# Urban regeneration, masterplans and resilience: the case of Gorbals, Glasgow

**Alessandra Feliciotti, Ombretta Romice and Sergio Porta**
Department of Architecture, Faculty of Engineering, University of Strathclyde, James Weir Building, 75 Montrose St, Glasgow G11XJ, UK. E-mail: a.feliciotti@strath.ac.uk

*Revised version received 25 November 2016*

**Abstract.** *Over the last 200 years, particularly since the Second World War, comprehensive spatial masterplans, aimed at increasing the efficiency, amenity and value of degraded urban neighbourhoods, have been developed widely in the UK. However, contrary to the assumption of their creators that stable long-term outcomes could be planned and achieved, resulting environments often failed to demonstrate the resilience necessary to deal with the multi-scale changes cities face throughout their existence, often worsening the problems they set out to solve. Masterplans have therefore been the object of strong criticism and only recently, guided by place-making principles, have they started to be re-evaluated. But are today's masterplans any better equipped to respond to the pace of current urban change? How can masterplans help make places better suited to positively respond to changes over time? To answer these questions, we explore the concept of resilience by comparing examples of nineteenth-century, modernist and recent masterplans, in a 150-year longitudinal study of Gorbals, a district of Glasgow. The successive developments are observed against five resilience proxies:* diversity, redundancy, modularity, connectivity *and* efficiency. *Preliminary results suggest that the transition from the first to the second development produced a reduction in all resilience proxies, only partially recovered by the latest development.*

*Keywords: resilience, proxies, masterplanning, Glasgow, Gorbals*

In a world where cities are subject to changes unprecedented in magnitude and speed (UN-Habitat, 2009), a number of urban designers have voiced the need to incorporate explicitly in urban design the element of change and the dimension of time (Thwaites *et al*., 2007). The concept of resilience, which emerged in system ecology in the 1970s (Holling and Goldberg, 1971), has been used to model change in adaptive systems (Allen *et al*., 2014; Gunderson and Holling, 2002) including urban systems (Vale and Campanella, 2005). In urban design, resilience has only recently been recognized as a useful problem setting and problem solving tool to help create places better equipped to adapt over time to socio-economic, political and environmental fluctuations (Chelleri, 2012). However, being still a relatively new concept in the field, urban designers often use it just metaphorically or loosely associating it with more established terms such as 'robustness' (Bentley *et al*., 1985), 'adaptability' (Brand, 1994) or even 'sustainability' (Ahern, 2013). Yet it is far from achieving a recognizable disciplinary form (Hassler and Kohler, 2014): more specifically, the resilience of places remains poorly investigated in relation to urban form, despite

  ISSN 1027–4278

its relevance to the environmental (Beatley, 2012), social (Thwaites *et al*., 2013) and economic (Tachieva, 2010) performance of cities. Indeed, the importance of building a stronger link between resilience, urban morphology and urban design is now openly acknowledged (Feliciotti *et al*., 2016, Zhang, 2016).

In a recent paper, Feliciotti *et al*. (2016) proposed a research approach aimed at uncovering the specific contribution of urban form to the resilience of places based on two fundamental assumptions: (1) resilience cannot be assessed directly, but only through observable and indirect context-based proxies (Carpenter *et al*., 2005); and (2) urban form is itself a complex system, characterized by nested spatial-temporal scales, each responding to change differently but, as a whole, contributing to the preservation of the system through constant adaptation (Romice *et al*., 2017). Acknowledging that there is currently no agreement on a unified list of resilience proxies of urban form, the authors have proposed five such proxies: namely *diversity, redundancy, modularity, connectivity* and *efficiency*. And they have explored the general implications of each proxy at different scales. However, a longitudinal, evidence-based study of resilience in urban form, and consequently a comprehensive discussion of the concept of resilience in masterplanning and urban design, has not previously been attempted. This lacuna is particularly evident at the scale most relevant to urban design – from the sanctuary area to the building – a scale especially relevant to disciplines such as urban morphology (Kropf, 2009).

In this paper, we build on the conceptual framework proposed by Feliciotti *et al*. (2016) and observe change in urban form through time in a case study covering the five proxies. We look at the 108 ha area located to the south-east of Glasgow city centre on the south bank of the River Clyde, known as Gorbals (Figure 1). Like many other Western cities, Glasgow evolved from a flourishing trading hub in the early-eighteenth century, to a manufacturing and heavy-industry centre during the nineteenth and early-twentieth centuries, before undergoing a period of de-industrialization and eventually shifting to a knowledge and service-based economy. These broad historical-economic periods were marked in Gorbals by three major masterplanned developments, each of which produced different physical environments emblematic of three distinct approaches to place design: Victorian (before the Second World War), modernist and contemporary (Figure 2).

Like parts of many other Western cities, Gorbals offers the opportunity to explore how radically different urban approaches to design, procurement, ownership and regulation influenced the resilience of urban form over a period characterized by major economic and cultural changes. The history of these transformations in Gorbals is traced in relation to the five resilience proxies of *diversity, redundancy, modularity, connectivity* and *efficiency*, at the spatial scales that are most relevant to describe the observed morphological changes and their impact over time.

## Gorbals: a history of transformations

### *Victorian Gorbals*

At the end of the eighteenth century, building development in Scotland was tied to feudal law and was led by the enterprise of private landowners (Reed, 1999), who commissioned the preparation of feuing plans. These determined the location of streets, sewers and water supply and showed the division of land into parcels to be sold to different developers in the form of an annual feu-duty in perpetuity attached to the land (Pacione, 2002). To protect their investment in the long term, landowners attached to each parcel strict clauses on permitted land use, size, and hygienic and aesthetic requirements of future buildings. Throughout the nineteenth century this process guided the transformation of Gorbals from a small medieval burgh to a dense urban area (Smith, 2014a). At that time most of the study area was owned by Hutcheson Hospital and James Laurie, with Glasgow Town Council retaining ownership over the medieval settlement. In 1789 Hutcheson Hospital commissioned a plan for the development of a new

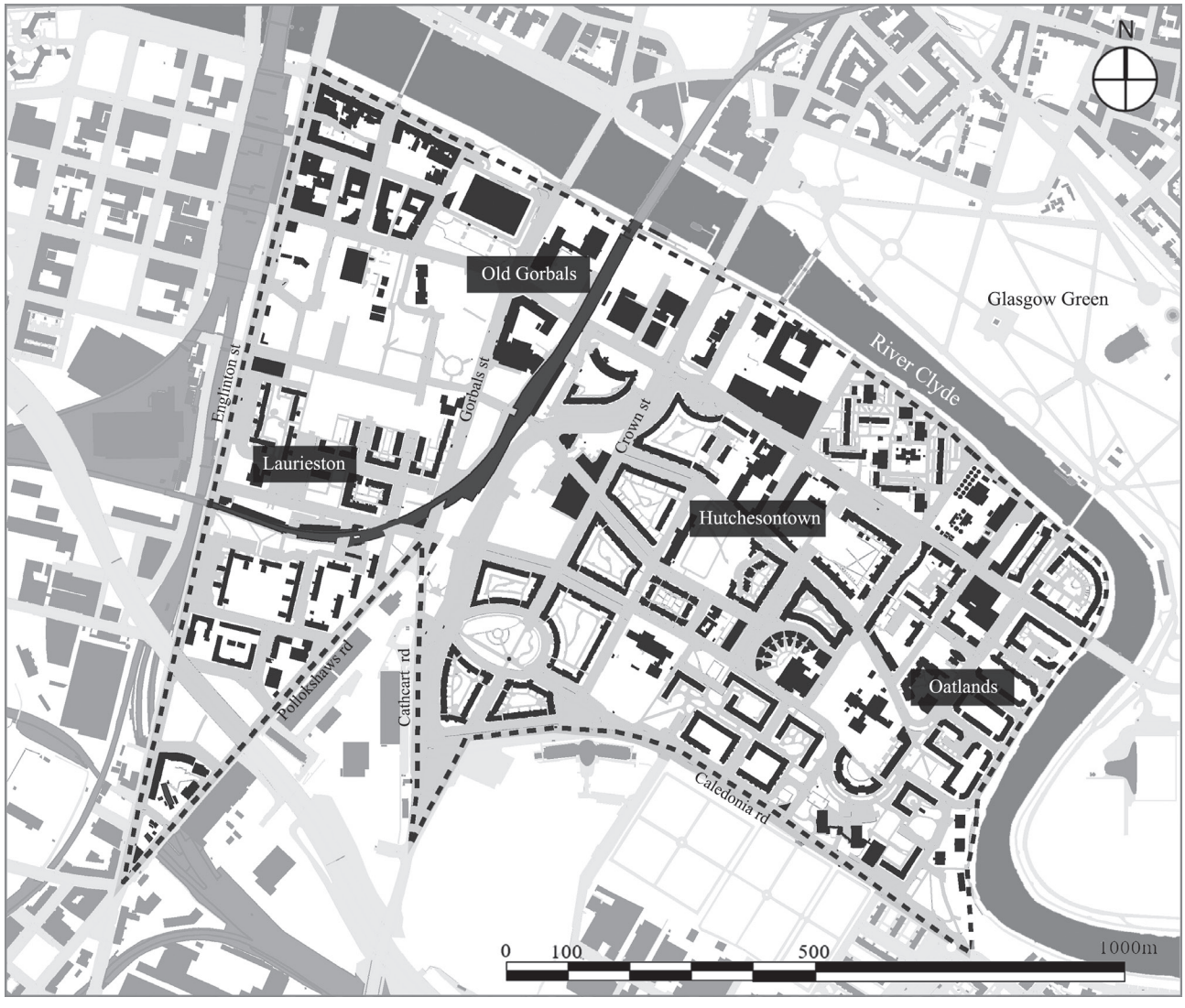


**Figure 1. The study area, bounded to the north and east by the River Clyde, to the south by Caledonia Road, Pollokshaws Road and Cathcart Road, and to the west by Eglinton Street. The railway line divides the area into two districts: the eastern portion, Hutchesontown and the western portion, Laurieston. Source: Ordnance Survey MasterMap, January 2016 (EDINA Digimap Service).**

middle-class suburb, Hutchesontown, and in 1801 James Laurie commissioned a plan for a further suburb, Laurieston. Both consisted of an orthogonal grid-iron street layout (Smith, 2014a), adapted to follow the River Clyde. The plans identified the parcels of land to be feued, and conditions were attached to ensure the high profile of the new neighbourhoods. Within a few years, plots were beginning to be occupied by spacious apartments arranged in continuous lines of four-storey red-sandstone tenements, with shops, offices and workshops occupying ground-floor frontages along main streets.

The occupants of the suburbs were initially quite wealthy. However, from the 1830s onward, with the growth of industry, thousands of unskilled immigrant workers started settling in the area, attracted by its proximity to the city-centre and industries, such as the shipyards on the Clyde (Robb, 1983). With the growth of the railways (Kellett, 1969) and the flight of the wealthy population to

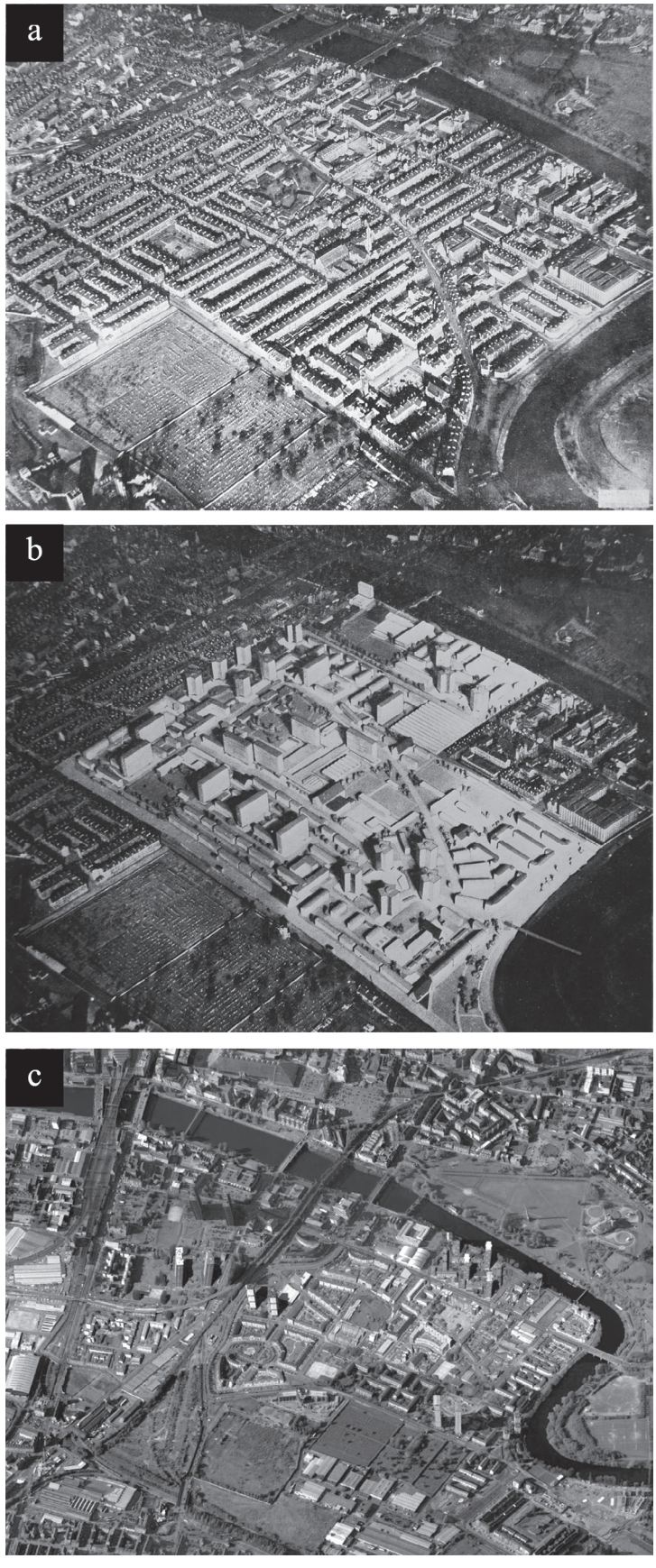


**Figure 2. (a) Victorian phase (reproduced from Johnston, 1957); (b) Modernist phase (reproduced from Johnston, 1957); (c) Recent phase (reproduced from 'Bird's Eye View of Gorbals, Hutchesontown and Laurieston' (Bing Maps, 2009) (https://www.bing.com/mapspreview) accessed May 2016.**

the west of the city (Reed, 1999), the large middle-class tenements were subdivided, back lanes occupied by poorly-ventilated, substandard dwellings, and new tenements were built to much lower standards (Wordsall, 1979). Meanwhile, the rapidly deteriorating conditions of inner-city neighbourhoods more widely and the increasing demand for affordable working-class housing led the City Improvement Trust to launch, from 1866, a programme of physical improvements. After a visit to Haussmann's work in Paris, in 1871 John Carrick, the City Architect, presented a feuing plan for the area of Gorbals owned by the City. This sought to replace the medieval fabric with a grid-iron street layout (Reed, 1999). The sale of plots to private developers started in 1872 and construction was under way by 1874. This last project took more than 20 years to complete (Figure 3a).

*Modernist Gorbals*

By the 1930s, Glasgow's booming industry, rampant speculation and ineffective building maintenance and regulation led to widespread overcrowding. Despite thriving with a diverse social and cultural life, its dilapidated building stock, lack of basic sanitation, and violence, made Gorbals notorious as one of the worst and most dangerous slums in Britain (Robb, 1983). In the inter-war years, in an attempt to deal with overcrowding, the local authority decided to rehouse part of its urban population outside the city boundaries (Corporation of the City of Glasgow, 1960). In Gorbals this policy did not solve overcrowding. A paradoxical situation arose in which under-occupancy and overcrowding coexisted (Pacione, 2002). Sporadic demolitions of some of the worst tenements also took place, generally involving no more than a few plots at a time, without producing much material improvement, while further reducing the housing stock. By 1950, the Corporation of the City of Glasgow was persuaded that more drastic action was required: the overall urban layout of Gorbals was deemed obsolete and hence needed to be replaced (Corporation of the City of Glasgow, 1953). The Town and Country Planning (Scotland) Act 1947 (ch. 53, 10 and 11 Geo. 6) had provided the necessary financial means and legislative backing for the Corporation to do so through the designation of Comprehensive Development Areas (CDAs). These were the basis for the clearance and comprehensive redevelopment of entire inner-city neighbourhoods (Figure 3b). Of the 13 276 houses existing prior to redevelopment (7605 in Hutchesontown and 5671 in Laurieston), only 280, which had been built by the Corporation in the inter-war period, were considered worthy of retention (Corporation of the City of Glasgow, 1956, 1965b). The remainder were earmarked for demolition and replacement in the form of tower-blocks and mid-rise deck-accessed slabs with ground-floor maisonettes (Smith, 2014b), a decision directly inspired by a visit of a delegation of the Planning Department in 1955 to Le Corbusier's Unité d'Habitation in Marseille and other CIAM hallmarks existing around Britain (Corporation of the City of Glasgow, 1960).

The Huchesontown/Gorbals masterplan, with its 3225 new dwellings, was fully implemented by 1974. But that of Laurieston/Gorbals CDA was never fully realized, less than 1350 of the 3100 expected dwellings actually being built (Corporation of the City of Glasgow (1965b; Smith, 2014b). This was partly owing to the suspension of the Highway Plan, which envisaged a ring of motorways surrounding the city centre and intercepting the southern portion of Laurieston CDA (Corporation of the City of Glasgow, 1965a), and partly to the cessation, at the end of the1970s, of the whole CDA programme (Smith, 2014b). In total, including the few retained pre-war dwellings, both developments would comprise less than 4850 dwellings, about one-third of the number existing in the 1950s.

*The new Gorbals*

Initial enthusiasm for the new dwellings was short-lived. Serious construction faults and problems with the surveillance of communal space emerged (Smith, 2014b). Environmental


**Figure 3. Ground plans of part of the study area in (a) 1934); (b) 1976; and (c) 2016. Reproduced from Ordnance Survey plans dated 1934 (scale 1:2500), 1976 (scale 1:1250), and 2016 (scale 1:1250): EDINA Historic Digimap Service (http;//digimap.edina.co.uk).**

and building improvements throughout the 1980s did not prevent over two-thirds of the structures from being vacated and progressively demolished. In 1989, Glasgow City Council opted for a further redevelopment of the area overriding the philosophy of CDAs (Crown Street Regeneration Project, 1992). The aim was to attract private sector investment, enhance the image of the area and stimulate positive trickle-down economic effects. Through multi-agency partnerships, including public sector institutions and stakeholders, housing associations and representatives of the local community, masterplans for three new mixed-use residential neighbourhoods were commissioned: Crown Street (1992–2000), Queen Elizabeth Square (1991–2010) and New Laurieston (2012 – expected 2022), in addition to several other improvement initiatives (Smith, 2014c). In all three masterplans, development was phased into manageable 'packages' gradually released on the market. In the first two, conditions on such matters as building height and alignment, position of entrances, focal points, parking and materials were imposed on design quality through site-specific briefs. These had greater relevance in Crown Street than in Queen Elizabeth Square. Indeed, in the former, land price was fixed and the briefs were the sole basis of the assessment of proposals. In the latter, developers also bid on land price, with looser adherence to the briefs. For New Laurieston there was not a clearly defined design brief (Smith, 2014c).

This last three-tier phase of development was explicitly inspired by townscape theories and principles of sustainability (CABE, 2004) and shows an appreciation of the fine-grained mixture of uses, perimeter blocks of tenements and busy shopping streets characteristic of Glasgow's traditional fabric (Thompson-Fawcett, 2004). The three masterplans sought to reinterpret the traditional street grid structure, with most important streets oriented north-south as in old Gorbals (Figure 3c). The masterplans for Crown Street and Queen Elizabeth Square included 1394 new dwellings (28 per cent of which were subsidised). New Laurieston had 364 new dwellings constructed and a further 400 are due to be completed by 2022. If 571 units are added from other local initiatives (Smith, 2014c), about 1600 surviving post-war units and 200 pre-war and Victorian units, the grand total in the study area is about 4500 dwellings.

## Gorbals through five resilience proxies

In this section the five proxies of urban form resilience originally introduced in Feliciotti *et al*. (2016) are briefly defined, first in general terms, and secondly in terms of morphological components. Such definitions condense a comprehensive literature review, which compares the last 40 years of research on urban resilience and borrows from the long established research tradition of urban morphology (Conzen, 1960; Kropf, 2009). Then, each proxy is discussed as a descriptor of each of the three phases of development. Variations and common patterns among components of urban form are considered at the same scale, as well as interdependencies across scales, to derive conclusions regarding their impact on overall resilience over time. Initial lessons for practice are also provided. Whilst we touch on aspects of building typology, we bring our exploration only down to the scale of the plot, leaving out that of the building and its internal structure.

### *Diversity*

In general terms, diversity can be understood as the extent to which an environment is made up of different types of components. In ecology, diversity of a system is a combination of two aspects: its *richness*, or the number of taxa present in an ecological community, and its *evenness* in the distribution of individuals for each species (Magurran, 2004): higher richness and evenness imply higher diversity. In a system, diversity contributes to promote multi-functionality and greater interaction between components, especially in conjunction with a high level of spatial *mixité* of such components. Diversity is influenced by sampling, and its understanding comes from observation at different scales.

In terms of resilience, diversity is crucial in making space for innovation, while helping to maintain relative stability across different conditions (Ahern, 2013). Most importantly, diversity sustains further diversity and creates cross-scale synergies. A resilient urban fabric features diversity at every scale: mixture of economic activities, co-existence of buildings of different ages, sizes and layouts, presence of different types of street and public spaces, and availability of diverse transport options within or across areas. This kind of diversity can attract households of different composition and income, and with different needs and requirements, thus promoting social diversity.

To assess this crucial property, an initial survey was made of the number of retail and service land-use units grouped into eighteen categories. Functional diversity was compared across the three developments (Table 1). Nineteenth-century Gorbals was characterized by a wealth of uses. Before its redevelopment there were 860 shops (categories 1–3) and over 170 community facilities (categories 4–18), either distributed vertically within the same building or horizontally juxtaposed within contiguous plots. In addition to this, the area contained about 526 industrial premises (Corporation of the City of Glasgow, 1956, 1965b). This diversity was lost in the modernist redevelopment. The principles of zoning and land-use segregation condemned this intricate mix of uses as disordered and inefficient (Corporation of the City of

**Table 1. Non-residential units by land-use type in the study area in the 1950s, 1980s and 2010s**

| Category | 1950s | 1980s | 2010s |
|---|---|---|---|
| Restaurants, cafes, pubs, takeaways | 190 | 29 | 19 |
| Service and repairs | 133 | 9 | 26 |
| Retailing | 537 | 46 | 20 |
| Religious | 18 | 12 | 5 |
| Community halls/ Community centres | 41 | 4 | 3 |
| Cinemas, bingo halls, theatres, music | 8 | 2 | 3 |
| Libraries | 2 | 2 | 2 |
| Police stations | 2 | 1 | 1 |
| Offices and Third sector | 19 | 6 | 13 |
| Employment exchange/business centres | 1 | 0 | 1 |
| Post offices | 4 | 1 | 1 |
| Doctors and dentists | 57 | 7 | 3 |
| Non-profit organizations | 2 | 3 | 11 |
| Nurseries/crèches | 1 | 2 | 6 |
| Education | 16 | 10 | 6 |
| Social care | 0 | 3 | 4 |
| Sports club | 0 | 1 | 2 |
| Local government | 0 | 2 | 6 |
| **Total** | **1031** | **140** | **132** |
| **Simpson Diversity Index** | **0.67** | **0.83** | **0.90** |
| **Normalized number of units** | **1.00** | **0.14** | **0.13** |
| **Weighted Diversity Index** | **0.67** | **0.11** | **0.11** |

The Simpson Diversity Index, used in ecology to account for both the richness and evenness of an ecological community, is weighted by the total number of units in each time period normalized between 0 and 1. The final values convey a Weighted Diversity Index which also accounts for the difference in terms of total number of non-residential uses across the three time periods. Data for the 1950s from Corporation of the City of Glasgow (1956, 1965b); data for the 1980s and 2010s from Smith (2014c).

Glasgow, 1960). Industrial and commercial uses were largely excluded. Those that acquired sites struggled owing to the absence of complementary functions. A vicious circle was triggered in which the introduction of new functional types, which tends to lead *spontaneously* to an increase in diversity (Luhman, 1989) was overridden by a dramatic reduction in the total number of non-residential units (from 1031 to 140 within 30 years). Owing to the failure of the modernist redevelopment to promote a socially and functionally mixed community, diversity was set as a fundamental target (Crown Street Regeneration Project, 1992). However, despite this, there was no significant change in functional diversity.

The predominant building type until the modernist phase was the tenement (Figure 4a). This long-established building type, though often in poor condition, was able to cater for different social groups and adapt considerably over time: the fine grain spatial structure, combined with extensive private ownership, was conducive to many plots being frequently divided or amalgamated (Worsdall, 1979). In contrast, in the subsequent redevelopment, dwellings of different size were accommodated in high-rise structures, in the form of tower blocks or deck-access/maisonette slabs (Figure 4b). This new fabric proved far less adaptable. As housing was entirely public, *control*, *ownership* and *use* were separated


**Figure 4. Comparison of the three generations of built forms (a) Victorian, (b) modernist, and (c) recent. Based in part on Ordnance Survey plans of 1934, 1976 and 2016. Sources as for Figure 3.**

from each other – the former two being in the hands of social landlords and only the latter in those of the tenants: any alteration or adaptation in layout required centralized authorization. This *permissive* form of control (Akbar, 1988) resulted in rigid management and standardization.

The latest redevelopment borrows from the traditional typomorphological vocabulary of Victorian Glasgow. A modified version of the tenement was introduced, featuring a vertical mix of ground-floor maisonettes surmounted by 'walk-ups', occasionally accommodating parking within the plot, but still arranged in a continuous frontage of outward-facing perimeter blocks and townhouses with on-street parking (Figure 4c). The combination of tenures (rented and privately owned) and the finer-grained building type admixture is a step forward towards diversity and adaptability.

*Redundancy*

Redundancy entails the presence in a system of a multiplicity of components or pathways performing the same or a similar function. Duplication ensures substitutability of the individual components, and a multiplicity of options increases the variety of responses and strategies available at any point in time. In resilience terms, redundancy protects against damage or failure by guaranteeing backup strategies while allowing flexibility. In the urban fabric, redundancy entails that the same facility or good is provided in different forms, by different independent agents, in different sizes (for example, fine-grained ground-floor retailing, department store and commercial centre), appropriately contained in a mixture of plots of different sizes. At the level of the street, redundancy is about having available a multiplicity of alternative paths linking origins and destinations: in this sense, interconnected grids have the highest redundancy and tree-like street networks have the lowest.

In nineteenth-century Gorbals, ordinary uses, such as small offices, workshops and local shops, were accommodated in small plots, and the larger plots provided suitable conditions for containing specialist functions or district services, such as public facilities, theatres and large industries. Before redevelopment, the soon-to-be Hutchesontown/Gorbals and Laurieston/Gorbals CDAs had, respectively, 60 and 39 people per shop excluding pubs and vacant premises (Corporation of the City of Glasgow, 1965b). To the modernist planner this was far too few people per shop and it was increased to between 225 and 450 people per shop (Corporation of the City of Glasgow, 1965b), thereby eliminating redundancies. The result was that, prior to the latest round of redevelopment, Gorbals was under-served by both retailing and community facilities (CABE, 2004). Only recently have several small-scale retail units started to reappear, particularly in the Crown Street area where efforts were made to provide opportunities for activities of different sizes to develop. However, in Queen Elizabeth Square and New Laurieston few non-residential uses have so far been introduced.

At the scale of the street network, redundancy varied considerably across the three phases of development. In the earliest, the tight grid-iron layout offered plentiful alternative paths to choose from. In contrast, the street system of the modernist redevelopment, with a typical rigidly-tiered hierarchy of regional, district, neighbourhood and local connections and large super-blocks (Panerai *et al*., 2004), reduced considerably the options for navigation of the whole area. The latest redevelopment is somewhere in-between: the attempt to create an interconnected circulation network was thwarted by high-speed thoroughfares and motorways, which remain largely detached from the local network (CABE, 2004) and have generated a tortuous local street system with few obvious traversing routes.

*Modularity*

Modularity is the tendency for a system's components to disaggregate into smaller units or aggregate into larger wholes. In a modular system, each component (or module) is structurally and functionally autonomous but,

at the same time, interdependent with others. Hence, while modules are individually simple, discreet and rather ordinary, it is in their aggregation that higher complexity is achieved. Modularity is important for resilience because it helps spread innovation through interdependency, while limiting the damage caused by failure of individual components. Finally, systems that are highly modular tend to display, at fine scales, a decentralized pattern. In resilience terms this implies a more even distribution of key resources, which decreases the risk that the system will 'stall'.

A modular urban form is one in which every morphological scale is clearly evident, so it is possible to discern how each level in the hierarchy is made of smaller-scale components (for example, blocks made up of many smaller plots). Plots are a good example: individually, they are relatively simple and autonomous, still exhibiting a good capacity to aggregate along street edges and in street blocks, yet without losing their individuality. However, for plots to function as proper modules, their size is crucial: smaller plots are generally geometrically and functionally simpler, while larger plots, being more articulated, are particularly disadvantaged (Habraken, 1998; Moudon, 1986; Panerai *et al*., 2004): as size increases, functional complexity and specialization tend to both increase, reducing adaptability and hence resilience. This has repercussions at other spatial scales: for example, street blocks comprising one or very few super-plots cannot be easily subdivided into smaller units.

In nineteenth-century Gorbals, individual plots were autonomous, small, and functionally simple: they could contain only a limited number of dwellings or only relatively small businesses, and individual demolitions or vacancies had limited impact on the whole area, allowing the system to quickly re-tune to contextual conditions with alternative uses and configurations. In contrast, the modernist redevelopment shows much larger and more articulated plots, often hosting complex specialist functions. Owing to this coarser grain, alterations or failures had considerable impact on the whole area: each demolished tower-block affected hundreds of people at the same time, at the cost of millions of pounds (Smith, 2014b). Furthermore, as large areas were replaced simultaneously, future additions were left with little context to which to 're-tune'. Finally, while in the earliest layout an average street block contained 15.4 plots, having a relatively uniform size averaging 7200 $m^2$ (Figure 5a), in the modernist redevelopment plot density per block was reduced to 8 on average, while block size increased dramatically to an average of 14 635 $m^2$ (Figure 5b). As plots disappeared, street edges were also lost, leaving street blocks and superblocks as minimal spatial modules – a pattern typical in modern planning (Panerai *et al*., 2004). In the latest redevelopment, there is a tendency for smaller plots to be created (13.5 plots per street block on average) and reintegrated within their street blocks. However, even in this case, mean block size remains closer to that of the modernist redevelopment, about 14 625 $m^2$ (Figure 5c)., and plots are not as individually independent as in the initial phase, often hiding coarser-grained structures, where control is in the hands of a few centralized agencies.

In nineteenth-century Gorbals non-residential functions settled spontaneously in the most convenient locations. By virtue of the strong plot/street relationship they clustered in 'soft' and 'porous' nodes along main streets (Figure 6a). This changed when the area was redeveloped after the Second World War. Indeed, a grounding principle of modernist Gorbals, recurrent in urban design models such as the Garden City (Howard, 1898) and the Neighbourhood Unit (Perry *et al*., 1929), was that concentrating people and uses in a few large-scale integrated components would bring greater efficiency for a larger number of residents. Hence, in Gorbals, commercial and community facilities were clustered in one single shopping-community centre, the Cumberland Arcade (Figure 6b). A similar logic was applied to housing: a few high-density buildings housed hundreds of households and provided integrated community spaces for social activities completely separated from adjoining public streets, resulting


**Figure 5. Density of plots within each street block (number of plots per block divided by block area): (a) in the 1950s; (b) in the1970s; and (c) in the 2010s.**

in areas that were isolated and disconnected despite their physical proximity. In the latest redevelopment a more evenly distributed plot pattern is evident. Plots on average exhibit a higher degree of engagement with streets, thus ensuring mutual interdependence. But retailing and services remain clustered only along a limited portion of Crown Street (Figure 6c). Queen Elizabeth Square and New Laurieston remain almost exclusively residential. The latest redevelopment is incomplete, and conclusions on emerging patterns would be premature.

*Connectivity*

Connectivity expresses the ease of each component of a system to reach all the others. In a connected network (a-spatial or spatial), no vertex is unreachable, as every pair of vertices is linked by at least one path. However, the structure and distribution of connections also matter, as even in a connected network, some parts can be linked more tightly, others more loosely. In the first case, movement is facilitated. In the second, peripheral pockets are formed, which also drives the location of clusters of higher intensity of contact between parts of the system (Barthelemy, 2011). The role of connectivity for resilience is twofold: high connectivity facilitates diffusion of new knowledge, while low connectivity, to a certain degree, facilitates preservation of memory. An area that is well connected internally and to its surroundings is likely to facilitate the movement of people and goods, allowing high intensity of activities to develop (Hillier, 1996). At the street scale, areas with a higher number of street intersections, particularly three- and four-ways, show higher connectivity, while on a different level the 'transparency' and 'constitutedness' of the interface affects the connectivity between private and public space (van Nes and López, 2007). At the street block scale, size also indicates connectivity, as smaller blocks imply more streets and street intersections. Another important aspect of connectivity is accessibility, which can be assessed by considering the number of

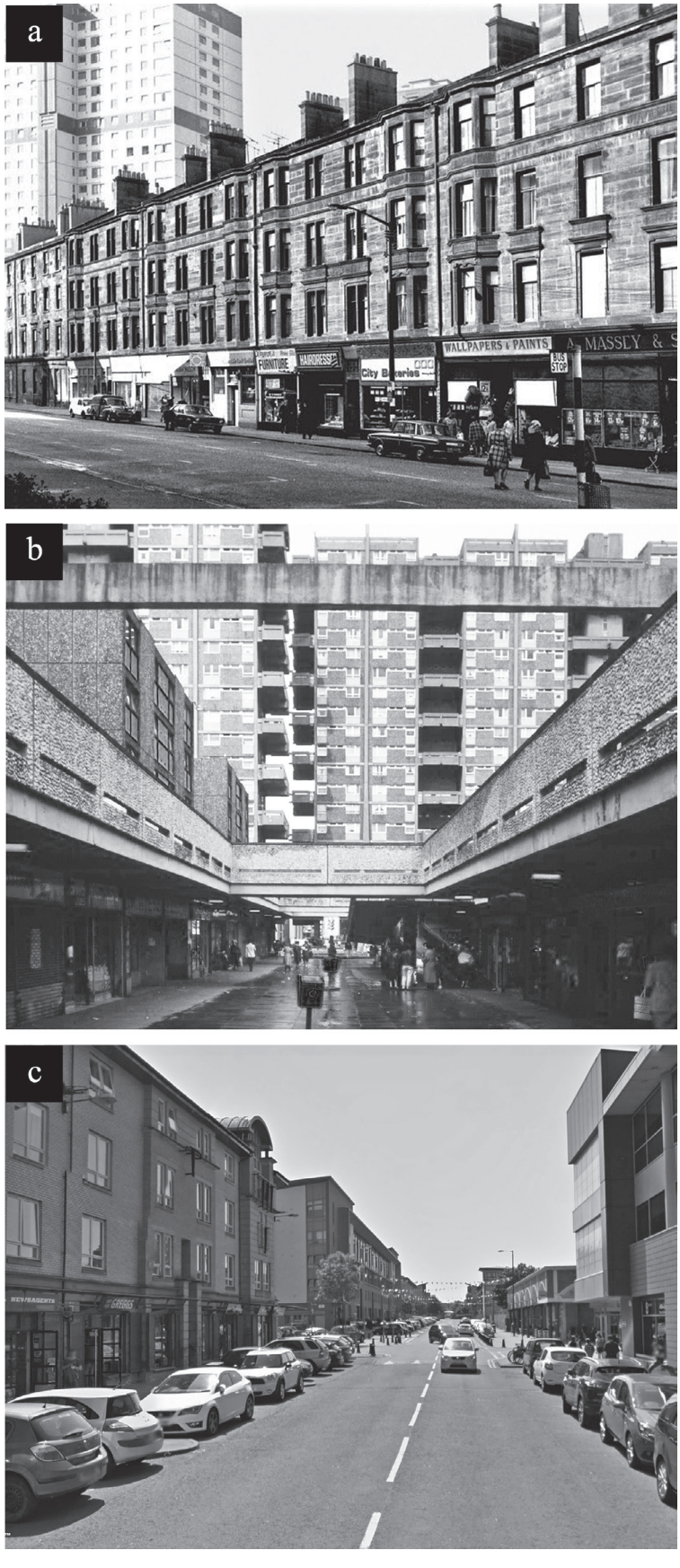


**Figure 6. (a) Continuous shops along the west side of Crown Street, south of Cleland Street, in 1973 (source: www.urbanglasgow.co.uk); (b) Cumberland Shopping Arcade in 1960s (source: www.urbanglasgow.co.uk); and (c) Crown Street looking south in 2016 (source: Google Street View).**

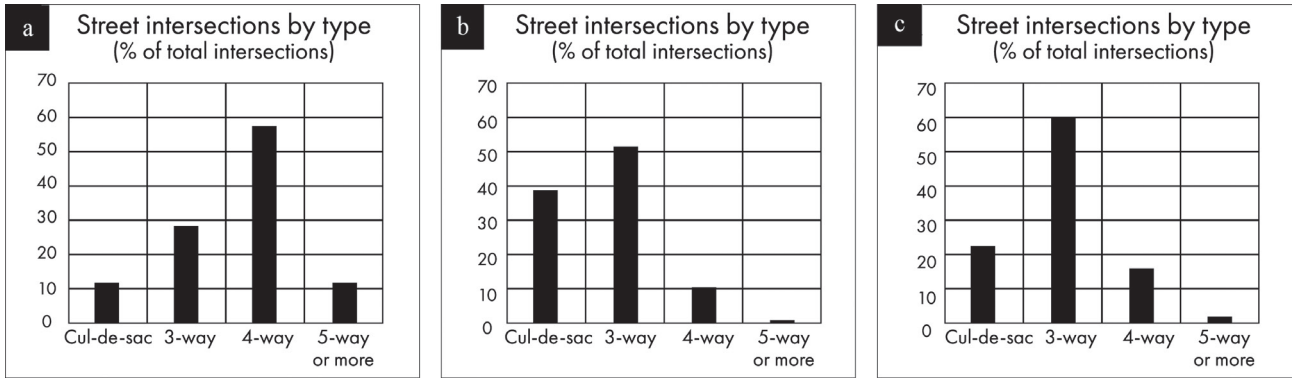


**Figure 7. Intersection types in the study area: (a) in 1934, when the urban fabric reflected the Victorian layout; (b) in 1976, when most of the second development had yet to be completed but most of Hutchesontown/Gorbals CDA was already complete; (c) in 2010 after the latest round of redevelopment. Based on Ordnance Survey plans of 1934, 1976 and 2010.**

plots accessible within a certain distance, the length of plots on a street, and the average distance between access points from the public space (Remali *et al*., 2015).

Across the three phases of development, consistent differences in connectivity exist. In nineteenth-century Gorbals, plots were smaller and their access points tightly spaced along the street offering a high degree of transparency and access to destinations. In contrast, the modernist development featured larger plots, often coinciding with a street block and having fewer entrances. This minimized direct contact with streets, and was conducive of a lower number of accessible destinations. Finally, in the latest development, a return to a finer-grained subdivision and a general increase in accessibility is recorded.

The grid-iron structure of nineteenth-century Gorbals featured many four-way and three-way intersections and few culs-de-sac (Figure 7a). In the modernist redevelopment, as street intersections were considered points of conflict between movement lines (Corporation of the City of Glasgow, 1953), the network was redesigned with few and widely-spaced intersections, sometimes replaced by underpasses or bridges to further segregate traffic by type and speed, and with a greater proportion of dead-ends (Figure 7b).

In the latest redevelopment, to re-establish street connectivity and reinstate previously severed links, great attention was paid to reconnecting the fabric internally. Street intersections are relatively frequent, despite the presence of many culs-de-sac (Figure 7c). Unfortunately, external connectivity with the surrounding areas remains poor, owing partly to the desire to protect the area from high-volume traffic and partly to the existence of large undeveloped areas and other spatial barriers (for example, the river, the motorway and the railway). Street-block size decreased but not down to nineteenth-century levels.

*Efficiency*

Efficiency consists of a particular form of organization of components and relationships within a system in which small, ordinary and frequent components and links are countered by progressively fewer large, specialized and rare ones. Mathematically, this is described by a power law (Salat *et al*., 2014). An efficient system features, at every scale, a similar level of complexity. Efficiency is important to resilience as it makes it possible for cross-scale synergies between components to emerge, ensuring a degree of stability. At the scale of plots, an efficient urban form is characterized by a great number of small plots and fewer large ones. Similarly, many small street blocks should be present, and few intermediate and

large ones. It follows that an efficient movement network is one that features few major routes connecting to the wider metropolitan area. It is also a network that has several main streets and many human-scale, walkable and dense local streets, so that both locally and more widely, different locations are readily accessible with the least effort. This combination of wider connectivity and local clustering, ubiquitous in all complex systems in nature, technology and society (Watts and Strogatz, 1998), also supports the emergence of a small number of high-level 'metropolitan' uses (for example, universities and large hospitals) and shared 'district' uses and facilities. It also ensures that everyday facilities are interspersed and within easy reach.

Prior to the modernist redevelopment, Gorbals had many small plots (Figure 8a). When the modernist redevelopment was implemented, increases in plot sizes led to an overprovision of medium-sized plots (Figure 8b), a pattern still visible today. Similar changes are evident in street-block sizes and street lengths across the three developments. Street blocks in the modernist redevelopment are considerably larger than in the nineteenth-century development, owing to the introduction of large communal courtyards within street blocks, rather than between them, and of large areas devoted to car parks (Moudon, 1986; Ryan, 2006). This confirms a similar pattern observed in cities in transition from a pre-industrial state to a modernist one (Salat *et al.*, 2014). In Gorbals the pattern has been partially reversed in the latest redevelopment, although the greater incidence of medium-sized plots persists (Figure 8c). This is partly explained by the recently perceived need to accommodate car parking within the plot space and increase the privacy of individual properties.

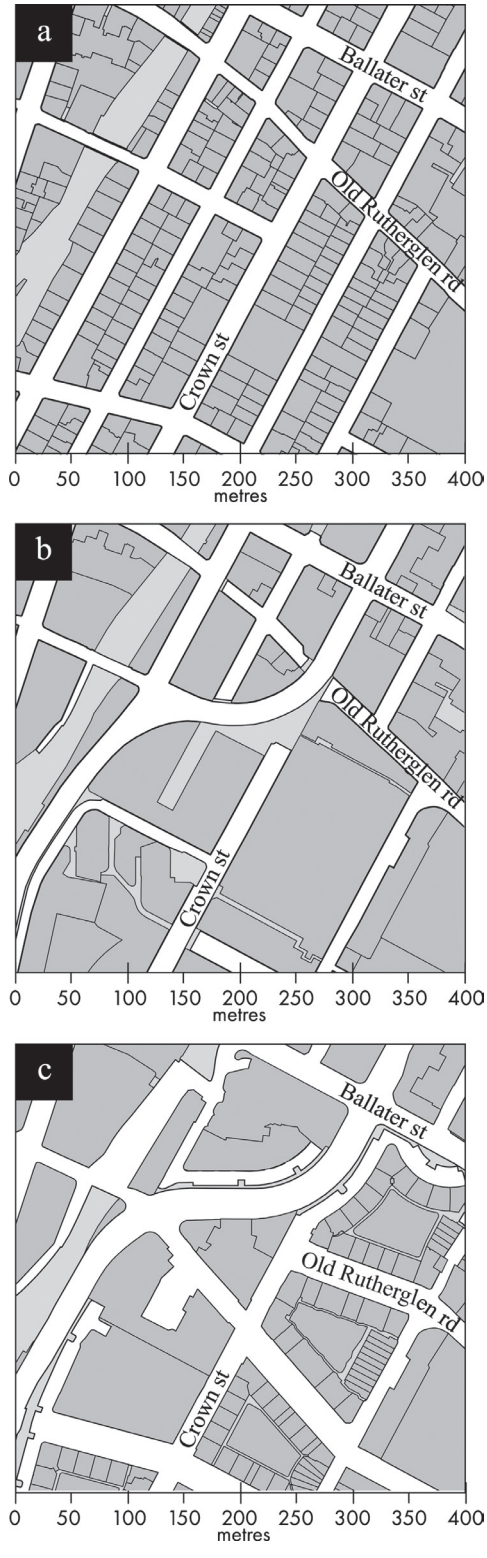


**Figure 8. Plot patterns in the vicinity of Crown street and Old Rutherglen Road: (a) in the 1950s; (b) in the 1960s; (c) in 2016. Adapted from Ordnance Survey plans.**

## Conclusion

The three developments considered in this paper represent very different approaches. By virtue of its complex spatial structure, the form of the nineteenth-century development was

increasingly diverse, connected, redundant, modular and efficient over many decades. In contrast, the modernist development generated a system of isolated individual components, simplified, coarse-grained networks of connections both internally and externally and highly centralized functions, creating a disproportionately large number of intermediate-scale morphological features. The capacity of the modernist system to adapt declined. The latest redevelopment was a reinterpretation of nineteenth-century Gorbals to meet new requirements (for example, accommodate cars and provide privacy) and new policy objectives (for example, attract young families and reinstate private ownership). However, though the new environment resembles the old tenement fabric, doubts remain as to whether the similarity has more to do with architectural appearance than with the structure of urban form. Though using building types and plots similar to the nineteenth-century model, the latest redevelopment is based on a rather different street-block configuration entailing different mechanisms of control and use. Additionally, though the street network recalls the interconnected Victorian grid, at a deeper level the segregation of types of movement reinstates barriers that make it closer to its modernist counterpart.

The patterns illustrated in this paper are representative of a type of development process that is shared by many inner-city neighbourhoods in Glasgow and elsewhere in the UK (Rudlin and Falk, 2009) and beyond (Moudon, 1986; Ryan 2006; Scheer and Felderman, 2001). This is confirmed by parallel research work in urban morphometrics recently carried out at the University of Strathclyde on several settlements in the UK and Europe (Dibble *et al*., 2016; Porta *et al*., 2014): similar development processes induce similar patterns of change in urban form, which remain recognizable over time and consistent across space. A further development of the proposed approach could involve comparisons with other areas in Glasgow which, though originally similar to Gorbals, did not undergo the same abrupt change in the post-war years and still retain their original urban structure. Indeed, though most of the fabric of old Gorbals no longer exists today, observation of cases in Glasgow where such fabric has survived to the present suggests a remarkable capacity of traditional structures to integrate the ordinary and the extraordinary, the old and the new, constantly adapting to often unforeseeable historical changes.

In Gorbals, each of the three developments offers lessons for practice regarding what aspects of urban form can contribute to the resilience of places. Whilst resilience does not depend on urban form alone, urban form has an important role in supporting or hindering evolutionary processes of socio-economic and environmental change over time that have significant implications for resilience. A more positive performance overall in terms of resilience and proposed proxies seems to come from the first stage of development, confirming a long strand of research that identifies guidance in the pre-modern city for the sustainable city of the twenty-first century (Alexander *et al*., 1987; Jacobs, 1961; Lynch, 1981; Rudlin and Falk, 2009; Tachieva, 2010; Tarbatt, 2012).

Needless to say, today's cities look very different from their Victorian counterparts. New uses, requirements and lifestyles have radically transformed the way we experience and value them. However, despite all the differences that distinguish our contemporary cities from their Victorian predecessors, our work suggests that the structural characteristics of urban form that have matured over centuries of gradual adaptation have managed to adapt to a wide range of circumstances and contingencies. Whilst this is exemplified here in the nineteenth-century fabric of Gorbals, similar principles have been observed in traditional urbanism (Hakim, 2014) and informal settlements in many parts of the world (Porta *et al*., 2014). This is in stark contrast to the landscapes of many post-war cities, of which the modernist redevelopment of Gorbals is a typical example. This fabric struggles to respond to new requirements when the purpose for which it was designed no longer exists (Brand, 1994).

The intuition that, in this specific case, the Victorian fabric has particular qualities that

are relevant for today's urban living and for the resilient city of the future is evident in the aspiration of more recent redevelopments to return to an earlier model (Crown Street Regeneration Project, 1992). However, this intuitive appreciation must necessarily be sustained by a solid knowledge of what made such urban form capable of adapting to the small cues of gradual change, rather than responding to increasingly risky and costly large-scale initiatives. This conclusion has already started to gain recognition in the discipline of urban design, even outside academic circles (Rudlin and Falk 2009; Tachieva, 2010; Tarbatt, 2012). A recommendation for practice is to focus on the structure of historical urban form and its morphological components to unlock their hidden regenerative potential – the very property we call resilience.

## References


Ahern, J. (2013) 'Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design', *Landscape Ecology 28*, 1203–12.

Akbar, J. (1988) *Crisis in the built environment: the case of the Muslim city* (Concept Media, Singapore).

Alexander, C., Neis, H., Anninou, A. and King, I. (1987) *A new theory of urban design* (Oxford University Press, New York).

Allen, C. R., Angeler, D. G., Garmestani, A. S., Gunderson, L. H. and Holling, C. (2014) 'Panarchy: theory and application', *Ecosystems* 17, 578–89.

Barthelemy, M. (2011) 'Spatial networks', *Physics Reports* 499(1–3), 1–101.

Beatley, T. (2012) *Green urbanism: learning from European cities* (Island Press, Washington, DC).

Bentley, I., Alcock, A., Murrain, P., McGlynn, S. and Smith, G. (1985) *Responsive environments: a manual for designers* (Architectural Press, London).

Brand, S. (1994) *How buildings learn: what happens after they're built* (Viking Press, New York).

CABE (2004) *Case Studies: Crown Street, Glasgow* (http://webarchive.nationalarchives.gov.uk/20110118095356/http://www.cabe.org.uk/case-studies/crown-street) accessed January 2016.

Carpenter, S. R., Westley, F. and Turner, M. G. (2005) 'Surrogates for resilience of social–ecological systems', *Ecosystems* 8, 941–4.

Chelleri, L. (2012) 'From the 'Resilient city' to urban resilience: a review essay on understanding and integrating the resilience perspective for urban systems', *Documents d'Analisi Geografica* 58, 287–306.

Conzen, M. R. G. (1960) *Alnwick, Northumberland: a study in town-plan analysis* Institute of British Geographers 27 (George Philip, London).

Corporation of the City of Glasgow (1953) *Proposals for comprehensive redevelopment: Hutchesontown and part of Gorbals, Govan, Royston. Report to the Housing and Planning Committee* (Corporation of the City of Glasgow, Glasgow).

Corporation of the City of Glasgow (1956) *Survey report: Hutchesontown/Part Gorbals Comprehensive Development Area, 1956* (Corporation of the City of Glasgow, Glasgow).

Corporation of the City of Glasgow (1960) *Glasgow Development Plan: the Survey Report of the City of Glasgow Development Plan* Quinquennial Review 1960 (Stationery Office Limited, London).

Corporation of the City of Glasgow (1965a) *Report on a highway plan for Glasgow* (Corporation of the City of Glasgow, Glasgow).

Corporation of the City of Glasgow (1965b) *Survey report: Laurieston/Part Gorbals Comprehensive Development Area, 1965* (Corporation of the City of Glasgow, Glasgow).

Crown Street Regeneration Project (1992) *Crown Street regeneration project: past, present and future* (Glasgow Development Agency, Glasgow).

Dibble, J., Prelorendjos, A., Romice, O., Zanella, M., Strano, E., Pagel, M.and Porta, S. (2016) 'Urban morphometrics: towards a science of urban evolution', in Strappa, G., Amato, A. R. and Camporeale, A. (eds) *City as organism: new visions for urban life*, Proceedings of the 22nd International Seminar on Urban Form, Rome, 2015 (U+D, Urbanform and Design, Rome) 2, 1143–54.

Feliciotti, A., Romice, O. and Porta, S. (2016) 'Design for change: five proxies for resilience in the urban form', *Open House International,* 41 (4), 23–30.

Gunderson, L. H. and Holling, C. S. (eds) (2002) *Panarchy: understanding transformations*

*in human and natural systems* (Island Press, Washington, DC).

Habraken, N. J. (1998) *The structure of the ordinary* (MIT Press, Cambridge, MA).

Hakim, B. S. (2014) *Mediterranean urbanism* (Springer, Netherlands).

Hassler, U. and Kohler, N. (2014) 'Resilience in the built environment', *Building Research and Information* 42, 119–29.

Hillier, B. (1996) 'Cities as movement economies', *Urban Design International* 1, 41–60.

Holling, C. S. and Goldberg, M. A. (1971) 'Ecology and planning', *Journal of the American Institute of Planners* 37, 221–30.

Howard, E. (1898) *Tomorrow: a peaceful path to social reform* (Swan Sonnenschein & Co, London).

Kellett, J. R. (1969) *The impact of railways on Victorian cities* (Routledge & Kegan Paul, London).

Kropf, K. (2009) 'Aspects of urban form', *Urban Morphology* 13, 105–20.

Jacobs, J. (1961) *The death and life of great American cities* (Random House, New York).

Johnston, N. (1957) 'Miracle in the Gorbals?', *Architectural Prospect* Spring, 18.

Luhmann, N. (1989) *Ecological communication* (University of Chicago Press, Chicago).

Lynch, K. (1981) *A theory of good city form* (MIT Press, Cambridge, MA).

Magurran, A. E. (2004) *Measuring biological diversity* (Blackwell Science, Malden, MA).

Moudon, A. V. (1986) *Built for change: neighborhood architecture in San Francisco* (MIT Press, Cambridge, MA).

Pacione, M. (2002) *The city: the city in global context* (Routledge, London).

Panerai, P., Castex, J., Depaule, J. C. and Samuels, I. (2004) *Urban forms: the death and life of the urban block* (Architectural Press, Oxford).

Perry, C. A., Heydecker, W. D., Goodrich, E. P., Harrison, S. M., Adams, T., Bassett, E. M. and Whitten, R. H. (1929) *Neighborhood and community planning. New York: Regional Plan of New York and its Environs* (Regional Plan Association, New York).

Porta, S., Romice, O., Maxwell, J. A., Russell, P. and Baird, D. (2014) 'Alterations in scale: patterns of change in main street networks across time and space', *Urban Studies* 51, 3383–400.

Reed, P. (1999) *Glasgow: the forming of the city* (Edinburgh University Press, Edinburgh).

Remali, A., Porta, S., Romice, O. and Abudib, H. (2015) 'Street quality, life and centrality in Tripoli', in Vaughan, L. (ed.) *Suburban urbanities: suburbs and the life of the high street* (UCL Press, London).

Robb, J. G. (1983) 'Suburb and slum in Gorbals: social and residential change, 1800–1900', in Gordon, G. and Dicks, B. (eds) *Scottish Urban History* (Aberdeen University Press, Aberdeen) 130–67.

Romice, O., Porta, S., Feliciotti, A. and Barbour, G. (2017) 'Masterplanning for change: design as a way to create the conditions for time sensitive place-making', in AlWaer, H. and Illsley, B. (eds), *Placemaking: rethinking the masterplanning process* (ICE Publishing, London).

Ryan, B. D. (2006) 'Morphological change through residential redevelopment: Detroit, 1951–2000', *Urban Morphology* 10, 5–22.

Rudlin, D. and Falk, N. (2009) *Sustainable urban neighbourhood: building the 21st century home* (Routledge, London).

Salat, S., Bourdic, L. and Labbe, F. (2014) 'Breaking symmetries and emerging scaling urban structures: a morphological tale of 3 cities: Paris, New York and Barcelona', *International Journal of Architectural Research* 8**,** 77–93.

Scheer, B. C. and Feldeman, D. (2001) 'Inner-city destruction and survival: the case of Over-the-Rhine, Cincinnati', *Urban Morphology* 5, 15–28.

Smith, R. P. A. (2014a) *The Gorbals and Oatlands: a new history. Volume 1: The Gorbals of old* (Stenlake, Catrine, Scotland).

Smith, R. P. A. (2014b) *The Gorbals and Oatlands: a new history. Volume 2: Redevelopment and its aftermath* (Stenlake, Catrine, Scotland).

Smith, R. P. A. (2014c) *The Gorbals and Oatlands: a new history. Volume 3: An example to be followed*, (Stenlake, Catrine, Scotland).

Tachieva, G. (2010) *Sprawl repair manual* (Island Press, Washington, DC).

Tarbatt, J. (2012) *The plot: designing diversity in the built environment: a manual for architects and urban designers* (RIBA, London).

Thompson-Fawcett, M. (2004) 'Reinventing the tenement: transformation of Crown Street in the Gorbals, Glasgow', *Journal of Urban Design* 9**,** 177–203.

Thwaites, K., Porta, S., Romice, O. and Greaves, M. (2007) *Urban sustainability through environmental design: approaches to time-people-place responsive urban spaces* (Taylor & Francis, London).

Thwaites, K., Mathers, A. and Simkins, I. (2013) *Socially restorative urbanism: the theory,*

*process and practice of experiemics* (Routledge, London).

Town and Country Planning (Scotland) Act 1947 (Her Majesty's Stationery Office, London).

UN-Habitat (2009) *Planning sustainable cities. global report on human settlements* (Earthscan, London).

Vale, L. J. and Campanella, T. J. (2005) *The resilient city: how modern cities recover from disaster* (Oxford University Press, Oxford).

van Nes, A. and López, M. J. (2007) 'Micro scale spatial relationships in urban studies: the relationship between private and public space and its impact on street life', in Kubat, A., Ertekin, Ö., Güney, Y. İ. and Eyüboğlu, E. (eds) *Proceedings of the 6th International Space Syntax Symposium* (Faculty of Architecture, Istanbul Technical Univesity, Istanbul) 023, 1–12.

Watts, D. J. and Strogatz, S. H. (1998) 'Collective dynamics of small-world networks', *Nature* 393, 440–2.

Worsdall, F. (1979) *The Glasgow tenement: a way of life* (W&R Chambers, Edinburgh).

Zhang, J. (2016) 'Twenty-Third International Seminar on Urban Form, Nanjing, China', *Urban Morphology* 20, 171–3.