multinational corporation, generating sorting effects. Sorting effects explain how the aggregated small differences in preferences of individual actors lead to distinctive zones, neighbourhoods and regions within cities (Clark 2008). When we want to Account for the differences in *who* and *what* wants to be in *which middle*, it is clear that we need not one single theory of centrality but several, emphasising different dynamics and trade-offs about being in the middle. Moreover, centrality theories work on different scales. So far, very concrete intra-city examples have been used but centrality theories equally discuss the dynamic between cities within regions or even between regions. In fact, this chapter will put most emphasis on the latter.

The avid reader will notice that materials discussed in this chapter might appear a bit old-fashioned. The theories were developed in the early 20th century when scholars were coming to terms with modern urban change: skyscrapers, telephones, and the automobile were new features in the urban landscape. Subsequently, in the 1950s and 1960s *zeitgeist*, formalizing these notions in abstract theories of centrality really took root. This was a period when scholars were increasingly interested in formulating and mathematically testing abstract theory, often using newly available computational tools (Barnes 2003; Johnston et al. 2019 Van Meeteren 2019a). Particularly in geography, many defined the substance of the discipline as being specialized in explaining abstract spatial patterns that were valid across contexts. Consequently, scholars prioritized the extraction of context-independent causal mechanisms and abstracting them to a point where they could explain many different instances (Bunge 1966[1962]; Haggett 1965; Ullman 1980). Another characteristic of this 'spatial science' era is exploration of the possibilities of 'relative space'. (Harvey 2006[2004]: 121-123). According to Harvey (idem: 122) 'on the mundane level of geographical work', exploring relative space means that 'The uniqueness of location and individuation defined by bounded territories in

absolute space gives way' to a perspective where the places and locations are studied relative to each other in terms of distance, cost, relations, [and] time [...]. Theorizing with relative space meant that geographers were less concerned with specific locations but rather wanted to understand the spatially-articulated processes that mediate the relation between different places. Spatial science experimented with computational methods and different geometrical representations (e.g. Tobler 1961; Bunge 1966[1962]) to calibrate these spatial relations. Regarding centrality it entailed thinking abstractly how 'being in the middle' affects spaces, organizations and individuals. Since the 1960s, geography has expanded its spatial-theoretical repertoires even further (Harvey 2006 [2004]) and therefore this chapter will chiefly rely on mid-20th century classic references to emphasize the relative space perspective. However, for each theory, contemporary applications will be indicated when sketching the evolution and current (ir)relevance of theoretical ideas.

As the notion of abstraction plays an important role in theories of centrality, the chapter will first elaborate different aspects of abstraction. Thereafter, sections will follow on centrality and land use theory, central place theory, centre-periphery theory and urban network theory. The chapter concludes with reflecting on the relevance of these notions for the contemporary spatial disciplines.

The power of abstraction

Abstraction comes from the Latin verb *abstrahere*, which means 'to draw away'. To abstract is to identify those properties of an object relevant or even essential to the question at hand. We ignore from those characteristics that we are not interested in while focusing on those that do. In the social sciences abstraction means isolating the crucial elements of a causal mechanism while bracketing the inessential (Sayer 1992 [1984]: 138).

A first relevant aspect of abstraction is about '*modelling*' as centrality theories tend to be based on 'models of centrality'. Modelling is an abstraction technique where idealized representations of reality are created in order to demonstrate certain isolated properties. Models are heuristic devices that communicate certain causal hypotheses but do not pretend to provide a comprehensive account of reality. Rather, they inform research questions and empirical inquiry to test the 'fit' between a model and a segment of the world outside (Haggett 1965: 19-23; Haggett and Chorley 1967; Van Meeteren 2019b). It is only when models find empirical justification that they start to become part of established theory: statements that have the pretention to explain (parts of) reality (Saey 1968; Barnbrock 1974). More complex models might provide more comprehensive explanations for specific cases as several causal mechanisms and their interactions are grasped simultaneously. However, this comes at the expense of validity across cases as combinations of causal mechanisms tend to vary from place to place (Van Meeteren et al. 2016b). This is why model-builders are inclined to emphasize 'Ockham's razor', the problem-solving principle where one strives to provide answers that make the fewest assumptions. Unless there is a clear reason to do otherwise,

Ockham's razor suggests preferring simple models (and theories) over more complicated ones.

A second aspect of abstraction relates to the question of 'what is the *middle*'. When geographically articulated phenomena are isolated in a model, its properties are projected onto a hypothetical space. That projection requires choice of a geometrical system. Different projections accentuate different properties in a model. When we think of projection on a surface to emphasise the role of physical nearness and distance, abstraction in Euclidian geometry associated with topographic maps is appropriate. When connections between objects are emphasized, abstraction in topological geometry associated with representations of networks is apt (Van Meeteren et al. 2016c). These abstractions are not mutually exclusive and transforming between geometrical systems can be very insightful to explore spatial relations (Tobler 1961 cited and elaborated in Bunge 1966 [1962]; Getis 1963). However, different geometrical abstractions might define another middle: the middle of the network might not be in the middle of the plane (Chisholm 1975: 105).

The third aspect of abstraction regards *what* is being in the middle. The theories discussed below were first formulated based on substantive research questions. It is for instance farms, firms, shops, consumers or social relations that are in the middle. Many have tried to generalize these theories by abstracting them to more general theories of centrality in terms of accessibility or communication. This suggests a two-step abstraction process: After making a model that accounts for a specific mechanism, this mechanism is further reduced to an even more abstract concept that accounts for other phenomena as well. For instance, in the case of central place theory, a theory that explains a centrality in shopping becomes a theory of communication where shopping is regarded a special case of communication (Claval 1986). Especially in the 1960, formulating general principles that could account abstractly for many different phenomena were considered a highly desirable outcome of geographic research (Bunge 1966[1962], Berry and Pred (1965) [1961]). Although geographers nowadays tend to be more sceptical on the usefulness of grasping the world in a single formula, formulating such theories is still aspired by many in science. Resultantly, other disciplines such as physics have filled this abandoned geographical niche (e.g. Bettencourt and West, 2010; see Derudder and Van Meeteren 2019). Regardless, when debating the usefulness of general formulations on high levels of abstraction it is important to understand the methodological pitfalls. Although it is possible to see the city as an abstract networked or hierarchical system and infer meaningful properties of it, it does not mean cities can be reduced to this geometrical representation (Sack 1972; Harary and Rockey 1976).

A final caution regarding abstraction posits the question of 'being in the middle of *what*?'. Geographies of centrality are often what Warntz (1957) termed 'macroscopic geographies'. The aggregated behaviour of many individuals generates an opportunity landscape that is emergent on the scale of the macrogeographic system. Consequently, individual behaviour

cannot be deduced from this geography because of the ecological fallacy (Van Meeteren and Poorthuis 2018). At best, one can make assumptions what 'a rational human being' would do in that opportunity landscape but those 'economic man' assumptions have proven to be poor predictors of individual geographic behaviour (Wolpert 1964; Massey 1973; Barnes 1988). The rationality assumption's pitfalls begs important considerations because centrality is ultimately made through the actions of individuals: whether entrepreneurs, governments or consumers (Vance 1970; Barton 1978). Therefore, although abstract models of centrality might provide an adequate explanation of urban structure in the past and describe potentialities in the present, they are not infallible when predicting urban evolution in the future.

Centrality and land use theory: putting a price on being in the middle

As noted above, classic firm location theories are also centrality theories. They provide models that explain the optimum 'central' location if the transport costs of inputs and outputs for the firm or the flow of customers is to be optimized (Alonso 1975 provides a thorough introduction). However, as firms' needs differ enormously, these are principally 'microscopic geographies' that do not easily scale to the city level. This is not the case of Von Thünen's (1966 [1826]) model of agricultural land use (see Garrison and Marble 1957 for an early model-based elaboration). The Von Thünen model posits a single marketplace on an isotropic plane. Based on the differential transportation costs and prices of agricultural products, the likely agrarian production profile of the surrounding area of the 'isolated town' is estimated. The model results in an image of concentric rings of different agricultural products. To simplify the models' conclusion: Heavy products that command a high price at the market are grown close to the market while products with lower margins that exceed lower transport costs are produced further away.

William Alonso (1960) translated Von Thünen's ideas into a theory of urban land rent, effectively formulating a model that puts a market price on being in the middle of a city. Different land use functions (agricultural, residential, industrial, commercial) will bid different rents for use of the most central space, because different functions gain differentially from being in the middle. Higher land prices encourage more intense land use resulting in taller and denser built environments. For Alonso, differential transportation costs are still the causal mechanism. The result (Figure 1) is a model that explains differentiations of functions and/or density in the city. Friedmann (1968) replaces the transport accessibility function for an information-based one arguing that information and innovation-rich environments are more valuable to some actors/land uses than others. Later formulations (e.g. Baker 1982) attempt to abstract individual preferences into a generic category of 'utility' that could account for the demand surface in bid rents. Particularly this last abstraction is subject to criticism (Barnes 1988; 1996: 63-68) as it obscures the notion of *who* wants to be in the middle and *why*. Alonso's theory became a central target of criticism on location theory in the 1970s (Harvey 1973) as it seemed to naturalize given patterns of land use in a city and obscures housing

inequalities, institutionalized racism and real estate politics. Ultimately it is entrepreneurs and politics that capitalize on land values and might even pump them artificially. Krijnen (2018), provides a recent overview of these issues. Moreover, she provides navigation in the debates around gentrification, as Alonso's assumption that all 'rational residents' prefer spacious new car-oriented suburbs is a little bit outdated.

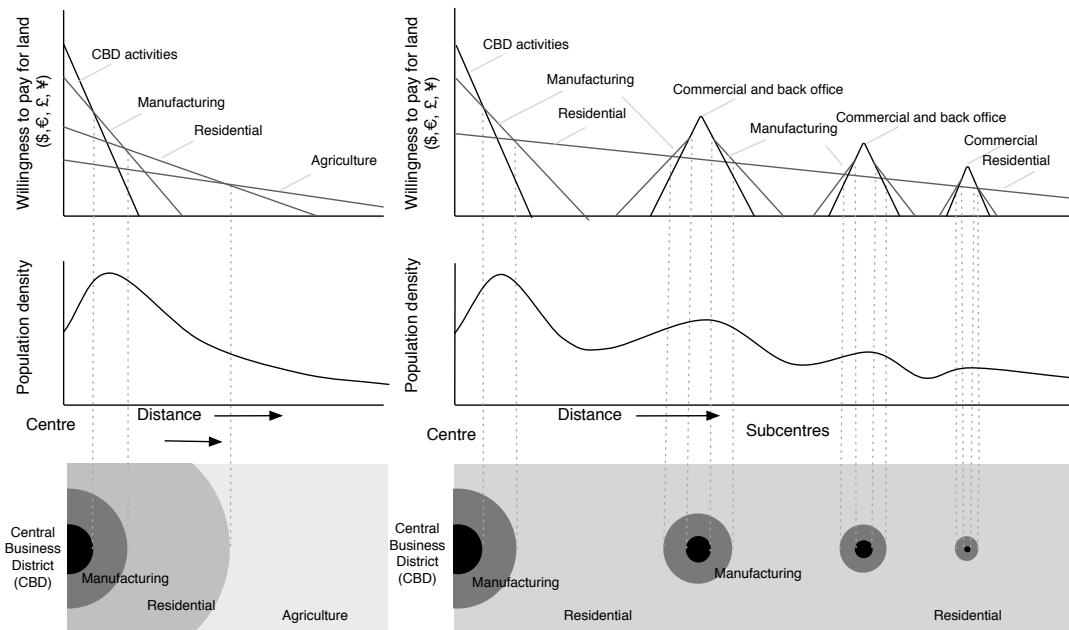


Figure 1. Putting a price on centrality. The Von Thünen-Alonso model of land use in its monocentric and polycentric varieties (redrawn from Clark 2000: 144, based on Bourne 1981 and Cadwallader 1996; reproduced with permission from William Clark and Wiley-Blackwell)

Regardless of valid critique, the Alonso's model has stood the test of time relatively well for its original purpose: providing a model that puts a price on being in the middle (Van Nuffel and Saey 2006; Verhetsel et al. 2010). Perhaps the most important augmentation of the theory for its original purpose is the necessity of taking urban structures into account that have competing centres, that is, a polycentric model (Clark 2000).

Central place theory

Historical settlement geography finds that the genesis of cities is associated with the relationship of cities with their *umland*¹ (Gradmann 1916, cited in Müller-Wille 1978). Central place theory models this city-umland connection. As the city-umland relationship can take many forms, there is a large variety of central place theories. According to this criterium, Von Thünen's model is also a (usually unrecognized) central place theory (Ullman 1941). The two

¹ The German word *umland* (surrounding lands) is often mistakenly translated into English as hinterland (the lands behind the city) which suggests an eccentric location (Bird 1977).

most known archetypes of central place theory (CPT) are those of Christaller (1966 [1933]) and Lösch (1956 [1940]) which consider the supply of services and goods from the city to the umland. These two archetypical formulations are not comprehensive theories of urban location and only explain some functions of urban relations (Preston, 1975). The main difference between the two is that Löschian theories allocate umlands according to principles of monopolistic competition between central function providers while Christallerian theories are built on the propensity of consumer travel. The models look visually very similar but are built on incompatible axioms and only converge under special circumstances (Saey 1973). Moreover, many of the derived theories built from these two archetypes are incompatible with the foundational statements. This necessitates careful specification when discussing CPT (Van Meeteren and Poorthuis, 2018). This section will first discuss the Christallerian original before addressing attempts at further abstraction.

The empirical starting point of Christaller's (1966 [1933]) CPT is that the spacing of settlement sizes, in his case in Southern Germany, exhibits interesting regularities. If you travel between two cities of the same size, you might notice that the smaller towns in-between tend to show a regular size pattern of alternating smaller and larger towns. It is this regularity that Christaller's central place model theorizes. The causal mechanism underpinning Christaller's (1966 [1933]) CPT is that every central place provides a limited selection of central goods to its complementary region or catchment area (the umland of a central place function). Umland regions are simultaneously under the influence of several central places with different levels of service provision. If needs cannot be provided by the nearest central place because its offerings are too limited, one tends to go to a better equipped central place –in Christallerian terms 'a place of a higher level'– further away. This is self-evident: in a village you might be able to find a bakery or a hair dresser in your local shopping street but if you want to buy expensive jewellery or frequent a shop that specializes in trading rare and vintage musical instruments you need to go to a bigger town.

The microfoundations of Christaller's CPT (Van Meeteren and Poorthuis 2018) theorize that every central good has a specific range with a lower and upper limit. The lower limit of the range (often called threshold, Berry and Garrison 1958a) is defined by the minimum number of goods or services that need to be sold for a central function can exist. The upper limit of the range (henceforth 'range', idem) is the maximum distance an average consumer is willing to travel before the consumption of central good in this central place is foregone. The following simple calculations intend to clarify these basic concepts:

- Hypothesize that a hair dresser needs to do 12 haircuts a day on average if s(he) is to stay in business. That means $365 * 12 = 4380$ haircuts on a yearly basis.
- Hypothesise that the average person will go to the hairdresser every 3 months. That means every person procures $12 * (1/3) = 4$ haircuts per year.

This means that the minimum population in the complementary area for a full-time hairdresser to exist is $4380/4 = 1095$ inhabitants, this is the threshold.

Hypothesize that the range for a haircut is 5 kilometres. If one has to travel more than 5 kilometres everybody will start cutting their own hair instead. This means that the average population density of a complementary region (5 km radius, translating in a surface area of $\pi * 5^2 = 78,5 \text{ km}^2$) needs to be $1095/78,5 = 13,9$ inhabitants per km^2 for a full-time hairdresser to stay in business. In reality there often is leeway between the minimum complementary area (umland) of the threshold and the maximum complementary area (umland) of the range. This leeway is indicated by the difference between the 'real range' and 'ideal range' in Figure 2. A smart entrepreneur can make use of this room as there is potential for an extra supplier or expansion of existing suppliers (Getis and Getis 1966)

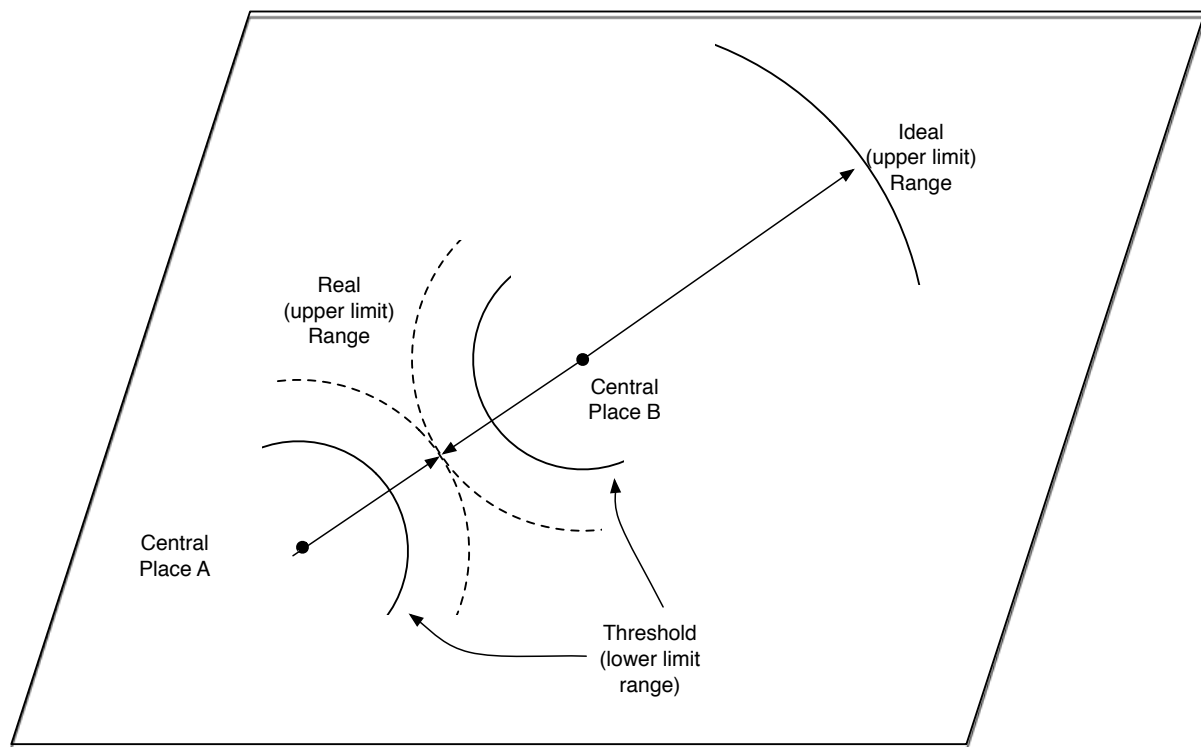


Figure 2. The interplay between the ideal range, the real range and the threshold when defining complementary regions (after Getis and Getis, 1966: 221, reproduced with permission from Arthur Getis).

The model simplifies. Specialization and complementarity (having several musical instruments shops divided by genre or instrument family) can emerge in higher-density areas or between two interacting places. Moreover, complementary regions are intersected by roads, overlap, and plagued by congestion, which change real ranges (Van Meeteren and Poorthuis 2018). However, we have to remember Ockham's razor and bracket these complications, although many can these days be taken into account with GIS software (idem).

In Christaller's CPT, every central function has a specific combination of range and threshold but they nevertheless group in distinct 'baskets of central functions'. We can think of this as

'typical' central place environments: Small-town shopping street, ribbon shops, high streets or malls (see Carol 1962; Borchert 1998). In idealized isotropic circumstances where transportation costs are equal across the plane, population is evenly distributed, people always frequent the nearest central place, and there is no multipurpose shopping, this interaction of central goods in Christaller's CPT generates a model landscape of perfectly nested hexagons between places (Figure 3). The hexagons emerge from equally dividing up the leftover areas of circular central places (Getis and Getis 1966 provide a step-by step elaboration). Apart from this '*versorgungsprinzip*', clumsily translated in English as 'marketing principle', Christaller (1966 [1933]) also formulated idealized models of urban structure based on traffic and administrative principles.

Although idealized models, Christaller-type figures can be discerned in the urban landscape when the conditions of urban genesis show some conformity to Christaller's assumptions (Van Nuffel and Saey 2005). Nevertheless, the contemporary urban landscape hardly ever resembles the idealized geometric models that in the 1960s caught the imagination. However, more interesting when understanding contemporary centrality is that the interplay between range and threshold seems to be still valid today (Boussauw et al. 2013; Van Meeteren and Poorthuis 2018), although the most central places in cities have often moved to more peripheral locations (idem; Clark 2000).

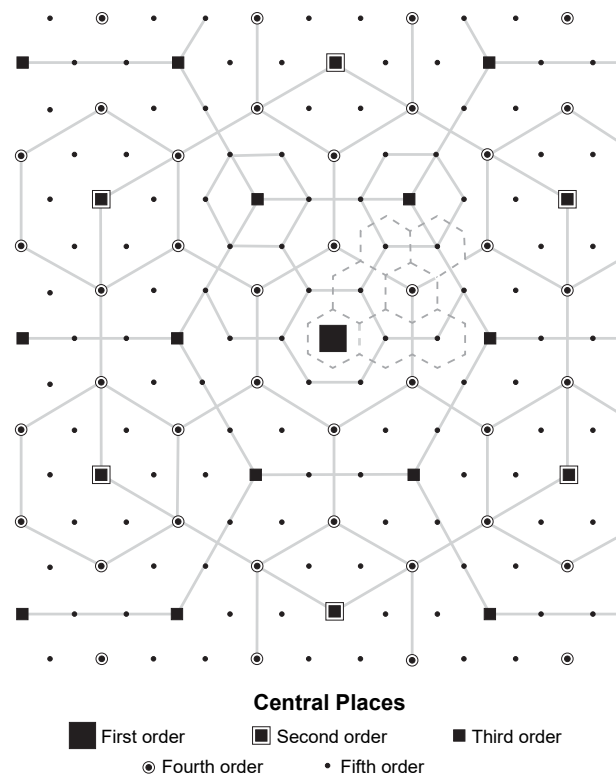


Figure 3. A Christaller-type central place system according to the marketing principle with five orders (redrawn by Mark Szegner from Saey, 1973: 183, with permission from the Royal Dutch Geographical Society and Pieter Saey)

Christaller had already made a leap of abstraction when empirically testing his model. Back in 1933, the excess telephone connections over what was to be expected of a city of a certain size were considered a sufficient indicator to calculate the influence on the umland. As telephones became ubiquitous midway the twentieth century, research resorted to other proxies to measure centrality such as wholesale ratios, newspaper circulation or counting shops (Sidall 1961; Davies 1967; Preston 1975). In the 21st century, machine learning and big data can come to the operationalization rescue (Van Meeteren and Poorthuis 2018) but scholars also find interesting results using indicators of accessibility and central functions (Zhong et al. 2018). Interestingly enough, the notion of hierarchical relations between the larger and smaller central places got only very limited attention in Christaller's (1933[1966]) original treatise (Buursink 1975). Later on, however, abstracting a theoretical hierarchy between settlements was defined as the core characteristic of CPT (Berry and Garrison 1958b; Parr 1978). In the 1960s, theorizing the umland as a catchment area analogous to rivers became increasingly popular. The rationale behind comparing central properties of rivers and cities is the promise of an abstract notion of centrality being universally valid for different analogically structured phenomena (Woldenberg and Berry 1967 take this to the next level). Even if research had little to do with the procurement of central goods and services, a wide variety of research questions were routinely squished in the mould of the central place model (Vance 1970; Bird 1977). For instance, innovations were thought to 'trickle down' through the urban hierarchy (Berry 1972, see Pred 1977 for critique) although the causal mechanism for these processes is far off from Christaller's microfoundations. CPT became synonymous with the idea of '*the* urban hierarchy' that exerted causal effects on the level of a system, probably aggravated by the theory's widespread use in spatial planning (Blotevogel 1996) and the adoption of the abstracted variety in mainstream economics (Fujita et al. 1999). In any case, it is important to keep a close eye on what scholars actually mean when they invoke CPT, regardless whether they praise or criticize it.

Centre-periphery theory

In Christaller's CPT, centre and umland are in a symbiotic relationship. The centre needs the clients from the umland, while the umland receives services from the centre. Centre-periphery theory, however, emphasises unequal relationships between centre and periphery and has a connotation of 'winners' and losers'². Centre-periphery theory again originates in the 1920s and 1930s when two University of Chicago scholars, sociologist Roderick McKenzie (1927) and geographer Charles Colby (1933) tried to make sense of the Windy City. Their divergent interpretations of centre-periphery relationships have coloured the literature ever since. McKenzie (1927) describes centre-periphery relationships as instances of dominance. The centre is the locus of hierarchy that commands the economy in the periphery while the benefits disproportionately accrue to the centre. McKenzie (idem: 31) noted that innovations

² This chapter considers core-periphery and centre-periphery nomenclature as synonymous.

in transportation technology were strengthening this centre-periphery relationship. For him (idem: 32), with normative undertone, 'the city has ever been the symbol of civilization; which, even in its crudest form, represents a spatial pattern of a fixed center of dominance with tributary subordinate districts'. Colby (1933), distilled from the same empirical case the aforementioned shifting spatial equilibrium account. While the centre becomes stronger (centripetal forces), the periphery benefits through sorting processes (centrifugal forces). Although the centre might gain corporate headquarters and 'dominating' functions, Colby clearly saw that with suburbanization some the city's riches were moving in the opposite direction.

Centre-periphery theory became prominent in the 1950s and 1960s. The immediate post-1945 environment and the advent of macroeconomic development policy put regional economic inequalities centre stage. Colby's students, Harris (1954) and Ullman (1958) conducted empirical studies on centre-periphery relationships in the United States, showing how the most urbanized regions in the US (the 'central manufacturing belt', now sometimes called the 'rustbelt') were growing at the detriment of the periphery. Both theorize how improved connections between core and periphery could induce centrifugal forces. Moreover, a United Nations commission argued that economic discrepancies between centre and periphery were not only detrimental at the national scale but also internationally. The developing countries were being dominated by the centre through unequal terms of trade (Prebisch 1950). Note that the mechanisms are similar as with McKenzie (1927), but that the moral evaluation of this situation had made a 180 degree turn after World War II: Civilization was now about spreading wealth to counterbalance the centralizing metropolis.

Apart of the terms of trade argument, it was Swedish economist Gunnar Myrdal (1957)³ that cogently described a causal mechanism and spatial model for core-periphery relationships. The driving force of accumulation in the centre is a process of circular and cumulative causation. Growth begs more growth and decline begs decline. If a region⁴ is doing well economically, it will attract inward migration of talented people, inward capital flows, infrastructure investment, and centripetal tendencies. These have to come from somewhere, which tend to be from less well-off areas. These are backwash effect where the centre's gain is the periphery's loss. The centre's relative advantage is strengthened making the relative unevenness with the periphery larger. Myrdal also identified centrifugal forces in his model, called spread effects. Because of pressure on the centre, sorting effects not unlike the Alonso model occur that lead to effective diffusion of growth. Crucially, however, spread and backwash effects work on different scales: spread effects in the immediate vicinity of the

³ At the same moment, others like Albert Hirschman, François Perroux and Bert Hoselitz formulated similar theoretical ideas. Friedmann (1966), Friedmann and Weaver (1979), and Gaile (1980) provide introductions.

⁴ Myrdal explicitly referred to national economies in his analysis, however Friedmann (1966) makes the case that these centre-periphery relationships can be located at different scales from the urban to the global.

centre and backwash effects in the further periphery (see Gaile 1980; Chapman et al. 2003, Figure 4).

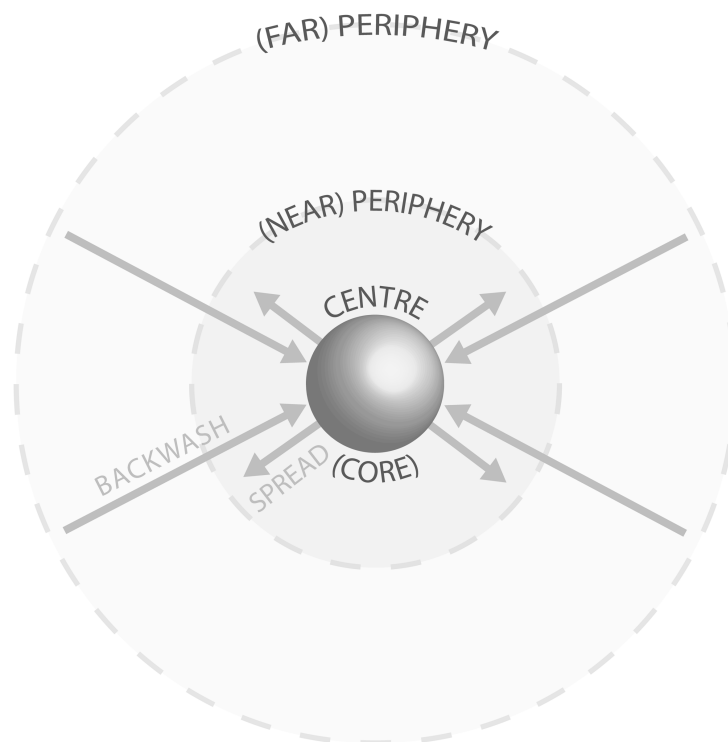


Figure 4: Myrdal's (1957) core-periphery model (figure by Mark Szegner, inspired by Chapman et al. 2003)

Initially, there was a strong confidence about governments intervening to help overcome centre-periphery polarizations. Uneven development was even argued to be an intermediary symptom until all regions in a national economy would reach a 'mature developed state' (Friedmann 1966). Until the 1970s, some success with 'spatial Keynesianism' (Brenner 2004) policy was achieved, for instance in Belgium (Van Meeteren et al 2016a), or France (Veltz 1996). The long economic crisis of the 1970s largely crushed belief in spatial-economic planning. In some cases, tectonic economic shifts from areas known as 'core' to areas known as 'periphery' (from rustbelt to sunbelt, see Smith and Dennis, 1987) took place. This incited scepticism of spatial Keynesianism and the theories underpinning it (Brenner 2004; Veltz 1996). Although the –often recently decolonialized– 'third world' was a welcome playground for the development-oriented core-periphery model (Friedmann, 1966), Prebisch (1950)'s report spawned a critical literature. *Dependencia* and world-systems theories (e.g. Frank 1966; Amin 1974, Santos, 1974; Hopkins and Wallerstein 1977) emphasise that the relationship between core and periphery cannot be symbiotic or developmental as long as the core benefits disproportionately from the periphery. Drawing on Marx-inspired theories of uneven development and imperialism, these theories use the core-periphery model to emphasize that the development of the centre is due to *underdevelopment* of the periphery. These critical strands get the upper hand in the 1970s as global economic inequality

exacerbates. The most prominent convert is John Friedmann (Friedmann and Weaver, 1977: 186-216), who originally helped synthesize the development version of the core-periphery model (Friedmann, 1966). Friedmann subsequently recasts a new critical version of his theory as the world city hypothesis (Friedmann and Wolff, 1982) where powerful corporations located in cities in the core, in the midst of deindustrialization, accumulate and dominate at the detriment of cities in the periphery.

Centre-periphery theory was from its inception formulated on a high level of abstraction. The notion of 'urban dominance' central in McKenzie's account (1927) is ambiguous and operationalized in many, often incompatible, ways. Colby's (1933) version is somewhat more concrete and clearly indicates that economic variables such as rent and transportation costs do the majority of the work in the centrifugal and centripetal relationships. This focus on tangible transportation costs is prominent in the geographers' accounts and in Friedmann's (1966) treatise. These are centre-periphery relationships that are easily and meaningfully mapped in Euclidian geometry. However, as Copus (2001) notices, it is distance costs that have been increasingly irrelevant in the late 20th and early 21st centuries. He therefore proposes a distinction between 'spatial' and 'aspatial' peripherality, where the causal mechanisms that are not explicitly articulated in relative space can be subsumed under the latter. Following that argument, there is the case to be made that the centre-periphery relationship is more meaningfully depicted as a network. Come what may, spatial or not, core-periphery relationships between cities and associated uneven development endure as an important empirical phenomenon in our contemporary world (Brown et al. 2010; Van Meeteren and Bassens, 2016)

Urban network theory

Technological change has made it increasingly sensible to discuss centre-periphery relationships through the spatial metaphor of an archipelago rather than assuming contiguous territories. The archipelago metaphor denotes a geographical form where territorial 'islands' are connected through flows of people, information, capital and goods interspersed by less-connected places (Veltz, 1996, Van Meeteren and Bassens 2016). The notion was first used to describe the speckled geography of early capitalist relations. (Braudel 1984: 30). As argued above, a central place is one of the possible functions of a city and some other types of cities may have little relation with their umland (Siddall, 1961). For instance, port cities, where they talk about forelands and hinterlands, are also gateways (Bird, 1977; Vance, 1970) that connect 'islands' in a networked archipelago. The same argument is easily made for airport hubs or indeed McKenzie's corporate headquarter places as recast in the world city model. Here, speaking about a 'hinterworld' is even more appropriate than a hinterland (Taylor and Derudder 2016, Derudder and Taylor, 2018). Archipelago structures, due to their networked character, suggest that abstracting them in a network is useful (although not exclusively, see Van Meeteren and Bassens, 2016).

When relationships between cities are seen as a network, these relationships are expressed in the topological language of 'nodes' and 'edges' (Neal, 2013: 15). Nodes represent the objects that the relationships connect and edges represent the relationships between nodes. Abstraction of an empirical phenomenon in network language requires 'nodalization' (Van Meeteren et al. 2016c). In the case of inter-urban network analysis, this usually means that cities are considered nodes and relationships between cities edges.

Attractive about network thinking is that it provides different conceptions and measurements of centrality. There are two general notions of centrality in network analysis: structural centrality of the network as a whole, and the centrality of individual nodes within a network (Freeman, 1979). The notion of structural centrality allows gauging the degree to which a structure is 'centralized'. It enables calculating and comparing whether an urban network is functionally dominated by a single city or whether it is more polycentric (Burger and Meijers 2012; see Pereira et al. 2012 for a Euclidian geometrical measure). Moreover, structural centrality allows comparing different urban (sub) systems. For instance, Taylor and Derudder (2016, Chapter 5) develop the notion of 'global network connectivity' to gauge the structural composition of contributing countries to the world city network.

Individual centrality measures provide different indications how central a specific node is in the network. These can provide convincing explanations for geohistorical phenomena. For instance, in a classic paper using network-analytical methods, Pitts (1965) shows how the emergence of Moscow as the dominant city in Russia can be explained by the city's centrality in Russia's medieval transport networks. There are several indicators of centrality in a network and all depict a different property of a node's role (Freeman 1979; Neal 2013 provide more thorough introductions). The three most common are:

- Degree centrality expresses the number of edges a node is connected to. It is commonly standardized to account for the total amount of nodes in the network.
- Closeness centrality is a measure that expresses how close a node is on average to all the other nodes in the network by looking at the shortest paths to get from a node to all the other nodes, again often standardized. One could say that the lower the closeness centrality, the higher the 'peripherality' in the network.
- Betweenness centrality is a measure that measures how often you have to pass through the focal node to 'travel' the shortest pathways between two other nodes. This is important for making arguments whether nodes have a kind of 'middleperson' function.

All these measures are mathematical constructs which have no a priori social causal mechanism attached to it. Hence when these centrality measures are used, a hypothesis about the causal mechanisms that these mathematical constructs represent needs to be formulated first. It is for this reason to caution using overly complex centrality measures as these can be difficult to interpret in terms of causal mechanisms (Neal 2013).

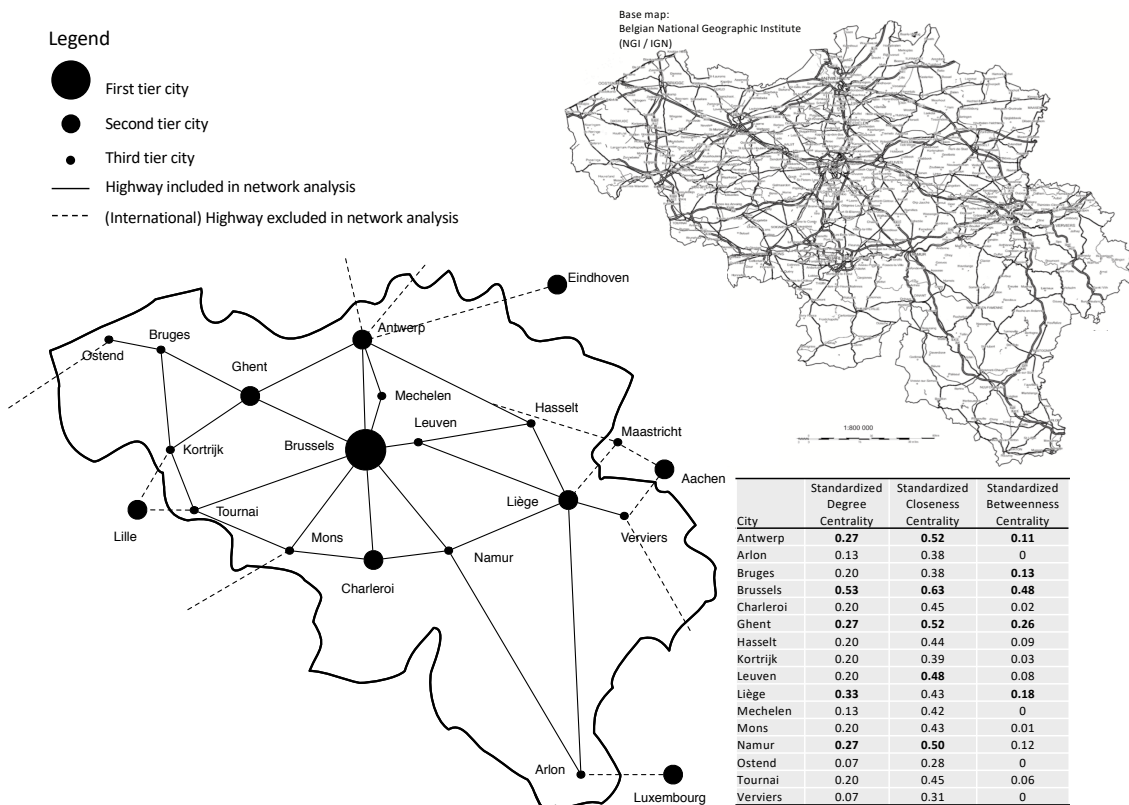


Figure 5. Belgium crudely nodalized

Figure 5 clarifies some of the categories. The Belgian urban system of cities and roads is first nodalized: the highways and most important cities are extracted in the simplified graph in the left corner. The table compares the three centrality measures where the top five scores are in bold. It is clear that Brussels is the most central node in the Belgian urban network and Ghent and Antwerp are important hubs. The high betweenness centrality of Brussels suggests a very centralized character in the Belgian urban system. Note for instance that Leuven and Mechelen are in the core (high closeness) but relatively unimportant for the other measures. Bruges scores high on betweenness because it completely controls the gates to Ostend. If you think I went too fast and should have included road distance, railroads, or your favorite town that got dropped off the map, you have just discovered why nodalization is difficult. 'Slicing up' an empirical object in a language of nodes and edges has an arbitrariness to it where many slippery judgments calls about borderline cases have to be made (Garrison 1960: 137). For instance, if the analyses would have included cities across the country border, such as Lille, Aachen, Luxembourg or Maastricht, centralities would look different already. For instance if we include the foreign cities connected with the dotted lines in the analyses, Antwerp's betweenness centrality more than doubles (from 0.11 to 0.28) while the standardized centrality values of Brussels go down with 0.08 (betweenness), 0.07 (closeness), and 0.13 (degree). Therefore, depending on the topical and geographical framing, there is not a single

statement about Belgium made on the basis of this graph that cannot be disputed. Yet I would invite the reader to immerse in the history of the Belgian settlement geography (Van Meeteren et al. 2016a) and gauge to what extent these findings 'make sense'.

So far, urban network analysis has been depicted as merely a different way of operationalizing and abstracting substantive arguments. For instance, one can analyze CPT through network analytical methods (Nystuen and Dacey 1961; Neal 2013: 116) or centre-periphery theories (Smith and Timberlake 1995; Taylor and Derudder, 2016) and Neal (2011) demonstrates how to operationalize McKenzie's (1927) dominance categories in network terms. However, many authors have argued that urban network theory can also be a substantive theory of its own (Derudder and Neal, 2019). Tangible networks, whether social or physical, work as a transmission mechanism that make people, places and information accessible. The city is then considered as the 'connector of multiple networks' (Pred 1977; Rozenblat 2010; Pflieger and Rozenblat 2010). The empirical and theoretical question here is whether multiple different networks (such as airline, goods, organizations, Internet backbone) together shape an emergent 'inter-urban network structure' on which abstract theories such as 'central flow theory' can be formulated (Derudder and Taylor 2018, see also Smith and Timberlake, 1995; Pflieger and Rozenblat, 2010; Ducruet et al. 2011). The result is an abstract notion of 'urban networks' that is often contrasted with the 'hierarchies' that are abstracted from central place theory. Some argue that the former will supersede the latter (e.g. Camagni and Salone, 1993). Others tend to emphasize the complementarity of perspectives and caution against a 'network fever' (Shearmur and Doloreux, 2015) where older perspectives are too easily jettisoned in favor of casting everything as a network (idem, Parnreiter 2014, Van Meeteren and Bassens 2016).

Conclusion

Centrality is such a central concept when thinking about cities and their relationships that it is unsurprising that much theorizing on the topic has already been done. It is a crowded intellectual field of ideas, and rightly so. Because so many authors engage with a topic, the topic is more likely to cause controversy. As different authors internalize a concept and make it work for themselves, different interpretations of theories and many misunderstandings in theoretical discussions appear; not because of a lack of engagement, but because an idea is so popular (Van Meeteren et al. 2016). This is definitely the case with the old-fashioned theories of centrality discussed in this chapter, which were very influential in the heyday of relative space thinking. Moreover, as these theories are also generational peers, some of the tenets of different centrality theories got tangled up and hybridized in some accounts, compounding conceptual confusion. The different meaning of 'hierarchy' in concrete versions of centre-periphery and central place theory is the exemplary case in point. Similarly one can argue, as I have done here, that network theories of centrality are just another way of (how we understand) being in the middle. To others, the notion of urban network has been

considered to be the antithesis to the notions of urban centrality of the past (Camagni and Salone, 1993). These are issues subject to continuing debate (Derudder and Neal, 2018). This chapter, apart from offering a basic introduction, has chiefly been trying to clear up some of the confusions between these positions so that debates can be more than semantic. By untangling the different theories of centrality, their genealogy, and the main causal mechanisms that they describe, both in their more abstract and their more concrete forms, a set clean of conceptual tools becomes visible that can be used to grasp the contemporary city. As technology is once again changing our cities, perhaps with automatic vehicles, the breakthrough of the platform economy, and the ubiquitous connectivity of the digital, what being in the middle is about might change. However, that does not mean that we have to completely replace our toolbox. Augmenting our existing tools might also suffice. The advantage of using the old tools is that we get a clearer view of what changes and what stays the same. This is important, because only the boldest or the brashest scholars would dare to claim that the future city will no longer be about being in the middle.

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