

ABSTRACTS

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UCL
Centre for
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3rd International
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& Resilience

13-14 June 2017, London

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Keynote Speeches

1 Resilient Urbanism 2.0: Designing for risk, crisis and everyday uncertainty

Jon Coaffee¹

¹University of Warwick, UK.

Jon Coaffee is Professor in Urban Geography based in the School of Politics and International Studies at Warwick. He is a recognised international expert in urban resilience. At Warwick he has established the Resilient Cities Laboratory, and directs the Warwick Institute for the Science of Cities. He is also co-lead of the University's Global Research Priority in Sustainable Cities. Jon's research focuses upon the interplay of physical, technical and socio-political aspects of urban resilience and he has worked closely with a range of private and governmental stakeholders to ensure his research has real world impact. This work has been published in multiple disciplinary areas and most notably includes: 'The Everyday Resilience of the City (2008); Urban Resilience: Planning for Risk, Crisis and Uncertainty'; (2016) and 'Routledge handbook of International Resilience' (2016). His work has been supported by a significant number of UK and EU Research Council grants linked to building resilience across different socio-technical systems in response to a range of shock and stress events.

Abstract

In the century of the city when crisis has become the new normal, planners and other built environment professionals are trying to find ways to make cities less vulnerable and more sustainable. Here, the need to be adaptable to change and cope with growing risk, disruption, and volatility—to be resilient—is seen as perhaps the most urgent challenge of our time. While not geared toward any single shock or stress, urban resilience is a part of a process which recognizes that the future is going to be considerably different from the past and that in order to survive and thrive we need to radically change current approaches. Learning to adapt in pursuit of greater resilience provides an antidote to the unpredictability of our future world and is becoming increasingly central to redesigning urban life in the 21st century. Today, ideas of resilience (and sustainability) present different viewpoints that allow us to see the future afresh. In the recent past, ideas of reducing vulnerability through risk management have dominated discussions on how society can control the future. Whilst these conventional approaches helped us prepare and plan for disruption and to 'bounce back,' new approaches promote the need to anticipate future challenges and enhance the capacity to adapt: in essence to 'bounce forwards.' Using examples focused upon the challenges of security, climate change, economic turbulence, community cohesion and critical and green infrastructures this paper will illuminate the wide variety of ways in which ideas of urban resilience have become operationalised in practice and the implications of such practices for social and spatial justice.

2 Universalizing ‘The Story of the Three Little Pigs and the Big Bad Wolf’

Robert Muir-Wood¹

¹ RMS, United Kingdom

Robert is the chief research officer of science and technology at RMS. His responsibilities include enhancing approaches to and applications of natural catastrophe modeling. Robert has more than 20 years’ experience in developing probabilistic models to characterise the risk and ramifications of natural and human-led shocks.

He has recently pioneered research into the clustering of catastrophic events, extreme liquefaction, loss amplification factors in “super cats,” time-varying activity rates, and the economic and social impacts of water scarcity.

Robert was the lead author on insurance, finance, and climate change for the 2007 Intergovernmental Panel on Climate Change (IPCC) Assessment Report. He was also appointed a key contributor to the 2014 Risky Business study by former New York Mayor Michael Bloomberg and former U.S. Secretary of the Treasury Henry Paulson.

Robert has written six books, along with numerous papers and articles in scientific and industry publications. He is a member of the High Level Advisory Board of the OECD International Network on Financial Management of Large-Scale Catastrophes. Robert holds a first-class degree in natural sciences and a Ph.D. in earth sciences, both from Cambridge University, and he was a research fellow at Trinity Hall, Cambridge.

Abstract

The story of the Three Little Pigs and the Big Bad Wolf was written by an English student around 1840 after having experienced an intense and damaging windstorm. The Wolf is really the Windstorm, huffing and puffing at the fabric of house so that only the brick building survives. As the British exported brick construction, as the epitome of Victorian civilization, to places like Japan and California, it did not take long before it was realised the ‘Wolf’ was now the Earthquake ready to crush the brick house while the houses of sticks and straw remain unscathed. The history of cities attempting to modify their buildings to resist whatever had been the latest disaster, goes back centuries: from the West Indies to the Philippines. At the end of the 19th Century in reinforced (ferro)concrete finally there seemed a medium that could resist all the principal perils, but then along came the designs of Le Corbusier and the unfettered sale of cement to artisan builders in developing countries. How would we rewrite ‘The Story of the Three Little Pigs’ for today’s world?

Urban Social Dimensions

(Tuesday 13th June 2017, 11:20-12:30, Seminar Suite A)

1. The Social Networks of Urban Resilience in Self-Help Urban Settlements: the Case of Nezahualcoyotl, in the Metropolitan Area of Mexico City

Manuel Alejandro Rivero Villar¹

¹ UCL, United Kingdom.

Keywords: management Urban Resilience, Global South, Self-help settlements

Abstract

This paper investigates the networks of social capital that participate in the achievement of urban resilience of self-help settlements (settlements self-produced by low-income groups lacking of adequate infrastructures and services, often occupying areas of high risk (Gilbert, 2007; Platt, 2010)) at the municipal scale. Self-help settlements are widely acknowledged as intrinsically vulnerable to the effects of climate change (Hardoy & Romero Lankao, 2011; Satterthwaite, 2013b) and are foreseen to be the predominant form of urbanisation in the Global South for the XXI century (UNHabitat, 2006). UN's recent adoption of the 'Sustainable Development Goals' have placed the resilience of self-help settlements at the top of the global development agenda (UNGA, 2015).

Urban resilience is understood as the continued adjustment of cities in an evolutionary fashion through their histories (W. Neil Adger, 2000; Pickett, Cadenasso, & Grove, 2004) in face of environmental uncertainties and nonlinearities (Leichenko, 2011). Urban resilience depends on cities' ability to transform in relation to those factors driving vulnerability and risk (Bahadur & Tanner, 2014). It is acknowledged that societies have inherent capacities to overcome climate change, which are bound up with their ability to act collectively (W Neil Adger, 2010). Thus urban resilience scholars recognise a social dimension as central to explain how the inhabitants of a city can act collectively in identifying the sources of their vulnerability, and forward pertinent transformations to increase the resilience of the city (W Neil Adger, 2010; Ahern, 2011; Davoudi, 2012; Shaw, 2012).

Central to urban resilience's social dimension is the concept of social capital, which refers to the social rules of trust and reciprocity embedded in social networks that enable them to act collectively (Bourdieu, 1989; Coleman, 1988; Putnam, 2000). In the context of urban resilience, social capital can explain how social groups living in self-help settlements organise from the bottom up to create "pressure and partnerships for enhanced urban resilience" (Bahadur & Tanner, 2014, p. 204), focusing in achieving community development goals (e.g. accessing adequate services and infrastructures) to overcome the sources of their vulnerability (Gilbert, 2013; Satterthwaite, 2013a). In order to achieve this, a particular type of social capital called linking social capital is seen as necessary, which links, vertically, social groups operating in self-help settlements with "persons, agencies or institutions that can give them access to all the range of resources –other forms of capital– lacking in their environment" (Szreter, 2002, p. 577) to forward different development goals (Woolcock, 1998).

This paper takes as case-study the social networks involved in the achievement of the collective goals that shaped the urban resilience of Nezahualcóyotl (Neza, in short), a self-help settlement located in the

metropolitan area of Mexico City. In its history, Neza has faced multiple hazards, both environmental (the settlement is located on the drained bed of a salty lake, prone to flooding and sand storms) and institutional (at the moment of its formation, the area lacked formal government structures).

The approach of the research is longitudinal, given that the investigation tracked the evolution of the case-study, from its beginnings (1950s) to its consolidation (1980s). The research investigated the social networks linked with the collective goals that helped the case-study overcome the causes of its vulnerability, and thus improve its resilience: access to water supply & drainage infrastructures, roads & public transit, secure land tenure, and accountable governance. Data was collected relying on archive mining, and then analysed using the theoretical and methodological procedures of Social Network Analysis (SNA).

The main findings of the research are three: the evolution of networks, the emergence of strategic goals, and the formalisation of networks. The evolution of the social networks that participated in the resilience of the case-study followed a trajectory of three stages: formation, peak, and dissolution. Social networks, in the formation stage, gather participants around a particular topic, which keeps growing and gaining momentum, until social networks reach a peak in size, which allows them to achieve the pursued collective goals. Once a goal is achieved, social networks tend to dissolve.

The second finding is the longitudinal prioritization of collective goals, measured by the size of the networks; and the relative position that goals occupy in the network. While the most tangible goals (i.e. drainage and water supply infrastructures) were the ones that consistently gathered the largest number of participants, other collective goals occupied more central positions (secure land tenure and accountable governance), and linked the most influential members. This indicates a more strategic character of goals. It is interesting that even when these strategic goals gathered a relatively small number of participants, these goals helped the most to the achievement of the more tangible ones.

The last finding is the evolution of networks towards its formalisation. This means that even when the observed social networks had their origins as informal, local and bottom-up, all of them followed a trajectory in which government actors assumed the most relevant positions in the networks. Even when community actors are present during all the observed period, the number of community participants decreased as government actors concentrated the most relevant positions. This means that government actors assumed the control of Neza's social networks, and suggests that the evolution of social networks went from governance to government. This may question the relevance of governance approaches for resilience, and recognise the importance of the role of the state in the resilience agenda.

Research objectives

The research's objectives are: to understand the structural relevance of linking social capital in social networks of urban resilience, and locate what patterns of relationships, interactions and flows of social networks (Stephen P. Borgatti, Mehra, Brass, & Labianca, 2009) enabled Neza inhabitants to overcome the sources of their vulnerability.

Methodology

The identification of the social networks that participated in the achievement of Neza's UER was done in two stages: definition of social networks related with the collective goals that helped Neza inhabitants to overcome the sources of their vulnerability, and archive research. The selection of embedded units of analysis was done desk-based relying on bibliographical sources (Bolos, 2003; Espinosa Castillo, 2008; Selee, 2011), referring to the environmental challenges that Neza faced, and the actions that were relevant to solve them. However, during the data collection stage, a seventh collective goal was identified and integrated: land tenure.

The second stage of data collection consisted of the identification of relevant archives preserving historic documents of the case study (community petitions; minutes of community meetings; minutes of meetings between government officials and community representatives; lists of participants of community events,

and joint community and government events), regarding the identified collective goals. Data was then analysed using SNA's dedicated software UCINET (Stephen P Borgatti, Everett, & Freeman, 2002). This was done to measure and map Neza's social networks, which allowed the identification of the patterns present in them.

Potential development impact

This research contributes to the debate of the role of social networks in urban resilience, particularly in underdeveloped areas of the global south, where future urbanisation and the increasing damaging effects of climate change are expected to occur the most. This research also contributes to the global policy agenda, forwarded in the recent adoption of UN's Global Sustainable Development Goals.

Recommendations for future research and application

Future research should investigate the structure of social networks for urban resilience in multiple settings and time frames. The contrast of multiple results would increase our knowledge of the importance of social networks in urban resilience. And furthermore, this would shed light on what kind of social networks are relevant for the achievement of resilient urban environments.

2. The Social Dimension of Urban Resilience: a Methodology to Assess Social Dynamics Contributions to Urban Sustainability

Joana Dias¹, Margarida Barros², Maria Partidário³

¹ Joana Dias, Instituto Superior Técnico, Universidade de Lisboa;

^{2,3} Margarida Barros and Maria Partidário, Instituto Superior Técnico, Universidade de Lisboa

Keywords: Urban Resilience, Long-term Resilience, Social Dynamics, Social Innovation, Lisbon.

Abstract

The world has been facing a staggering population growth, as well as a continuous increase in the number and size of urban areas. This contributes to social dynamics changes and to the emerging need for examining and monitoring urban systems, namely in relation to its resilience to socioecological problems. The purpose of this paper is to share results from a research study conducted on how urban resilience can incorporate a social dimension: what socially drives the urban system, and what, why and how social disturbances and changes affect the urban system resilience. The objective is to show an adapted methodology and its implementation in the city of Lisbon, aiming to assess the social contribution to Lisbon's urban systems resilience. A literature review performed on social-ecological systems resilience, urban resilience; and social innovation concepts, provided a conceptual foundation to adopt an existing methodology already applied in Tokyo city region (Kumagai et al., 2010). The methodology used on this study consists in five steps – translation of the social dimension into urban resilience; definition of the focal scale; identification of indicators; development history and interpretation from the perspective of long-term resilience. The translation of the social dimension into urban resilience is performed through social dynamics and social innovation concepts, considering the characteristics associated to a city urban development. To enabling the assessment of the social dynamics and social innovation, key aspects and its evolution were looked at: demography, social vulnerability, mobility and city attractiveness. The methodology was then applied to the city of Lisbon, where the city governments' policies were analyzed, and the social drivers, social disturbances, and changes affecting the urban system resilience were identified and assessed. The results indicate that Demography, Social Vulnerability, Mobility and City Attractiveness are the key essential drivers to assess the social contribution to urban systems resilience. Therefore, these key drives can be applied into other cities with the same urban development typology as Lisbon. As overall conclusion, the assessment done shows that the city of Lisbon has been facing over the last 50 years a mix of desirable and undesirable qualities. The desirable qualities have been facilitating the urban system transition to a sustainable behavior, building urban long-term resilience; while the undesirable qualities present an opportunity for the current city governance implemented policies to reverse the city social disturbances negative trends.

3. Patients' Written Reviews as a Resource for a More Resilient and Sustainable Public Healthcare Infrastructure in UK

Radoslaw Kowalski¹

¹ UCL, United Kingdom.

Keywords: NHS, public organisation management, patient reviews, organisational resilience, online feedback.

Abstract

Vast amounts of patient-generated reviews of GP practices which are collected by NHS can be used in more ways than what is the current practice. They can be processed to obtain insight into patient preferences with machine learning algorithms such as topic modelling (Chaney & Blei, 2003) in order to boost the pace of organisational learning in NHS. Online reviews are a resource which is already widely used in commercial applications to improve companies' profitability and sales (Hogenboom, Frasinca, Kaymak, de Jong, & Caron, 2016). Commercial uses of the customer reviews data, however, are likely different from how public organisations such as NHS would like to make use of their patients' reviews. This study explores the usefulness of patient reviews processed with topic modelling, a machine learning algorithm, for public organisation management. Written patient reviews of NHS funded GP practices in England are the example dataset in use. It is argued that anonymous online reviews could be used as a resource for boosting organisational learning in the public sector, which enables organisations to respond more quickly to unforeseen shocks and make their services more aligned with end users' preferences. The study includes suggestions for how to use the data in management of GP practices at a national level, and offers ideas for how to overcome unknown opinion biases which exist in data published online by large numbers of anonymous reviewers.

The data used in the study consist of over 145 000 reviews of GP practices. Each reviewer posted a free-text message and 6 Likert-scale answers (from 1 to 5 stars) to survey statements about aspects of the GP service. The statements are: 1) "Are you able to get through to the surgery by telephone?", 2) "Are you able to get an appointment when you want one?", 3) "Do the staff treat you with dignity and respect?", 4) "Does the surgery involve you in decisions about your care and treatment?", 5) "How likely are you to recommend this GP surgery to friends and family if they needed similar care or treatment?", and 6) "This GP practice provides accurate and up to date information on services and opening hours". The data were processed with several topic models tasked to generate different numbers of key themes in the data¹. The LDA topic model which generated 60 key themes mentioned in the reviews was selected for analysis due to high interpretability of results and high topic exclusivity. The features extracted from text reviews with the 60-topic LDA model relate to a range of experiences of patients. The experiences relate to whether GP staff were helpful or not, to cases of perceived misdiagnosis and difficulties in having a GP appointment. Several topics also offered assessments of the situation of GP services, or were about comparisons between different staff members or between GP practices. Other topics covered evaluations of GP facilities such as toilets and information online about the practice. Finally, several topics have been generated which relate more to the choices of words used in specific comments than a discernible aspects of GP services. The topics had a varying prevalence across the GP reviews dataset, from about 5% to under 1% of the dataset. Topic labelled "friendly doctors" has been the most prevalent of all of them. Topics about the difficulty of scheduling an appointment also frequently featured in reviews, cumulatively constituting about 8% of all words in reviews. The topics generated with LDA were compared with regard to their similarity to one another. It became clear that patients who were least likely to express positive feelings about their GP

¹ The model was implemented with 'stm' software library available for R programming language. For a full description of 'stm' library, please visit: <https://CRAN.R-project.org/package=stm>, viewed on 6th February 2017

service experience had problems with reaching their GP service. Insufficient GP facilities, complaints about staff insensitivity and suspected cases of misdiagnosis were less likely to make reviewers refrain from expressing positive feedback about GP services. Furthermore, it was found that the percentage presence of specific topics in GP reviews is related to how reviewers rate their GP service experience in Likert-scale responses. Topic proportions tended to be significantly correlated to the Likert-scale responses when their meaning was related. For example, percentage presence of topics labelled “the worst ever”, “annoying” and “bad experience” tended to be smaller for reviews with higher star ratings in response to a question “How likely are you to recommend this GP surgery to friends and family if they needed similar care or treatment?”. Simultaneously, topics “go extra mile” and “respectful and understanding” were tended to be more present in reviews with high star ratings to the same question. Meanwhile, other topics which were considered as unrelated to star ratings on specific survey questions tended to have near zero coefficients.

In absence of established good practices of customer review analysis done by public organisations (Hogenboom et al., 2016), a study involving customer feedback about NHS services can take inspiration from analytical work for private sector organisations (ibid.). Previous studies helped improve the quality of products and services (ibid.), detect specific desirable or undesirable behaviours online (Hogenboom et al., 2016; Law, Gruss, & Abrahams, 2017) and helped increase product sales and profitability (Deane, 2012; Glovinsky & Kim, 2015; Qi, Zhang, Jeon, & Zhou, 2016). The commercial examples of analysis of customer feedback appear especially helpful for public institutional settings when the objective of data analysis is to achieve similar goals to those of commercial companies, such as using customer feedback to make services more financially lean (Di Pietro, Guglielmetti Mugion, & Renzi, 2013). On the other hand, oftentimes the needs of public organisations are different because they have “forced customers” as opposed to clients that have some choice (ibid.) and their objectives may be unrelated to service demand or profitability (Brownson, Allen, Duggan, Stamatakis, & Erwin, 2012). For example, a manager in a private GP surgery can reasonably assume that simply making patients happy stands for a high quality service (e.g. James et al., 2017). In the case of public healthcare, however, questions may be asked about whether the services which made the customer happy were all really necessary, and whether the treatment method ensured the most cost-effective care available equally to all. Therefore, the purpose and interpretations of analyses of customer feedback for public institutions may diverge from how private service providers would use them. An exploration into how to analyse customer feedback for public organisations, especially in case of public healthcare, constitutes the contribution of this study.

LDA topic model outcomes offer a broad range of insights. The outcomes are similarly complex and intuitively understandable to conclusions from qualitative studies of similar but smaller datasets (e.g. Lopez et al., 2012). As a result, topic models constructed from online patient reviews could be helpful at guiding change in NHS also on national and regional level, as opposed to supporting change only on a local level as it's the case at present (Tingle, 2014). For example, NHS could use topic modelling to identify successful GP practices by filtering the data to look at the most impressive GP practices across England, and learn from what makes them great. Other uses of topic models can include analyses of key challenges facing the NHS which had better be overcome nationally rather than locally. For example, finding from this study suggest that many patients are frustrated by the difficulty in making GP appointments. A nation-wide online booking system which GP practices and patients can use to transparently manage GP appointments could help. Patients, if they prefer so, could choose to attend practices where the GPs have lower appointment load or different opening hours and in this way relieve pressures from A&E wards in hospitals (and hence potentially save lives). An automated booking system could also help treat patients seeking repeat prescriptions for long-term conditions in a different manner from others to reduce unnecessary disruption in their lives and potentially reduce GP workloads with repeat prescriptions. Similarly, the topic model outcomes suggest that a nation-wide automated system for passing on GP prescriptions on to chemists, coupled with a delivery tracking mechanism, could remove the problem of patients calling and visiting repeatedly the practice in hope of reminding the GP staff and inquiring about what happens with their prescribed medicines. Finally, topic models can help inform research into public preferences with regard to NHS services and can help inform public about the current NHS challenges in terms of patient satisfaction.

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Climate Change

(Tuesday 13th June 2017, 12:30-14:00, Seminar Suite A)

4. Re-Thinking Resilient City: Urban Spaces and Politics

Erwin Nugraha¹

¹Department of Geography, Durham University, UK.

Keywords: Resilience, urban resilience, resilient city, governmentality, climate change.

Abstract

Cities around the world have started to undertake responses and actions to climate change. Those cities have started to undertake urban climate experiments, which here describes as an attempt for testing and exploring new ways of adaptation planning, undertaking partnership and knowledge production, experiencing different techniques of governance and shaping urban transitions (Broto and Bulkeley, 2013; Boyd and Juhola, 2014, Bulkeley, 2013; Evans, 2011, Anguelovski and Carmin, 2011). For example, cities in South Asia and Southeast Asia that joined the Asian Cities Climate Change Resilience Network (ACCCRN) since 2009, and recently 100 Resilient Cities (100RC), have started to test adaptation planning and implement different urban adaptation to climate change. The initiative involves adaptation planning that range from undertaking a vulnerability assessment, planning for a city resilience strategy, implementing adaptation projects and mainstreaming into policies (Brown et al, 2012; Archer et al, 2014), which leads to shape resilient city in practice.

This research paper presentation aims to evaluate the approach for building resilience to climate change through spaces and politics in urban areas. This will involve to analyse: (1) How building resilience is accomplished through diverse urban spaces in resilient city; and (2) How building resilience engage within power relations and produce new subjectivities in resilient city. The two case studies selected for this research are: Bandar Lampung and Semarang city in Indonesia. These two cities have joined ACCCRN since 2009, and recently Semarang with 100RC, and known as early adopters for resilient city. The specificity for the Indonesian cities as a case study provide a unique opportunity for engaging research within postcolonial development, post-authoritarian and emerging democratic state and growing urbanisation. This research involve a methodology for data collection through: (i) semi-structured interviews, (ii) ethnographic field research, and (iii) policy and project document collections. By using governmentality analysis, this research will analyse how urban resilience has been articulated, reconfigured, and practiced in Indonesian cities.

This research focus on risk and uncertainty from climate change, bringing local experiences from cities in Global South and improve understanding to better response to future hazards and risks. The urban resilience initiative has engaged working with multi-stakeholders group, developing new regulations and funds, and setting up new mechanisms for institutionalisation of urban resilience. Different technologies of powers have emerged within the ACCCRN cities, including the articulation of normalisation and standardisation, self-governing and autonomy through community-based adaptation, which contested within urban spaces and politics. This research will focus to understand how governing the city from climate change has been articulated, reconfigured, and practiced at urban setting. The idea of building resilience and achieving resilient city, could not be simply defined as a programmatic, deliberate and technocratic process for avoiding disruptions, natural hazards and maintain city's basic functions, but also as an endeavour for resilientization, through which more research on urban resilience and politics are demanded.

5. Resilient and Sustainable Cities - Idea, Purpose and Objectives: A North Pembrokeshire Sustainable Community Approach

Jane Nerys O'Brien¹

¹Renew Wales, United Kingdom.

Keywords: Community, resilient, sustainable approach, facilitate, tidal, wind, energy systems.

Abstract

Transition Bro Gwaun (TBG) arose (in 2008), as individuals in the community were concerned over climate change and our abilities as a community to address environmental issues whilst at the same time enhancing our community and protecting our beautiful surroundings. TBG is part of a worldwide network of transition communities looking to secure a more sustainable future whilst developing their local economy, utilising local resources and improving local peoples lives. The following are the groups Articles of Association:

- 1) The promotion of the conservation, protection and improvement of the natural environment and prudent use of natural resources for the benefit of the public in Fishguard, Goodwick and environs by advancing education and raising awareness of climate change, resource scarcity, peak oil and economic resilience; promoting individual, community and organisational commitment to a reduction in CO2 emissions, energy saving, reducing reliance upon carbon emitting sources, and increasing resilience to resource scarcity.
- 2) The promotion of sustainable development for the public benefit of the citizens of Fishguard, Goodwick and environs by:
- 3) The preservation, conservation and protection of the environment and the prudent use of natural resources;
- 4) The promotion of sustainable means of achieving economic development and regeneration in order to reduce reliance on scarce resources including oil.
- 5) Sustainable development of Fishguard, Goodwick and environs means development that meets the needs of the present citizens of Fishguard, Goodwick and environs without compromising the ability of future generations of Fishguard, Goodwick and environs to meet their own needs.

Findings and Originality

TBG has a number of key projects:

- Surplus Food project
- Abergwaun Community Wind Turbine
- TBG Tidal Flow Project
 - Linked to a local energy systems approach (under development)

Surplus Food project

Surplus Food project aims to increase awareness in our community of reducing food waste and using surplus food. Part of Transition Bro Gwaun's Surplus Food Project, Transition Cafe opened in June 2013, in Fishguard, Pembrokeshire. It currently stops an average of 1000 kilos of food from being thrown away every month. Food is collected from local businesses, also donations are from allotments, people's gardens or house clearances too. Food turned into snacks, meals and preserves for the cafe. Food the cafe cannot use is collected by a pig farmer and anything unfit for humans or pigs is sent for anaerobic digestion.

Also run Transition Redistribution of Food (TROF) to supply local charities and groups.

Abergwaun Wind Turbine

Sited on land adjacent to Fishguard this is a joint venture with Parc-y-Morfa Farms Ltd. It took 4 years from conception to installation; On 27th August 2015 an Endurance X-29 225kW Turbine was commissioned. Raising the £285,000 needed for TBG's 50% share of the project proved easier than expected, the whole amount being lent by 29 individuals and 3 local community groups within five months.

The turbine estimated output is 590,000 KWh per year, equivalent of powering approx 140 homes, within its first 12 months this has been 11% higher, at 648000 kwh.

Tidal Flow Project

TBG aims to realise the first community owned/led tidal flow project in Wales. Development of a community tidal flow device to provide a working demonstration of tidal technology, offers a blueprint for other communities to utilise marine energy as a resource for future resilience.

The timescale depends on three key external factors:

1. Identification of a suitable tidal device/s with market readiness;
2. Seabed leasing process.
3. The environmental impact assessment (EIA)

This is a new and emerging market; historically the few devices that have been successfully deployed have been pilot projects with extensive timeframes. Based on a maturing market, the project is currently projected at approximately 3 -5 years. Other factors such as the scale of the array and the required infrastructure i.e. grid connection / storage etc, may also impact on the timeframe.

The launch of the project took place 24th November 2016, there will also be a Wales Coastal Communities Event 22nd March 2017 in partnership with Renew Wales.

Work so far has covered: consultation with Crown Estate on the seabed leasing options, currently scoping for tidal flow potential around the coastline area linked with EIA in partnership with Marine Space consultants and SEACAMS 2 at Bangor University.

Storage/Energy demand

The development of renewable technologies, is a part of a local energy system.

In addition, opportunities are being sought to engage with others on local energy and storage networks. It is important to address the issue of grid network links or look to other options such as production of hydrogen for vehicles or the Fishguard train(Arriva) or Ferry(Stenaline are partners of the Tidal project). Initial contacts have taken place with a number of specialist organisations in the field of hydrogen storage and fuel cell solutions, alongside this TBG have been in contact with the current 4 franchisees for the Wales rail network in regard to hydrogen/fuel cell trains, there is currently a consultation period up to July '17. Other solutions are also being developed such as the wind turbine and other sources providing electricity to the local grid i.e. direct to local consumers or hydrogen to the local gas network. The event in March will hold a skype session with an example of a local system 'surf and turf' in Scotland.

Conclusion and Impact on Policy.

In order to realise the aspirations of the group, it was clear that this required a multi faceted approach towards a resilient and sustainable future. Thus from the outset individuals were encouraged to pursue different interests and form subgroups or separate entities were possible, addressing many issues including: energy, food waste and local growing, green tourism, transport and heritage.

This facilitative role and also a willingness to embrace and encourage community and stakeholder consultation throughout all processes have been key to the successes of the community thus far, alongside the local knowledge and networking skills of the core group.

In addition there have been key organisations that have assisted with specialist support, mentoring and funding to achieve specific projects, sourced from Welsh Gov, EU, lottery and locally including: Ynni Fro and latterly Ynni Lleol Wales renewable energy community programmes, LEADER . Pembrokeshire Coastal National Parks Sustainability fund and RENEW Wales

For more: <http://transitionbrogwaun.org.uk/>

6. Building Sustainable and Resilient Cities to Climate Variability and Climate Change. A case Study in Tijuana, Mexico

Roberto Sanchez-Rodriguez^{1,2}

¹ El Colegio de la Frontera Norte, Mexico

² University of California Riverside, USA

Keywords: Vulnerability, resilience, local sustainability.

Abstract

This presentation discusses the research results of a two-year project addressing challenges and opportunities to build sustainable and climate resilient cities using the city of Tijuana as a case study. The case study was developed in cooperation with local authorities to bridge the science-practice/policy divide. The project's main objective was to build an operational and feasible approach to climate resilience as part of a process to construct a local sustainable development process. The methodology focused on social vulnerability modifying the working definition of the IPCC (a function of exposure, sensibility, and adaptive capacity), to transform it from a conceptual approach to an analytical tool to identify and analyze key drivers causing vulnerability. The methodology includes the creation of a historical database of climate related damage in the city between 1970 and 2015. Each record is georeferenced and incorporated in the GIS created for the analysis of social vulnerability and it was used to calibrate and complement the analysis of social vulnerability. The methods used in the project included regional climate change scenarios and an analysis of urban growth trends to identify vulnerable areas in 2030. The results of the vulnerability analysis led to identify and develop feasible actions to build local resilience to climate variability and change. The case study in Tijuana illustrates the advantages of the analytical steps needed to build an operational to climate resilience in cities. The presentation discusses them in the context of building local urban sustainability considering a range of options from non-regret actions addressing development stressors to actions to create present and future resilience. The last part of the presentation suggests recommendations for future research and application based on the results of the project in Tijuana and lessons learned of opportunities and challenges to enhance collaboration with local authorities.

Urban Resilience

(Tuesday 13th June 2017, 15:30-16:40, Seminar Suite A)

7. Lessons of Resilience from the Surviving Ottoman Residential Neighbourhoods: the Case Study of Amasya

Meryem Gurel¹, Magda Sibley¹

¹University of Sheffield, United Kingdom

Keywords: Resilience; Ottoman residential neighbourhoods; design and planning principles; survival; crisis.

Abstract

The aim of this research paper is to understand design and planning principles of traditional Ottoman residential neighbourhood and how those principles helped residential neighbourhoods to survive in a time of crisis and after from the 14th-century Ottoman-era to the 21st century, today. Residential quarters were 'the determining component of the urban fabric in Muslim cities, not only because of their sheer quantitative dominance but also because of the particular attitude of Islam towards formal civic institutions and its relative low emphasis on monumental public buildings' (Bianca, 2000, p. 72). 'Most Islamic cities [also Ottoman cities] followed an "organic" pattern of growth, marked by the presence of certain archetypes of built form which acted as architectural "seeds."' (Bianca, 2000, p. 30). In the centre of residential neighbourhoods, there are one mosque and service buildings such as shops, coffee house, library, madrasah (school, higher institution), maktab (school), imaret (soup house), hammam (public bath), fountain (Atik, 2011). Quarters were self-reliant as an 'autonomous social unit, embracing a representative cross section of society and establishing, controlling and maintaining the basic shared facilities, such as local mosque, one or several hammams, and public ovens, and a number of street fountains' (Bianca 2000, pp. 152-153). These self-sufficient residential neighbourhoods were formed around the main city core and created the urban fabric (Sahin, 2006). Ottoman residential neighbourhoods defined as a smallest administrative unit where people who know each other, responsible for each other's behaviour, live together in social, economic, and cultural cooperation (Bayartan, 2005; Ergenc, 1980).

A residential neighbourhood is a unit that creates the whole which is a city, but also it can represent whole by itself. It helps us understand Ottoman lifestyle and the development of today's Turkish lifestyle (Alada, 1989, cited in Maydaer, 2008). That survived fabric faced natural disasters, invasions, wars, rebellions, immigration flows. Those factors changed the urban fabric over time. Earthquakes, floods, fires, and wind storms damaged monuments and residential buildings at different levels. (Altun, 2013, Bostan, 2011; Catal, 2009; Keskin, 2015; Kocaman, 2011; Misirli, 2014; Noyan, 2013; Oltulu, 2006; Senol, 2010; Zeybek, 1998). Another factor that has triggered the major transformation of Ottoman cities was a proclamation of Tanzimat Fermani (Imperial Edict of Reorganization in 1839). The aim was using 'Western' techniques and culture to 'modernize' the state and the society. This edict also affected physical development of Ottoman cities (Hudson, 2008; Yerasimos, 1999, cited in Canitez, 2010). With the foundation of the Republic of Turkey in 1923, cities entered into a transformation phase with planning activities but showed slow progress until the 1950's (Avci, 2005; Sari, 2010; Coban, 2012). After the end of World War II, the economy started to develop, immigration from rural to urban started and cities started to show fast urbanization rate. (Altunbas, 2008; Coban, 2012) New planning regulations started to be applied after the 1950's, leading to the formation of new residential neighbourhoods with new housing typologies and construction techniques (Genc, 2008; Sari, 2010). Traditional houses in the Ottoman city residential neighbourhoods were abandoned and left to decay or were demolished to make space for new built multi-storey concrete apartment blocks (Gultek

1997, Sari, 2010; Tureli 2014). In the 1980's, a new period of urbanization with awareness to the importance of heritage buildings and their protection has started. For the first time, with the 1982 constitution, cultural and natural properties were protected by law. In 1983, the act on cultural and natural heritage protection (law number 2863) defined heritage terms, protection rules, the area of jurisdiction of ministries and local protection committee in detail. (Ozdemir, 2005). During this period, traditional houses in the historical quarters are registered and restored (Sari, 2010; Tureli, 2014). All these various factors show the transformation that historical residential neighbourhoods faced from the 14th century to today and their ability to survive. As mentioned in recent studies, this ability brings this investigation to the area of resilience. Urban resilience is defined as 'the capacity of the cities to absorb shocks and perturbations without undergoing major alterations in its functional organization and economic, physical and social systems' (Ozel et al., 2014, p. 1). 'Continuous evolution process of social, economic and cultural events for the territory and the community' in historic built environments shows these environments' abilities to resist any change or disaster, repair afterward, and adapt to new conditions because it is a result of a knowledge that passes from one generation to the other by correcting its' errors (Ozel et al., 2014; Fatiguso et al., 2016, p. 1). Even though there are some objections that indigenous knowledge might not be a part of scientific knowledge (Folke, 2004, cited in Ozel et al., 2014), integrating the current knowledge with the local knowledge can help to gain more resilience (Ozel et al., 2014) Therefore, these residential neighbourhoods can serve as a model for how the built environment and its community can be resilient and survive throughout the centuries.

This research will be investigated through historical and archival research through a case study by drawing upon 'derived from archival or artefactual sources, largely because the research question focuses on a setting or circumstance from the past' (Groat and Wang, 2013, p. 16). Historical research, therefore, helps to understand design principles of formation of residential neighbourhoods in Ottoman cities and, also, helps to investigate the survival of a residential neighbourhood in a time of crisis from the 14th century to 21st century. The investigation scale will be chosen as a residential neighbourhood and the formation and transformation of residential neighbourhoods in architectural, social, economic and sustainable, in short, in interdisciplinary point of view will be investigated from the past to today. Understanding architectural formation of residential neighbourhoods will help to understand the urban fabric since 'urbanization meant the same with the process of residential neighbourhood formation in the first period of the Ottoman Empire' and it is considered as a unit in the city which can also represent whole by itself (Alada, 1989, cited in Maydaer, 2008; Cerasi, 2001, cited in Kayici, 2012). Therefore, studying residential neighbourhood scale lays a better landscape for research to understand the historical formation and transformation of Ottoman architecture in building scale, neighbourhood scale, and urban scale, through a one chosen scale. If the remaining parts and the way of their integration to current urban context can be understood, it may help to understand the survival of residential neighbourhoods and design process of the new settlements. Therefore, the characteristics of residential neighbourhood design and adaptation process will be analysed to set principles to adapt traditional quarters to the current context without losing its character and create guidelines to designers for new living area design. To achieve this, Amasya, which is a city in Turkey, is selected as a case study for this research because having a major administrative role in Ottoman era which caused significant city growth and created exquisite examples of Ottoman architecture. Amasya was known as Shahzadah (Ottoman crown prince) city. A city where the Ottoman Crown prince next in line is sent to. 15th and 16th centuries were the rises of Amasya, due to its role in Shahzada's education. During this period, a lot of artists and politicians are raised in the city (Oltulu, 2006). Husameddin (cited in Oltulu, 2006) states after the conquest of Muslims, the city is renovated and showed biggest architectural improvement in the time of the rise of the Ottomans (Emecen, cited in Catal, 2009). Even though Amasya faced a lot of disasters, invasions, hardships throughout the centuries, today, it has whole entity survival of mahallas. A current preserved historic fabric makes Amasya a case study for this investigation (Eroglu, 2010). Understanding the design principles which helped Amasya's historic fabric to survive for centuries, might help to design new neighbourhoods with resilience in today's Turkish cities.

8. Dubai's Morphological Evolution: Mapping Urban Change and Transformation

Khaled Alawadi¹, Asim Khanal¹, Ahmed Almulla¹

¹ Masdar Institute of Science and Technology, United Arab Emirates.

Keywords: Dubai, Morphological Analysis, Regional Planning, Urban Form, Neighborhood Pattern, Typology, Urban Growth

Abstract

Background

In the United Arab Emirates, a nation set up in 1971 when seven Emirates joined to shape a Federation framework, Dubai is the most populated city (Herd-Bey, 1982). The city's informal birth is regularly followed to 1833 when a tribe from neighboring Abu Dhabi withdrew and made a trip up north to settle a town at the tip of a little brook and announced themselves (without resistance or strife) the rulers (Davidson, 2008). The tribe, the Al-Maktoums, are still the ruling government today. With a populace of more than two million (Dubai Statistics Center: www.dsc.gov.ae 2016), it is difficult to trust that only a century back, the populace floated at around 10,000 occupants (AlShafieei, 1997). This paper identifies the urban patterns that emerged as a result of the burgeoning urban development in Dubai, from about 28 km² of built area in 1973 to about 4300 km² in 2011, and explores the factors that made the aforementioned urban growth possible.

Cities are being transformed and built at a massive pace and scale, which often precludes forethought and justification. Dubai, some argue, is a case where numerous mega-scale developments were constructed in a record time without being contagious or integrated into the prevalent urban fabric. With this extreme and intense form of urbanism, a large set of development typologies emerged, leading to the creation of a city structure with a distinct, yet debatable built landscape.

The paper begins by providing a general timeline of the city's growth, which we split into six growth periods (Alawadi, 2016a; Alawadi, 2014) based on an intensive review of the existing literature, government documents, and our own site visits and observations. We identify and highlight distinct neighborhood patterns as they evolve through the periods to reveal nine unique neighborhood (residential) typologies that have developed over the last six decades. The GIS and satellite imagery analyses examine the arrangements of streets, blocks, buildings, land use, and open space at each formal typology of Dubai. While identifying the patterns in conjunction with the city's growth, the paper discusses the different political, economic, environmental, and cultural factors that shaped/influenced the general outcome of Dubai's built landscape and we draw the city's decision-making matrix and political process as it relates to the city's urban form and development. Finally, we consider how built landscape types relate to managing future growth, suggest some planning policies/guidelines, and outline further research directions.

This research relies on field observation and intensive GIS analysis using Arc Map to map the evolution of Dubai's physical landscape. In particular, we ask: What are the different patterns and forms that are prevalent in Dubai's housing landscape; and what are the major driving forces or factors that influenced Dubai's urban transformation and its current landscape? What are the major challenges and issues with Dubai's housing landscape? What policies and design interventions could contribute to the development of better housing environment?

Results identify nine distinct and diverse neighborhood patterns namely Al Baskatia'ya, Organic Dense City, Organized Planned Apartment Blocks, Labor Housing Complexes, Single Family Large Neighborhoods, Gated Communities, Linear Contemporary Downtown, Tower Complexes, Island and

Offshore Developments and Exclusive Waterfront Developments. Moreover, two landmark projects such as Business Bay Canal and Calatrava Tower are also included. Identifying and classifying is aimed at creating a typological index for Dubai's urban landscape. These patterns are presented under six thematic developmental periods stretching from 1900 – 2016. Based on the identified typologies, the analysis further compares four main elements of the built landscape across the different landscapes: street systems, land use, open space, and land parcelization. Analysis and mapping are applied to an area of 1 square kilometer (1 km²) at a neighborhood scale. This area is large enough to explore how morphological attributes shape people's lives, behavior, and mobility (Wheeler, 2015).

Despite this diversity in typologies, several issues arise that city planners must address, namely: the lack of diversity within each typology and the scarcity of affordable housing, the institutionalization of segregation and sprawl through the government's housing program for the local population, and the disjointed landscape of free zones with competing semi-private developers.

Results also reveal that Dubai's form of urbanism creates several spatial and design challenges because it compromises the environment to meet economic and social goals. Future development must take both cultural affinities and environmental stewardship into account to create workable compromises. To eradicate the ills of sprawl and auto-dependent land utilization, the planning profession in Dubai must derive culturally-relevant lessons from a number of internationally recognizable trends in town planning such transit-oriented developments and polycentrism ideals.

This study investigates the development and the change of Dubai's Built Landscape in the most recent ten decades. The city's shape amid this period changed from a minimized urban design to a divided and isolated scene that expands a few miles into the desert landscape and along the Gulf shore. Examining the historical backdrop of urban form and the contributed elements that affected this pattern of urbanism could provide a direction for drafting laws and strengthening land use legislation for the formation of a feasible city texture.

Methodology, Research Objectives & Outcome

Dubai has received more recognition than any other city in the Gulf region for creating its own kind of urbanism (Alawadi, 2016). The vast majority of the work expounded on Dubai in the urban planning literature portrays either the city's history or its quick pace of improvement. There is an untold story of Dubai and this paper will expose the myths encompassing the city's urban shape and advancement. This assembled landscape-oriented examination, which expects to comprehend existing city shape and fabricate a typological index for the city, will be an aberration in the region. Therefore, this paper is intended to express and investigate the morphological attributes of Dubai. Specifically, the examination expects to answer the accompanying questions:

- What are the different patterns and forms of Dubai's built landscape; and
- What are the major driving forces or factors that influenced Dubai's urban transformation and its current landscape?
- What policies and design interventions could contribute to the development and better housing environment?

The thematic analysis of literature, mapping, and analysis conducted in Arc GIS, an investigation performed by thorough examination of old maps and documents obtained from the governmental agencies and usage of Google Earth are the methods by which this research has been carried out successfully. Thus, outcome obtained from this research is the identification of 10 unique patterns of urban form that originated in different time passages, factors that led to their origin and corresponding problems that exist in these urban patterns. These patterns are named according to their character, causation, influences and guiding factor. The basis of classification is generally a morphological characteristic such as street network, plot size, building form and the resulting urban fabric. ArcGIS was used for mapping and transforming the

available data through intensive analysis. Picturing the same set of data in a disparate way, just considering some particular attribute is made possible by the ArcGIS software. Also, AutoCAD has been used in many instances to edit and modify polygons representing communities, parcels, plots or buildings. Moreover, the Adobe Creative Suite has been used to finalize the diagrams to make them visually appealing. After the process of identification, literature regarding Dubai, its history, and its development were referred extensively. The facts and details from the scholarly articles have been used to back the fact that the historical, political and social spheres that influenced and consequently led to the creation of the 10 uniquely distinguishable urban forms ranging from 0.059 km² (fishing village) to 219 km² (contemporary suburban neighborhoods) in size, as we witness today.

This paper traces the urban proliferation of Dubai and classifies different residential neighborhoods in terms of their morphology. Furthermore, this research paper reflects on several paradigmatic urban planning/design movements, (e.g. compact urban planning, modernist, sub-urbanization, bigness, and so on). These urban planning ideologies have exerted the strongest influence over urban form in Dubai. Understanding the impact of the application of these contemporary theories in Dubai requires understanding the progression and changing the status of the city. We will begin each section by providing a working definition for the thematic phase, the list of urban typologies (and their related planning paradigms) that emerged and the major contributing factors to the urban formation.

Recommendations

Future research prospects and application of this study can be the development of a toolbox to formulate sustainable urban forms in Middle Eastern Cities and other cities similar to Dubai. Morphological study coupled with spatial analysis of various factors that influence built form, as carried out in this study, could help in the formulation of a toolbox that identifies the shortcomings of urban planning practice. Moreover, the interrelation between socio-economic indicators such as ethnicity, segregation, affordability and the urban form can be carried out following up the findings of this paper.

9. Can Governance Enable Resilience? The Case of Urban Density in Mumbai

Rachna Lévêque^{1 2}

¹ UCL, United Kingdom;

² BuroHappold, United Kingdom.

Keywords: Cities, social-ecological resilience, urban densification, governance.

Abstract

Research context

Popular interpretations of resilience often consider resilience to involve a rapid return to a fixed stable state. Similarly, current approaches to metropolitan planning and governance seek certainty and linearity and resist change. Yet, transformations in complex urban systems are effectuated by diverse actors influenced by intricately linked social, economic, political, environmental and technological factors. In this context, how can governance in cities help successfully navigate slow and uncertain, yet desirable, change?

This paper elaborates the demands that rapid urban change (caused by increasing urban density) places on resilient planning and governance. Testing a theoretical framework against empirical data from Mumbai, it considers how a city's urban institutions deal with urban social-ecological stresses at several scales and what the implications are for governance that is resilient, ie enables adaptation and transformation.

Research objective

The objective of this research is to provide an empirical investigation into how urban planning and governance can support resilience in the face of the uncertainty that arises from constant urban stresses such as urban densification. In particular, it explores how diverse actors across multiple scales get involved in strategic policy discussions around urban densification, and what the scope for learning, collaboration and innovation is within such processes. The focus is the metropolitan scale, a point of mediation between national and regional policy and local initiatives.

Research design

This research uses urban densification (broadly interpreted as increase in resident population, employment, or built up area) as its lens of enquiry. Often implicit in aspirations of 'compact cities', 'brownfield redevelopment', 'sustainability', 'transit-oriented development', and 'polycentric cities' (McKendry, 2011; Rérat, 2012), densification is a form of urban transformation desired by many cities and a policy norm rarely questioned by practitioners in the field. Nonetheless, it is also the source of multiple stresses, such as on urban infrastructure, natural resources, micro-climate, civic amenities, environmental quality, habitats, public health, etc. Mapping the implications of densification, an exercise undertaken as part of this research, clearly demonstrates that these stresses are not limited to departmental remits or scales; rather they are multi-scalar and intricately interlinked. Hence, the uncertainty introduced by a seemingly simple policy aspiration such as increased density has the potential to challenge the capacities of city authorities and civic organisations in terms of governance.

Social-ecological resilience is the metaphor adopted to understand how urban planning and governance can respond to this uncertainty by allowing the social-ecological urban system to adapt and transform in the face of multiple interlinked and dynamic stresses presented by urban densification. The social-ecological systems view focusses on the complex feedbacks between the social and ecological, and in particular how the social and ecological alter each other and "co-evolve" (Berkes, Colding, & Folke, 2003: 3). (Economic and technological considerations such as land values and infrastructure are firmly embedded

in the 'social' of social-ecological systems.) Hence, the social-ecological systems view moves away from the linearity and predictability of separate sub-systems to emphasize non-linearity, uncertainty, emergence, scalar dynamics, self-organisation, and complexity, wherein system boundaries are fluid and open to external influences. Accordingly, theories of social-ecological resilience place uncertainty and surprise at their centre, raising several questions about policy-making and governance that are relevant to urban densification processes.

This approach - combining a social-ecological resilience framework with a prevalent policy aspiration - allows the myriad planning and governance processes around urban densification to be evaluated, and explorations to be launched into how learning, innovation, experimentation and adaptability are embedded within processes of metropolitan-level densification to enable governance 'for' change, as opposed to governance 'of' change (i.e., proactive action that takes change in its stride, rather than reactive decision-making aimed at controlling change) in the face of an uncertain future. Specifically, this research asks: **how can governance of densification processes in a complex social-ecological urban system support the resilience of that system?**

More specifically, the research investigates:

1. How do discourses of social-ecological resilience relate to those of governance? More importantly, what would be expected from processes governing urban densification in order that they can support the resilience of a social-ecological urban system?
2. Increased density is often adopted as a policy norm in planning today's cities. How does a desirable change like urban densification place dynamic and undesired stresses on social-ecological urban systems? Does the governance of densification processes at metropolitan scale reflect an understanding of these complex and inter-linked stresses by stakeholders?
3. How is governance for resilience evidenced in governance practice in specific cases of urban densification? How effective is this at supporting the resilience of these urban social-ecological systems, and why?
4. What insights do these provide for planning and governance theory?

Method

The case study for this research is Mumbai. A cosmopolitan city where a history of trading has given way to its status as the financial capital of India, Mumbai is also a city where formal policy has long ignored the increases in population and employment, while the scarcity of land continually creates conflicts between those wanting to protect communities and/or habitats, and those wanting "progress". Governance in Mumbai is effectuated by the dynamics between its passionate and active civic arena, which simultaneously supports its *laissez faire* metropolitan authorities and attempts to keep them in check, its real-estate lobbies, politicians and a few international organisations.

The empirical work uses policy reviews to identify key issues and priorities around densification in Mumbai. The primary data comprises interviews with public, private and non-governmental actors influencing densification policy at the metropolitan scale. These include actors at multiple scales (national-regional-local), as well as across sectors (housing, real-estate, transport, water, waste, environment, ecology, health, etc). In addition, field journals are maintained and newspaper articles and other sources of information collated.

The empirical data is analysed using an interpretative approach (Wagenaar, 2011). The codes for the qualitative analysis in Atlas.ti are partially derived from the theoretical framework and partially arise from the data itself.

Key literature

Key bodies of literature this research relies on include:

- Social-ecological resilience

- Urban density and its implications
- Urban ecology, eco-system services
- Urban planning and governance
- Writings on the case-study city

Expected outcomes

In line with its objective, this research sheds light on how governance around a multi-scalar phenomenon such as urban densification occurs in practice, and how such governance may create opportunities for learning, collaboration and innovation, and thereby support resilience. It attempts to identify the spaces conducive to the emergence of new partnerships, ideas, and experimentation, and the circumstances under which these occur. In untangling the myriad governance practices in the specific case of urban densification in Mumbai, this research also attempts to understand the consequences of adopting outcome-oriented approaches to planning (i.e., densification or compact cities) and the elements within this process that enable governance for resilience.

Elaborating the interlinked nature of the stresses arising from urban densification in cities offers a better understanding of urban areas as social-ecological systems. This is potentially very important in our metropolises, where economic priorities often dictate the course of urban change, yet social and environmental concerns are generators of multiple uncertainties within the urban system.

Academically, this research contributes to the efforts of social-ecological resilience researchers and planners to bring resilience thinking to urban development discourse and practice (for example, Goldstein, 2009; Wilkinson, 2012). Going beyond drawing theoretical similarities and interpretations, the research contributes an empirical application of social-ecological resilience to urban planning and governance. In doing so, it questions the extent to which governance for resilience can be top-down. In this way, it may provide insights for planning and governance theory.

As a result of my association with the professional world, I also seek, through this research, to understand how consultants can better be involved with city-level governance and planning processes to build adaptive capacity where it is needed by tapping into resources that can help navigate uncertain change in the medium- to long-term.

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Green Infrastructure

(Tuesday 13th June 2017, 11:00-11:20, Seminar Suite B)

10. Viscous Biomaterials for Application in the Built – Environment

Shneel Malik¹

¹ UCL, United Kingdom.

Keywords: Biomaterials, Adaptive, Interdisciplinary, Bio-scaffolds, Additive manufacturing

Abstract

With the increasing urgency to respond to the changing Climate, Researchers and innovators are increasingly finding ways of developing artificial 'natural' systems. We have evolved to not just 'mimic' natural-existing biological systems, rather to progressively imbibe the spirit of its performative function within the designed environment. The field of Art, Design and the Sciences are increasingly beginning to work closely, in order to design composite technologies and create hierarchical architecture that aims to give shape to a more 'responsive-based' naturally pure - version of tomorrow.

Assimilating from the natural world, wherein shape and matter has been carefully crafted through growth and adaptation, resulting in highly tunable and hierarchically structured constructs. We identify water as nature's molecule of life; explore the possibilities of developing water-based biomaterials, that when incorporated with stiffness gradients would demonstrate the creation of multi-functional graded components for application within 'biological' construction. They are further seeded with 'algae-cell' cultures, that flourish within the material due to it's biocompatibility, performing photosynthesis and allowing the 'gel-like' material to behave as a photo-bioreactor; which opens up a wide range of applicatory-based possibilities for the scaffold.

Integrated material-based design studies, novel computational technologies, advanced manufacturing mechanisation driven with a sustainable motivation give shape to a technique that produces functional bio scaffolds - in the form of architectural components or product - based prototypes - diversely embedded with microorganism cultures. These large-scale biocompatible prototypes provoke an era of biological construction; based upon the active development with 'living materials'.

Research objectives

Biological fabrication techniques and material design considerations are enabling the transition from 'resilient' to 'responsive' architecture. Through the idea of innovating heterogeneous bio-integrated systems in buildings, and not just advanced homogeneous 'inert' components, the research aims to create new architectural 'Bio scaffolds' (for instance, algae – laden hydrogel facades) that are able to adapt to changes in the environment through self-regulation without the need for additional and costly maintenance. Such water – based biomaterials promote life on buildings, not only changing its aesthetic expression, but also contributing significantly to the urban environment, and ultimately create greater sustainability in cities.

This research aims at exploring new grounds in architecture, that involve material 'tunability' of water-based gel materials, along with an added dimension of biologically - attuned systems through the active involvement of living cells as part of the system building.

However, what remains key amongst such technological advancements is the need to engineer a material process that consumes low amount of energy, produce little to no waste, and take advantage of ambient conditions. This stands hugely in contrast with the current digital manufacturing platforms that are generally characterised as uni- functional, wasteful, fuel - based and often toxic.

Novel approach

This research tries to understand through laboratory experiments the concept of designing 3D water - based gel cell cultures, with the means of looking at adopting potentially large-scale architectural 'bio scaffolds' that learn from the laboratory - based precision designed cell culture systems. This research involves the growth of the most simple cells - 'algae' cells amalgamating the behaviour of photo bioreactors within gel - based 3D cultures, further giving rise to extracellular matrix - architectural components that increase their capability to interact with the environment.

With this comes a major shift in design thinking with labs and studio practices merging to create new sorts of prototypes to experiment with new biological materials and forms. This research suggests, exploring a new way of considering the relationship between diverse disciplines, such as synthetic biology, engineering and design, allowing architecture to move away from the idiosyncratic formal expression and towards architecture that is increasingly biologically responsive and adapted to the vicissitudes of its local environment.

In order to produce such scaffolds the research aims to employ innovative robotic additive manufacturing techniques in order to control, regulate and print with the highest level of accuracy.

Research methodology

The aim is to explore and design techniques of architecturally generating bio-scaffolds that gradually show variations in structure and composition through the process of hydration and de-hydration of the same synthetic material. (Inspired from the squid's beak and its impressive composition of two completely different structural characteristics all with the variation to the same chemical composition).

Simultaneously, design work and fabrication with latest technological advancements shall be carried out in order to generate prototypes that depict the feasibility and ways of incorporating / establishing water - based gel materials in architecture.

The process further builds with living cells being encapsulated within the material system aiming to increase the scaffold's biocompatibility. Such integration of living matter, fabrication and environment with digital - manufacturing processes should result in emergent material behaviour tailored by architectural design techniques and principles, aligning with both fields of research, namely - architectural design and synthetic biology.

Therefore, we also look at:

- Ways of activating synthetically designed water - based gel materials through the physical impregnation of living cells i.e. algae cells, allowing them to grow and multiply within the environment of the moisture - laden systemic material.

Bio scaffolds and 3D cell cultures possess rather 'soft' physical properties as opposed to the otherwise rigid, sturdy and concrete like properties of materials traditionally used in architecture. Usually architects and designers consciously or unconsciously turn to 'hard' materials when it comes to fabricating their products, as they find materials that are sturdy enough to hold the shape / form together.

As the field of architecture is governed by visual and aesthetic appeal, it becomes rather crucial to investigate into ways and techniques of fabricating material ecologies with a new aesthetic appeal. In contrast with common techniques, this research discusses and explores the use of soft materials as active and a rather new means of fabrication in architecture. While exploring the 'living' dimension of such materials, we also look at design and fabrication techniques through which even soft materials are made capable of holding their geometric form, rendering such materials suitable for both visual and physical use in architecture.

This research project combines the fields of architecture with synthetic biology. This interdisciplinary approach requires the sharing of tacit and explicit knowledge from both fields and the development of a reciprocal means of working.

This particular research requires rigorous experimental and design - based involvement in not just architecture but, equally or more so in the field of synthetic biology. With this, runs simultaneously two very distinct yet amalgamated fields of research. Whereas, on one hand we step into the Lab performing a role of the scientific researcher in order to understand in detail biological systems and henceforth, in order to develop the synthetic water - based gel material. On the other hand, our experience and design background as an architect is the key background player, through which we alter the consistencies of the material to achieve architecture - friendly synthetic biological systemic prototypes.

Potential development impact

Tuning 'built-structures' into heterogenous 'Living' composites will certainly introduce a new approach towards the designing and construction of buildings and cities. Realigning and redefining the true meaning of 'sustainability', allowing to prototype sophisticated objects and structures. These water - based architectural scaffolds, would just as it's in nature, employ mild chemicals (or naturally occurring polymers), produces little to no waste, and uses small amounts of energy to produce multifunctional and adaptable systems.

Biological structures adapt to external stimuli by growth-induced material property variation resulting in hierarchically structural forms. Conventional design and construction tools, by contrast, lack in robust integration of computational tools, digital fabrication environments and the material itself. Preliminary results of this research demonstrate the ability to digitally design and fabricate structured hierarchies with chemically attuned biomaterials. At the core of this research lies our motivation to explore the possibilities of innovating and fabricating 'performance-based' variable property structures.

Recommendation for future research and application

This research is the first of a pilot study that aims to demonstrate and analyse the various properties of designing for and with biological composites. Integrating design with novel biomaterials and there successful large-scale fabrication isn't the most linearly-based approach in terms of fabrication.

To begin with, harnessing water to tune biochemical properties, in order to guide shape, mechanical and structural formation has and continuous to be a major challenge. Nature seamlessly demonstrates to generate its structural characteristics based upon a homogenous logic of stiffness - gradient. However, in order for us to test and determine the appropriate proportions, that generate our desired outcomes of multi-functional self-supporting structural constructs is of prime concern. Such hierarchical distributive depositions will evolve over time, as a result of a series of tests and experiments conducted both within the lab and the Additive Fabrication nodes of the research.

Further, maintaining the hydrated components with the appropriate moisture content, further proving the right nutrients for photosynthesis, while maintaining the geometrical arrangement of the construct continuous to be explored. The research shall continue to improve upon this nature-inspired technology in

order to establish informed nano-to-macro scale relationships between shape, material composition, hydration rates, and design-induced deformation.

11. Compatibility of social and ecological functions of urban green spaces

Ishtiaque Shams¹

¹ University of Manchester, United Kingdom.

Keywords: Theoretical framework; user preference and perception; spatial use behaviour and pattern; urban biodiversity; human-nature interface.

Abstract

Urban areas are now home to more than half (54% in 2015) of the world's population and that percentage is expected to rise (66% in 2050). This rapid rate of urbanisation has and will continue to place challenges on urban areas if sustainable and resilient urbanisation is not practiced. Urban green spaces (UGS) are one such sustainable urbanisation tools which can alleviate the challenges while itself being adversely impacted by rapid urban growth. This is reflected in the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals, and also at the United Nations Conference on Housing and Sustainable Urban Development (Habitat III). This importance afforded to UGS in current development policy agendas is due to an emerging academic recognition of its importance. Research showed that UGS are necessary for citizens' psychological and social wellbeing and also serve as a means of counteracting the loss of natural landscapes due to rapid urbanisation. These two functions – the social and the ecological – make UGS a focal point of interaction between the human and the natural in the urban environment, and consequently an important element in modern urban planning. Conventionally, cities provide these functions in a dichotomized manner, i.e., protecting natural areas for ecological functions and creating parks and gardens for social functions. However, there is an advocacy for multifunctional UGS which can provide both social and ecological functions by naturalising certain areas within parks and gardens and, by providing greater access and facilities within natural areas. Such 'dual provision', however, raises questions about the compatibility of the functions and the requirements from a planning and management perspective to minimize the possible conflicts at the interface of the functions.

This research, guided by the aim "to analyse the compatibility of dual provision of social and ecological functions in urban green spaces by investigating preferences and perceptions of users and providers and the interactions between the two functions," addressed this issue. The research involved a mixed methods approach to collect empirical evidence from four UGS in Manchester and Leeds, the selection of which was based on size, proximity to city centre, and level of deprivation among community members. The research tools included intercept and photo elicitation interviews with green space users; direct observation of usage behaviour in different paths and patches within the study sites; ecological surveys of habitats and biodiversity of trees, ground flora and birds in the study sites; and semi-structured key informant interviews with academics, government and private green space managers. The collected data was used to meet the following research objectives.

Objective 1 – to identify user preferences for green space types and perceptions about dual provision – was addressed through the analysis of quantitative and qualitative data from the intercept and photo elicitation interviews with 150 UGS users. User preferences for different types, activities, characteristics and facilities of green spaces, and their perceptions about dual provision and related conflicts/synergies were identified. Analysis of the findings showed that users have a greater inclination towards green spaces which are natural or have some natural elements. While some preferred activities or goals of green space visitation require less natural areas like open lawns, others require much wilder areas where people can connect with nature and have restorative experiences. Hence, based on user preferences, multifunctionality in the sense of both natural/less managed spaces along with less natural/more managed spaces is desirable in green spaces. Users perceived dual provision (mixed) green spaces more favourably compared

to either natural or manicured green spaces. The positive perception about dual provision was linked to their ability to provide naturalness along with social elements like paths, benches, other users, and open spaces.

Objective 2 – to identify the barriers and/or opportunities for implementation of dual provision – was met through the analysis of 12 semi-structured key informant interviews. It was found that while dual provision in green spaces was considered to be both possible and desirable by the key personnel; user demand, knowledge and understanding about green spaces, and budget/funding served as key barriers/opportunities for providing and maintaining such areas. According to the key personnel, greater awareness and knowledge dissemination among the general population as well as green space managers, wider public engagement during planning stages, development of implementation guidelines for managers, and use of context specific innovative measures can enable providers to overcome the barriers and create more opportunities for dual provision.

Objective 3 – to analyse the reality of perceived conflicts and synergies due to dual provision – was addressed through examination of the interactions between social and ecological functions, and identification of similarities and/or discrepancies between actual usage behaviour and user/provider perceptions. This was based on analysis of data from direct observation of green space users and ecological surveys of trees, ground flora, birds and habitats. It was found that user/provider perceptions closely matched the actual usage patterns of different paths and patches within the study sites. While large mixed patches like parklands showed positive interactions or synergies between the two functions, urban patches like ornamental gardens exhibited negative interactions or conflicts. The analysis indicated parklands, woodlands, and waterbodies to be the most suitable patches for dual provision. This was followed by grasslands and outdoors sports areas, where social and ecological functions could only be provided through proper management.

Objective 4 – to provide a theoretical understanding of the dual provision of social and ecological functions in urban green spaces – was fulfilled by this research. Prior to this research, the body of knowledge on UGS lacked a robust theoretical framework which incorporates the social and ecological functions of UGS and their interactions/conflicts on a single platform. The theoretical understanding of dual provision provided by this research will not only advance the academic debate and interest on dual provision but will also boost academic interest and input on social functions and ecological functions individually. Development of this theoretical understanding will also aid other academic debates and agendas, like Green Infrastructure (GI), biocultural diversity and urban ecology, by providing deeper insights into the human-nature interface in cities. Moreover, the theoretical understanding will aid assessment, decision-making and planning processes in relation to dual provision. The objective was fulfilled first with a review of the current knowledge on UGS, which provided insights on the social and ecological functions of UGS and highlighted knowledge gaps about user perceptions, barriers/opportunities, and interface conflicts/interactions related to dual provision of the two functions. Secondly, the knowledge gaps identified were addressed through the analysis of empirical evidence collected by this research.

Objective 5 – to provide recommendations for implementation of dual provision of social and ecological functions in urban green spaces – was met through the development of an implementation guideline for the dual provision to aid policy, planning and management related to dual provision. This addressed the following issues with existing guidelines and policy on UGS in England. Firstly, the existing policies lack a holistic framework for the implementation and management of dual provision green spaces in urban areas. Secondly, UGS characteristics which can be objectively measured and standardised, like quantity, proximity, accessibility and connectivity, are dominant in policy compared to the subjective aspects of UGS like quality and disturbance. Lastly, there is an advocacy in current policy programmes for local authorities to formulate need and priority based policies as opposed following a standardised national level policy on UGS. However, this creates confusion and can sometimes delay implementation or cause less than optimum provisions. The implementation guideline developed by this research addressed these issues by creating a multiphase dynamic plan which incorporates both subjective and objective aspects of UGS and

which can be catered to local needs. The first phase of the guideline states how dual provision can be implemented by taking into account both subjective and objective aspects of UGS based on user preferences, perceptions and usage patterns. The second phase provides management guidelines for overcoming barriers to implementation and resolving conflicts between the functions. The third phase is about monitoring and evaluation of the provision to ensure compatibility is maintained and to feedback the findings influence changes in phase 1, creating a fluid adaptive system.

This research addressed the key knowledge gaps related to dual provision of social and ecological functions in UGS. However, further research in this area is needed to overcome the limitations of this study and generate more knowledge on the interface between the two functions. While this study tried to account for the socio-cultural diversity of UGS users in selecting respondents, the small sample size and narrow geographical focus impeded the analysis of the inter-group differences which can be a focus of future studies. This study analysed direct observation of user behaviour; future studies could also incorporate behavioural studies of the fauna to better understand how aspects of their behaviour like nesting, foraging and mating impacts and is impacted by people's use behaviours. Finally, the theoretical understanding developed in this study needs to be tested in other socio-economic and geopolitical contexts.

12. Building with Nature: Developing a Benchmark for Green Infrastructure

Gemma Jerome^{1, 2}

¹ Gloucestershire Wildlife Trust, United Kingdom;

² University of the West of England (Bristol), United Kingdom.

Keywords: Theoretical framework; user preference and perception; spatial use behaviour and pattern; urban biodiversity; human-nature interface.

Abstract

Overview

This paper presents the development of a benchmark for green infrastructure (GI). Green infrastructure brings together many land uses (e.g. parks, gardens, cemeteries, allotments, nature reserves, surface water), urban design (e.g. street trees, landscaping) and functional features (e.g. sustainable urban drainage systems, green roofs) operating at differing spatial scales. There is a substantial body of research demonstrating the multiple benefits of GI. Despite this evidence base there is still considerable uncertainty as to how GI can best be delivered and maintained in practice.

This benchmark for GI has been developed through a combination of literature review and engagement with key stakeholders including the planning, landscape architecture, and developer communities. It provides a points-based benchmark that allows an assessment of the process of GI creation, from policy, through to planning, design, delivery and long-term management, ensuring that current good practice has been adopted at all stages.

The benchmark standards consider different aspects of GI in terms of form and. Where standards or guidance exist it sign-posts to these or, where they do not, it draws from the evidence base. This paper will present the framework for the benchmark and findings from a feasibility study examining its practical application.

Session aim, including learning objective:

The aim of the session is introduce people to Building with Nature, the green infrastructure benchmark that Gloucestershire Wildlife Trust are developing, in partnership with the University of the West of England (Bristol), to set a new standard for green infrastructure design, delivery and long term management and maintenance in new and existing development.

Outline of workshop content and format:

The workshop adopts the thematic framework of the Building with Nature benchmark – exploring the themes of wildlife, water management, and health and wellbeing. Information will be shared on key principles that may be used by built environment professionals to ensure the longevity of multi-functional green infrastructure and the wide range of co-benefits associated with its strategic delivery. The session will be useful for those involved in bringing development forward such as developers, ecologists, landscape architects, as well as those responsible for ensuring development is sustainable and contributes to high standards of living for new and existing communities, namely local planning authorities and public health professionals.

The workshop introduces a set of benchmark standards which define the foundation of ‘good quality’ green infrastructure in the context of designing, implementing and managing and maintaining individual features and components so they work effectively in a network. The standards, organised around the three themes of wildlife, water management, and health and wellbeing, are used to frame a discussion of how green infrastructure features in residential and commercial development creates opportunities to deliver a range

of benefits, including: climate change resilience, minimising environmental impact with respect to air, soil, light, noise, water and waste management; flood resilience and associated economic wellbeing; net biodiversity gain through habitat creation and integral build environment features for wildlife; and flourishing communities through provision of accessible, natural green space for play, recreation, education, food production, and public events.

Future application of outcomes:

The benchmark is currently being tested in Gloucestershire and the West of England, assessing the application of the standards to live planning applications, completed development schemes, and local planning policy documents. There is resource available for further testing in other areas where there are opportunities to evaluate green infrastructure in either development schemes (pre-construction and post-construction) or policy documentation (e.g. Local Plan, Green Infrastructure Strategy).

Resilient Infrastructure - Part 1

(Tuesday 13th June 2017, 14:00-15:10, Seminar Suite B)

13. Infrastructure: Opportunities from Interdependencies

Darren R. Grafius¹, Liz Varga¹ and Simon Jude²

¹ Complex Systems Research Centre (CSRC), School of Management, Cranfield University MK43 0AL, United Kingdom;

² Centre for Environmental Risks and Futures (CERF), School of Water, Energy and Environment, Cranfield University, MK 43 0AL, United Kingdom.

Keywords: Infrastructure, resilience, opportunity, complexity, business models.

Abstract

Introduction

The recognition and treatment of interdependencies at all scales between infrastructure systems range from ignorance to full substitution under the current paradigm of treating interdependencies as vulnerabilities which might compromise infrastructure resilience¹⁻³. Global interconnections have forced many infrastructure networks to function as a 'system of systems', which is at odds to their historical development and management as isolated industries and sectors. Efforts to understand the dynamics of this new complexity have remained predominantly focused on the risks and vulnerabilities presented by interdependencies between separate but functionally linked systems. This paper argues that interdependencies, that is dependencies outside the direct control of a product or service provider that are essential to the provision of the product or service, provide opportunities, from simple to integrative, which have the capacity to aid resilience and sustainable growth.

Methodology

Mixed methods have been used to collect both quantitative and qualitative data. Three approaches were used to collect data: literature review, workshops and expert panels and infrastructure and disaster event data for a region of the UK. Data analysis took a combined economics and environment perspective, identifying interdependency opportunities for which sustainable business models and reduced environmental impact were possible.

We take a complex systems' perspective which recognizes infrastructure systems as dynamical, inter-connected, and co-evolving. Using this perspective we look beyond the role of interdependencies as merely a source of risk and vulnerability to system service delivery, and explore opportunities for positive interdependencies at different levels of intensity and integration. We also consider fundamental principles of ecological systems, where complexity is generally accepted to facilitate rather than impede resilience, and investigate parallels with current and proposed infrastructure developments.

Findings

We propose a threefold typology by which interdependency opportunities can be classified and understood according to the intensity of their interconnection. Knowledge-based opportunities recognise the potential for understanding and expertise to improve standard practices when shared across industry and sectoral boundaries and applied in novel ways through collaborative efforts. Geographical/physical opportunities arise where multiple systems can benefit one another through infrastructure sharing practices, increasing efficiency through the identification and reduction of avoidable costs. Integrative opportunities represent the

most tightly-coupled variety, where two systems are interconnected and interdependent through shared functioning.

Infrastructure systems have largely originated from a traditional systems engineering perspective, in which design principles are goal-oriented and deterministic; however, the complex and interdependent nature of modern global systems has forced the adoption of more systematic perspectives⁴. Ecological systems exemplify ways in which complexity can build resilience rather than vulnerability, and as such their key principles of interdependence, cyclical flows, cooperation, flexibility, and diversity⁵ are explored in the context of current and proposed infrastructure developments.

Examples of advantageous use of interdependencies were found to fit most combinations of ecological sustainability principles and type of opportunity. Current efforts to upgrade various infrastructures with smart technologies, enabling real-time feedbacks between information and functionality, represent integrative opportunities that build on interdependency, cooperation and flexibility⁶. By optimising information flows through the system about system functioning, both managers and end users may gain the ability to match supply to demand and maximise efficient behaviours. The ongoing transition toward circular economies to increase efficient and sustainable use of resources exemplifies the principle of cyclical flows⁷, while also depending on cooperation between organisations and the exchange of knowledge as well as material flows. Partnership and cooperation are embedded in infrastructure sharing agreements in numerous sectors⁸, which are already in wide use through arrangements such as common carriage, track sharing in rail transportation and local loop unbundling in telecommunications. Such cooperation is also practised and essential across multiple industries seeking to adapt to the risks and uncertainties presented by global climate change⁹. Flexibility is strongly linked to resilience and adaptability in the face of uncertain future risks, again with respect to climate change. Additionally, flexibility in infrastructure design, management and use can facilitate the delivery of novel services or the dramatic transformation of existing ones. This is particularly exemplified by the developing advent of autonomous vehicles in dense urban areas and their capability to alter social behaviours, lead to considerable net gains in system efficiency and reduce pollution¹⁰. Finally, diversity is important in the design of network topologies, as the inclusion of distributed and redundant pathways can prevent the breakdown of service delivery in the event of local node or link failures. Diversity is also exemplified in a different way by the electricity generation industry; both currently with electricity being derived from multiple fuel sources to reduce dependence on individual resources, and in anticipated future developments through the increased uptake of renewable sources and micro-scale generation and storage technologies¹¹⁻¹³. The ability to generate electricity near its point of use will reduce demand on the overall network infrastructure, and a network of distributed power storage solutions will make the network more resilient to disturbances and aid in smoothing discrepancies in the relative timings of supply and demand.

Many of these examples begin with the sharing of knowledge and build upon their interconnections until highly complex and integrated systems emerge. Such systems must be designed and managed effectively, and risks must be adequately considered and mitigated. Our approach does not advocate that risks and vulnerabilities be ignored; rather, we argue, when a truly system-wide perspective is taken, both risks and opportunities become apparent. Currently a majority of research efforts focus on risk and vulnerability but ignore opportunity. By identifying and recognising the opportunities, however, current human-designed and built systems hold a great deal of potential for more effective functioning.

All of the above examples, either realised or planned for future development, represent economically viable ways in which infrastructure interdependencies can be exploited to produce benefits. These benefits can take a variety of forms; increasing the quality of services delivered, increasing the efficiency with which this is done, creating and delivering entirely new services to respond to shifts in demand, and fundamentally increasing the sustainability and resilience of the overall system of systems. All of these are relevant and essential to the needs of modern infrastructure systems, when considering the uncertainties and risks associated with growing populations, anticipated and unanticipated changes in stakeholder demands, and global climate change.

Contribution and next steps

This paper raises awareness of the notion of opportunity from interdependency in contrast to most papers in the field of resilience, which treat interdependency as risk that needs controlling at some level, often through creation of back-up and temporary interventions^{2,3}. The theoretical contribution is the tabulation and explanatory power of increasing interdependency opportunities, which have been derived from literature, experts, and data. It is a contrasting and complementary perspective to contemporary treatment of interdependency and re-affirms that interdependency has a hidden face of opportunity that has been recognised in some contexts but rarely made explicit^{14–16}. It provides a structure by which to determine and assess the level of opportunity and is aligned to basic principles of system survivability. The contribution for practice is that it raises awareness of interdependencies and the possibilities of exploiting them for positive economic and environmental impact.

There is major potential for impact by further development of this contribution since opportunity from interdependency has largely been overlooked in the haste to control it. Applications are possible in all infrastructure systems, through translation of examples in one domain to another. For example, sharing in transport can also be applied to sharing in telecommunications. Future research is required to validate, extend and critique the levels of interdependency opportunity. It is possible that examining such opportunities will identify gaps in legislation and regulation but also opportunities to liberate existing legislation and regulation when opportunities are constrained.

Acknowledgements

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14. Infrastructure Resilience: Towards a Transdisciplinary Definition and Analytical Framework

Ges Rosenberg¹, Neil Carhart¹, Colin Taylor¹, Vedran Zerjav², Andrew Edkins²

¹ University of Bristol, United Kingdom;

² UCL, United Kingdom.

Keywords: Resilience, infrastructure, sustainability, transdisciplinary, socio-economic.

Abstract

Infrastructure has become universally accepted as essential to the survival of a modern society, and is a critical determinant of a nation's future in terms of economic prosperity and whether it is to flourish socially. Our infrastructure supports the processes by which we transform the world around us, providing us the means to appropriate natural resources including energy, allowing us to transform these into the broad range of goods and services that modern society expects, and providing the platforms by which we interact socially and economically on a global scale. The UK's National Infrastructure Plan 2014 identifies the importance of infrastructure to the UK as follows:

“High-quality infrastructure boosts productivity and competitiveness, allowing businesses to grow and enabling them to reach suppliers, deepen labour and product markets, collaborate and innovate and attract inward investment. The choices that we make about infrastructure enable us to shape the type of economy and society that we want for the future. Infrastructure has the capacity to unlock economic potential in individual regions and ensure that growth and opportunities are distributed across the country, while also creating networks which bind together the different parts of the UK.” [HM Treasury 2014]

A prevailing theme in infrastructure research and discourse is that urban areas and their infrastructure should be 'resilient' in order to provide a dependable basis for future economic and social development, and for the infrastructure itself to deliver a range of policy goals such as a 'rebalanced' and sustainable economy. Although it would be very difficult to find arguments which oppose this statement, the task of creating such socio-economic 'resilience' and commissioning the supporting infrastructure systems is far from trivial. This is because to do so, requires solving many complex challenges in order to deliver the framework of policies, capabilities, resources, programmes and projects which together will deliver the vision of socio-economic 'resilience'. It also becomes clear that requirements for sustainable infrastructure, from a policy perspective, are often very far from what we are used to finding in discourses of mainstream academic disciplines.

While there is some consensus on what can be defined as infrastructure (i.e. systems for the provision of essential services to the public), the term is often misperceived as synonymous with large physical artefacts (e.g. sewers) and ICT. The same consensus cannot be found at all with the definition of resilience. If we couple the two words to make the term 'resilient infrastructure' there is a non-trivial issue of exactly what do we mean? Can infrastructure itself be 'resilient', or in fact can infrastructure only be assessed against measures of 'reliability', 'vulnerability' and 'robustness', and should resilience as a concept be reserved as a measure of society and its ability to recognise and respond to long-term adverse trends and/or recover from short-term shocks. This paper attempts to address these issues, by developing a transdisciplinary understanding of resilience and how this relates to society and infrastructure, drawing upon fundamental physics, engineering principles, systems theory, and applied social science.

Arising out of transdisciplinary work, resilience can be defined as an emergent property of any dynamic system that survives in the face of change and external forces or challenges. From this possible definition one can then move to consider 'resiliency', which can be understood as the capability of a system that

allows it to survive and, if we bring into play a further contribution from biology, to flourish. Applying this argument to the context of infrastructure, in this paper we argue how cities need to first recognise that when we are referring to infrastructure we are in fact referring to infrastructure systems and that second, we need these infrastructure systems to embody resilience capability and, implicitly, resourcefulness. This is envisaged as a multifaceted framework. The paper finally lays out a preliminary conceptual framework for understanding infrastructure within a general social system framework of resilience, and as a property that can be conceived, designed, and improved. We do this in an attempt to avoid the three most commonly encountered conceptual pitfalls when trying to understand infrastructure resilience.

The first pitfall can be addressed by asking “resilience against what”? Firstly we can construct definitions of resilience in terms of a known and predictable set of hazards. Secondly we can consider our resiliency in terms of events and phenomena that have not been previously anticipated or modelled. This problem domain is often downplayed in many of the existing policy and disciplinary arguments as if resilience is a homogeneous and indeed glaringly obvious idea applying to all things all the time. It is not. By contrast, defining resilience in a design space, i.e. as a solution to a problem, we are more likely to achieve an understanding that it (the infrastructure system) is fit for purpose in an urban and systems context. Here an important corollary is that when our needs or wants change as a society, then the infrastructure must itself be changed to meet new purposes. This in the past has led to a gap between much of our legacy infrastructure and future needs, e.g. energy inefficient housing that threatens the UK’s ability to meet its carbon reduction policy commitments.

The second conceptual pitfall is the level of analysis, appreciating that human made systems comprise hierarchies of order. A possible hierarchy, which we propose in this paper, captures the geo-political, economic-societal, organisational, and individual layers of the infrastructure system, or ‘system of systems’. This perspective becomes a valuable proposition considering the physical components of infrastructure are limited in their adaptability compared to the geo-political, economic and societal systems within which they sit, and the organisations and individuals that operate and use them. A consideration of the capabilities of these layers provides potential opportunities for additional resilience.

This leads on to the final conceptual pitfall is one of dynamism, i.e. the consequence of time and change. Systems change in time and as they respond to external or internal change. Appreciating the dynamic aspects of infrastructure resilience means taking into account both the identified and identifiable future risks as well as using practicable and reasonable endeavours to consider the future uncertainties. From these future-facing consideration the challenge is then to build in resourcefulness and capability that can cope with these challenges.

Appreciating the above-proposed basic features of infrastructure resilience can arguably help us design, develop and deliver infrastructure systems which are not only resilient and bounce back to the required level of equilibrium when faced with perturbations, but allows its users (the public, economies and societies of different scales) to more than survive and to flourish. This is an important argument as it can be the flip side of the resilience coin - if resilience is about risk management, then flourishing is about seizing opportunities which arise from change and uncertainties in the world.

The paper is structured as follows.

1. What is urban infrastructure & design research angle - resilience to what?
2. Development of the concept of resilience - systems theory - from natural systems to applied physics and engineering;
3. Human agency in systems;
4. Aspect of geo-political resilience;
5. Organisational resilience;
6. Individual resilience and learning powers.
7. Concluding remarks.

15. Resilient and Complex Infrastructure: Conjugating Opposite Ends of the Spectrum

Giuliano Punzo¹, Anurag Tewari², Eugene Butans², Martin Mayfield¹, Liz Varga²

¹ Department of Civil and Structural Engineering, The University of Sheffield, S1 3JD, United Kingdom;

² Complex Systems Research Centre, Cranfield University, MK43 0AL, United Kingdom.

Keywords: Infrastructure, engineering, resilience, complex systems

Abstract

Introduction

Over recent years there is an evolving body of Infrastructure systems, and more broadly, engineering systems', research that subscribes to the tenets of complexity science to design, optimize and improve the architecture, failure tolerance, reliability and resilience of complex engineering and infrastructure systems. A complexity perspective prompts infrastructure and engineering systems' research to reason why a system's behaviour exceeds what is intuitively the sum of its individual parts [Rouse 2007]. Although the core ideology of complexity such as adaptation, self-organization and emergence conflict with the purpose driven approach of infrastructure and engineering system design that looks for convergence of behaviours, and consistency of design and performance [Bujara 2010], still a complexity perspective has been progressively pursued, particularly for the study of system resilience, robustness and failure tolerance [Bujara 2010]. Complex systems provide the most appropriate framework for the assessment of system's reliability beyond the failure mode and effect analysis of individual systems and into the resilience of the overall system's ecosystem.

There is a compelling case on the utility of a complexity perspective in arguing resilience of large infrastructure and engineering systems, however the domain remains to be fragmented. The reason to it is that the contemporary complex engineering research, particularly on resilience, draws on interdisciplinary concepts borrowed from divergent fields like ecology and natural sciences and there remains some gaps in contextualising the tenets of complexity to engineering systems' research. To gain a better understanding of interdisciplinary definitions and constructs of complexity and to understand how can these be adapted in an engineering or large systems research, this study presents an interdisciplinary bibliographic synthesis of literature on complexity, resilience and engineering systems.

Methodology

The bibliographic study used a co-citation mapping based analysis [Persson 2009] of the literature on complexity and resilience from last 25 years. The motivation of co-citation analysis was to be able to identify the most influential works and sectors for the research area of resilience, complexity and large engineering and infrastructure systems.

Based upon broad set of keywords, two co-citation maps were drawn; first on complexity and resilience conjugation, and second on a subset of this within engineering systems.

Findings

A first co-citation analysis, indicates that the field of complexity and resilience is dominated by ecology. Other important communities are network science and environmental science. It follows that works from these areas are often cited together. Engineering and infrastructure research is a relatively small community in this scenario and the strongest connection to ecology is through the works of Hollnagel [2006] and Holling [1973]. Using a filtering criteria, based upon co-citation weights, the set of 6138 research papers listed in the basic search were reduced to a total of 325 research papers. A descriptive statistics of these articles

was conducted and then individual articles were synthesised for their contribution to the domain of resilience, complexity and large systems.

A second co-citation analysis was performed on the engineering subset (Figure1). All the co-cited documents were mapped and clustered considering those co-cited more than 5 times. This highlighted the strongest reference areas for engineering research in complexity and resilience. Interestingly these include ecology and network science, whose clustering is stronger than the clustering within engineering that in comparison appears homogeneous and concentrated on resilience engineering. Here the field is dominated by the influential textbooks by Hollnagel, previously cited, Dekker, Perrow and Vaughan [Dekker 2012, Perrow 1999, Vaughan 1996]. These analyse catastrophic cascade failures and the role that the system's complexity plays in these. In particular, already in 1984 Charles Perrow [1999], framed very well the problem of ensuring safe and reliable operations of systems that become hardly predictable due to their complexity. Some of the works in the resilience engineering cluster [Saurin 2012, Costella 2009, Gomes 2009, Morel 2009, Leveson 2004, Hollnagel 2004] are often associated to the field of safety engineering. For these, the work by Woods [2006] provides the fundamental link to the cognitive aspects and the human factors in safety and resilience engineering. Some fundamental papers in network science, such as the works by Watts [1998] Barabasi [1999] and Albert [2000] are amongst the most co-cited documents in the reduced set of engineering works. It must be noted that infrastructures do not appear popular in the research area defined by the intersection of resilience and complex engineering systems.

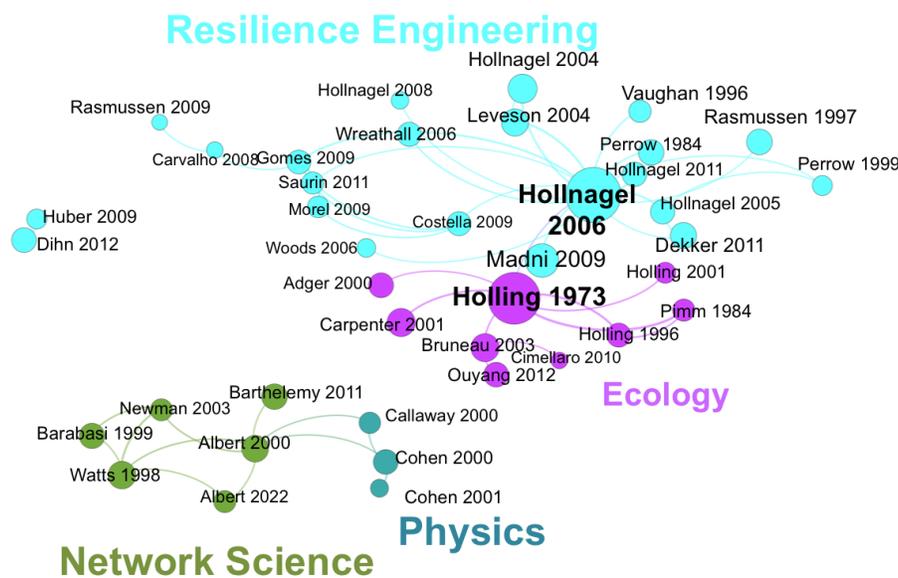


Figure 1: Co-citation map for Engineering Complex and Resilience keywords. The link weight threshold is 5. Only non-isolated nodes are shown.

Recommendations for future research and application.

The engineering systems' literature now recognises the existence of strong coupling among engineering system components, natural surroundings, infrastructure availability and interacting social systems, and argues that these complex interdependencies necessitate the study of engineering resilience from a complexity perspective. A complex system perspective provides the necessary theoretical foundation and analytical framework to study the dynamic and emergent nature of system resilience. Infrastructures, however are not at the forefront amongst the topics of interest in complex engineering systems resilience. The chasm between the intentions for integrated, intelligent and synchronised transportation, new energy sources, congestion-free urban environment and their realisation passes through integration of diverse systems and disciplines and a complex system approach.

Acknowledgements

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Resilient Infrastructure - Part 2

(Tuesday 13th June 2017, 15:30-16:40, Seminar Suite B)

16. Integrating Infrastructure Resilience into Sustainable Construction Design and Planning in the United States

C. Manoosingh¹, Y. Chen¹

¹ Georgia Southern University, Statesboro, GA, United States.

Keywords: Infrastructure, engineering, resilience, complex systems

Abstract

Impending climate change and rising sea levels indicate that certain communities in low-lying areas are increasingly prone to flooding. Additionally, increasingly adverse weather events due to an unpredictable weather cycle means that homes in nearly every region in the United States are vulnerable. The U.S average temperature has increased by 1.3°F to 1.9°F since 1895, and is projected to rise another 2°F to 4°F in the coming decades. As a result, changes in very heavy precipitation patterns have been observed across every region of the United States. Moreover, changes in the climate has also been linked to increasingly intense heat events, coastal flooding, and storm surge in certain regions across the United States (Melillo et al., 2014).

The United States construction sector is therefore at the frontlines of disaster mitigation through the anticipation of regional risk, and the incorporation of resilient construction techniques into planning and design of buildings. This research aimed to explore the current role of the United States construction sector in the planning and design of resilient infrastructure, and the extent to which the integration of both resilience and sustainability into construction planning exists. This research also aimed to determine to what extent the construction industry was interested in learning about the integration of resilient infrastructure design concepts, and what boundaries exist for the adaption of design strategies toward more resilient and sustainable infrastructure.

In order to achieve an understanding of current perceptions and integration patterns within the industry, a survey was sent to 150 major commercial and residential construction companies in the United States. The companies surveyed were chosen from every region of the country, and included small, mid-size, and large civil engineering and construction companies. The survey was organized into three main sections: current perceptions of sustainability and resilient infrastructure, access to information, and barriers to implementation. The first of these sections solicited responses regarding to what extent these construction companies and professionals engage with local disaster relief agencies, like the United States Federal Emergency Management Agency (FEMA). Questions in this section also asked respondents to gauge how active they were in learning about weather changes in their regions, and current design and planning considerations for construction projects their companies oversee. The second section of the survey asked respondents to evaluate their access to tools that could inform them of the impacts of weather-related events on their industry, and access to information regarding best practices in sustainable construction planning and design for resilient infrastructure. The third section of the survey focused on the barriers to the implementation of best design practices, like perceptions regarding cost and willingness to develop design techniques related to both resilience and sustainability.

Preliminary results indicate that the vast majority of companies were not engaged with local disaster relief agencies, and did not consider disaster resilience a factor in construction design and planning. In fact, more than 70% of respondents were unable to name one design strategy to incorporate disaster resilience in infrastructure. Survey results showed a strong desire to learn more about how resiliency concepts could be incorporated into design and planning, with more than 87% of respondents indicating that they would be very interested in educational modules that could inform them of best practices to integrate resilient design techniques into construction planning. A lesser number of respondents, about 63% indicated a similar desire to learn about sustainable construction techniques, and only 42% believed that there were overlaps between these concepts. Results also indicated that respondents considered resilient design techniques and materials to be costly to implement, but strongly agreed that there was a need to do so. It is to be noted that respondents in states along a coast, like Florida and Georgia, saw the integration of these techniques as a more urgent need than those survey respondents in land-locked states, like Kansas and Colorado.

This research further explores the results of the industry survey, and provides recommendations to facilitate the integration of disaster mitigation and resilience into construction planning and design. This baseline data provides a solid theoretical base from which researchers and practitioners can develop learning modules designed to address challenges experienced by civil engineering and construction companies in different regions of the United States. The development and delivery of these modules is anticipated to inform industry of key design and planning strategies for sustainability and infrastructure resilience, and to begin to close the knowledge gap between research and practice.

17. Getting Better Oversight of Infrastructure Resilience in the UK: Assessing the Potential 'Governance Grip' of Combined Authorities on Integrated Infrastructure Provision

Paul Honeybone¹ and Katrien Steenmans¹

¹City Leadership Lab, STEaPP, UCL, United Kingdom.

Keywords: Infrastructure; Governance; Systems; Coordination; Nexus.

Abstract

The paper reports UCL City Leadership Laboratory research conducted to assess the governability of critical infrastructure domains (water, energy, food and waste) in select UK city-regions. Fundamental in determining the resilience (or fragilities) of cities and regions, 'nexus' infrastructures underpin the systems of provision for 'liveability'. Planning and investment decisions in infrastructure systems provide medium-term 'steering' to advance system performance and connectivity. This work reveals insights about future directions for system coordination and pathways for governance improvements, given the range of roles and responsibilities.

With a mix of public and private systems in the nexus spheres of water, energy, food and waste, these vitally underpin daily city-region functionality and ability to sustain shocks. Local governments are positioned as a key coordination node on behalf of all citizens. The way they conduct this role plays out primarily at three main levels:

- attaining optimal and integrated 'business as usual' system performance
- improving strategic infrastructure development and investment
- responding with emergency management when system failure occurs.

These roles concurrently shape the assuredness in a city-region as somewhere to live with a secure quality of life and invest in the future with confidence.

With a focus on select Combined Authorities with Mayoral elections in 2017, analysis is conducted to produce a view on the state of the respective areas fundamental nexus resilience or fragility, with an assessment of their 'grip' on the issues, particularly at the level of improving strategic infrastructure development and investment. At the heart of the research is understanding the nature of accountability as it stands and testing what it might need to be for improved oversight and management in the near-term future. On this basis, new insights for advancing 'governability' and coordination are explored.

With a focus on ways to advance local government practice, while primarily adding local value in the regions where practice is considered, the findings are of interest to Whitehall departments, the National Infrastructure Commission (NIC) and other interested parties to help inform infrastructure strategies, investment and devolution responsibilities. The paper will also explore the academic methodological issues for doing research on physical infrastructure systems and the interface between technical and social domains.

18. Towards Structural Resilience in Offshore Wind Farms

David Wilkie¹, Carmine Galasso¹

¹ Department of Civil Environmental & Geomatic Engineering, UCL, UK.

Keywords: Structural resilience, offshore wind farm, offshore wind turbine, structural reliability.

Abstract

The offshore wind industry has grown to the point where it supplies 11.03GW [1] of electricity within Europe offshore [1], with a further 26.4GW of projects approved [2]. However, the overall cost of offshore wind farms (OWF) remains high and a recent UK government report [3] has highlighted “integrated design” and “whole farm control” as two areas that could improve cost reduction. Offshore Wind Turbines (OWT) are unique structures in that they actively adapt to the environmental conditions in which they operate and consequently they span a range of engineering specialisms, including components traditionally associated with: aeronautical, electrical, structural and mechanical engineering making integrated design challenging. Within the UK continental shelf most OWT are on monopile foundations [4]; these are effectively large diameter cylinders that are hammered into the seabed, the rotor and tower (a tapered tubular member connecting the monopile to the rotor) are then fixed on top. Currently structural design of OWT is undertaken at the component level, with the tower and monopile commonly being design separately [5]. Prescriptive codes are used to evaluate potential designs but these do not explicitly consider the risk posed by uncertainties associated with variability in physical properties nor the highly variable natural hazards which OWF are exposed to throughout their operating life.

Performance based engineering (PBE) supplies a general technique for inferring structural resilience of spatially dispersed infrastructure and thus provides a tool for considering risk in the design of OWF. In this paper we propose applying a PBE framework to assess an individual OWT, using dynamic structural analysis to estimate probability of failure, then estimating the potential losses due to component failure across the whole farm. This is intended to demonstrate that the concept of resilience is applicable to OWF.

A number of studies have investigated the reliability of OWT structural components, for example the fragility of OWT on jackets was investigated by Wei et al [6] who assessed the impact of variability in wind and wave loading on the structure. The result was fragility curves (which plot probability of failure against increasingly severe environmental conditions) based on damage, yielding, and collapse limit states. A similar method was proposed by Kim et al [7] based on using the first order reliability method to calculate the probability of structural failure over the structures operating life. The reliability of OWT on monopile foundations exposed to wind, wave and earthquake hazards was investigated by Mardfekri and Gardoni [8]–[11]. They developed a set of fragility curves using serviceability yield and ultimate limit state investigating varying environmental conditions and modelling uncertainties. All these approaches have considered structural failure only, however, as mentioned earlier an OWT is a complex structure with many subsystems – developing an integrated design technique requires an approach that combines structural fragility with the potential failure of other subsystems.

The concept of resilience is used within a number of different fields [12] and when applied to structural systems it incorporates the properties [13]: robustness, redundancy, rapidity and resourcefulness. It is commonly represented in terms of the consequence of an extreme event on a structure and the time required to re-instate operability afterwards, as indicated on Figure 1. However, these properties are difficult to quantify especially from the perspective of structural design, as information regarding the capacity of an organisation to make budget available (i.e. resourcefulness) may not be available to the engineer. Therefore, a technique for estimating resilience that only relies on the robustness and redundancy of the structure would allow this concept to be applied to structural design. One approach, investigated by Bruneau and Reinhorn [12], assumes that loss of functionality after an extreme event and the time to

recovery are correlated. This is intuitive, as in the general case if an event (i.e. wind storm) causes more damage it will take longer to repair the structure as a result, this assumption provides a starting point for OWF resilience and was applied to PBE of structures for blast [14] by defining a relative resilience indicator (RRI), which is correlated to resilience (R):

$$R(E) \propto RRI(E) = 1/C(E) \quad \text{Eq.1}$$

Where RRI can also be defined as the inverse of the consequence (C) of an extreme event (E). Under this assumption a structure that experiences a lower consequence (i.e. less damage) as the result of a hazard will be viewed as more resilient, however we require a method for quantifying consequence.

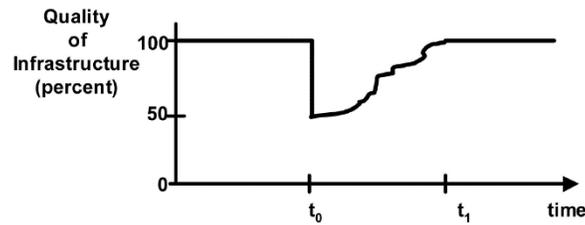


Figure 1: Graphical definition of resilience after an event (at t_0).

Source: Brunneau et al [12].

PBE was proposed by the Pacific Earthquake Engineering Research centre to assess failure of structures due to seismic hazards [15], and the approach has subsequently been applied to a range of hazards including wind [16], [17] and blast [14]. It is based on disaggregating risk into individual elements, and can express consequence as the probability of exceeding a predefined loss ($v(LS)$) in terms of conditional probabilities ($G(\cdot | \cdot)$):

$$v(LS) = \int \int \int G[LS|DM] \cdot G[DM|EDP] \cdot G[EDP|IM] \cdot f(IM) \cdot dDM \cdot dEDP \cdot dIM \quad \text{Eq.2}$$

Where DM is damage & EDP is a parameter describing structural response (i.e. force in a member) and IM is the intensity of a natural hazard. This framework can be expressed in a flowchart, see Figure 2, where the terms:

- Structural characterisation – The geometry of the structure, including any uncertainties in material properties.
- Hazard analysis – Develop joint probability distributions environmental conditions.
- Structural analysis – Captures uncertainty in mathematical models used to estimate structural capacity.
- Damage analysis – Expresses probability of damage given the structural response.
- Loss analysis – Probabilistic estimate of financial loss.

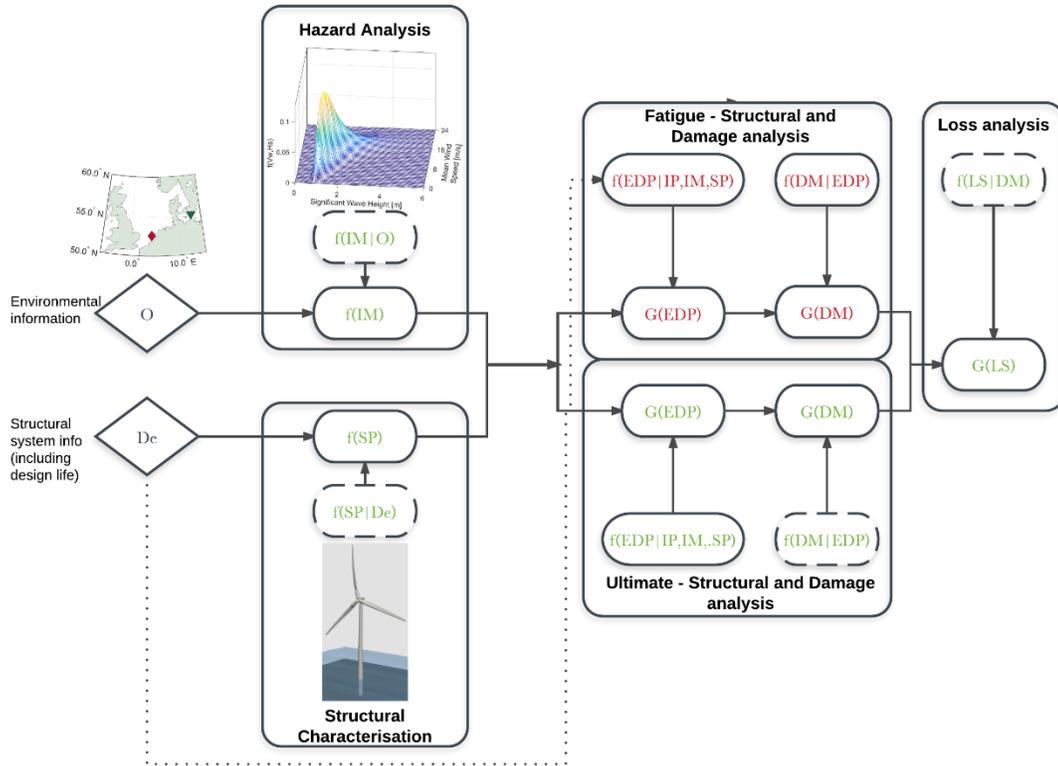


Figure 2: Proposed PBE framework for OWT structure. Green = included in the case study, Dashed line = included but simplified.

To demonstrate applying the framework shown in Figure 2 we estimate potential losses associated with an OWT by calculating the probability of structural failure combined with the losses expected from other sub-systems (i.e. electrical) in an OWT with 170 turbines. The framework is simplified to allow us to present it in a concise form and so uncertainties are limited to environmental loading. The structure employed was the NREL 5MW OWT [18] sited at the Kriegers Flak OWT in Denmark. Hazard analysis was performed using data measured over a continuous 10 years' period to estimate a joint probability distribution of extreme mean wind speed and significant wave height shown on Figure 3 (left). The structural analysis was performed using the structural dynamics package FAST [19] to calculate structural response at a wide range of environmental return periods and Monte Carlo simulation to estimate probability of failure corresponding to each condition, full details provided by Wilkie [20]. The output was two fragility curves describing the probability of failure of the monopile and tower at different environmental conditions (MRP), Figure 3 (centre). A simplified loss analysis was performed by estimating the loss associated with wind turbine sub-systems (electrical, blades and etc.) using a closed-form reliability technique [21] with failure frequencies and losses from Carrol et al [22]. The structural fragility curves allowed us to include loss associated with structural failure in this calculation, for simplicity we took the probability of structural failure of a single OWT to be the MRP at which first failure occurs in the structural model. The failure rate was multiplied by the number of turbines to estimate probability of structural failure across the whole farm. The probability of different loss levels associated with this example OWT results are shown on Figure 3 (right). These demonstrate that including structural failures skews the expected losses towards low probability high cost events, this is primarily due to the high robustness of the structural elements combined with the high losses if the structure fails (as it is associated with loss of all other components). It should be noted that these results are demonstrative only as the analysis was simplified to aid description.

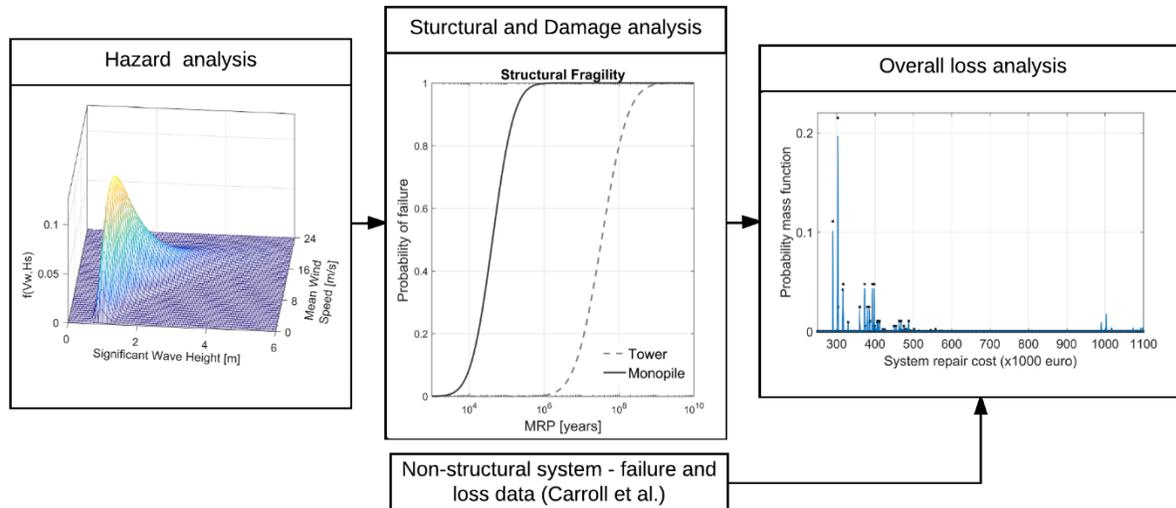


Figure 3: Simplified PBE framework applied to a case study OWF; with hazard assessment (left), structural analysis results (middle) and loss assessment (right, dots = loss without structure, blue line = loss with structural components).

This short paper has summarised existing approaches that have been used to estimate structural reliability analysis of OWT and noted that they mainly consider failure from the component level. The developing concept of resilience provides an alternative approach, which may allow us to consider performance of OWF as a whole. This paper proposes a framework for estimating resilience of OWF by applying the existing framework of PBE. A case study demonstrates how this calculation may be implemented to estimate potential loss associated with the multiple sub-systems present on individual turbines at the OWF level. Future steps will involve considering the risk posed to an array or whole OWF in greater detail, due to correlated hazards i.e. a wind storm effects the whole installation simultaneously. Many challenges remain to be answered, particularly relating to the choice of performance indicators [13]. However, if successful, this approach will aid in the development of integrated design techniques for OWF and therefore works towards meeting the goals set by the UK government cost reduction framework for offshore wind.

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Disaster Management

(Wednesday 14th June 2017, 9:30-10:40, Seminar Suite A)

19. Promoting Safer Building: Using Science, Technology, Communications and Humanitarian Practice to Support Family and Community Self-Recovery

John Twigg¹, Bill Flinn², Tiziana Rossetto³, Susanne Sargeant⁴

¹Overseas Development Institute, United Kingdom;

²Care International, United Kingdom;

³UCL, United Kingdom;

⁴British Geological Survey.

Keywords: Disaster, self-recovery, shelter, humanitarian assistance, reconstruction

Abstract

Poorly constructed buildings are often the largest cause of injury, trauma and death in a disaster. The great majority of disaster-affected families rebuild their homes relying on their own resources, with little or no external support. Indeed, it has been suggested that the shelter assistance provided by humanitarian organisations rarely reaches more than 30% of affected households within the first year after a major disaster, and is often significantly lower. Moreover, much of that support is in the form of temporary housing which may last only a few years.

The significance of shelter self-recovery has only recently been identified as an issue for research, there is relatively little literature on the subject, and very little of this is substantive research. As a result, policy makers and shelter professionals in the international humanitarian community, as well as national and local organisations, lack understanding of the self-recovery process and the different forms that it takes: they do not know how to offer the most appropriate and effective support.

This presentation reports on a pilot project (November 2016-July 2017) which seeks to identify and explore key gaps in our knowledge and understanding of shelter self-recovery after disasters. The findings of the research will inform humanitarian and other actors' strategies to intervene more effectively to support self-recovery and the construction of safer houses. The initiative is a partnership between the Overseas Development Institute, University College London, the British Geological Survey and CARE International UK. It is supported by the UK government's Global Challenges Research Fund through the Natural Environment Research Council.

The project is taking a multi-disciplinary approach, involving specialists in the physical and social sciences, structural engineering and humanitarian assistance. Through this, it seeks to develop a shared understanding of how self-recovery takes place, the various drivers and barriers to self-recovery, disaster-affected households' choices and decision-making processes regarding recovery, and the effects of different influences on these (for example, livelihood priorities, finance, culture, indigenous technical knowledge, local governance and institutions, the physical environment, and the availability of different forms of assistance). The project is also examining how scientific, engineering and construction knowledge currently support the self-recovery process and how this can be improved in future.

We will present the initial findings from fieldwork that is due to take place in April-May 2017 at a number of different sites in Nepal (looking at recovery since the 2015 earthquake) and the Philippines (recovery following typhoons, in particular Typhoon Haiyan in 2013), with a particular focus on the implications of this research for urban self-recovery processes. Although this is a pilot study, it is valuable in providing empirical research findings to support the emerging debate on this important yet neglected topic.

20. Appropriate Methods and Tools for More Effective Child-Focused Hazards, Vulnerabilities and Capacities Assessment in Urban Settings

Matthew Maclure¹, Virginie Le Masson¹, John Twigg¹, Gianfranco Gliozzo²

¹Overseas Development Institute, United Kingdom; ² UCL, United Kingdom;

Keywords: Children, urban, disaster risk reduction, vulnerability and capacity assessment

Abstract

Urban children in low-income countries face a range of hazards and threats, particularly if they are poor, street children, child labourers, or living in informal and slum settlements. Hazards, vulnerabilities and capacities assessment (HVCA) could play a key role in designing programmes to reduce these threats. HVCA is a method of investigation into the risks that people face in their locality, their vulnerability to those risks and their capacity to cope with and recover from disasters. Its purpose is to identify groups who are vulnerable, identify the factors that make them vulnerable and how they are affected, assess their needs and capacities, and ensure that projects, programmes and policies address these needs. HVCA is used as a diagnostic tool, a planning tool and a tool for empowering and mobilising vulnerable people.

A variety of HVCA frameworks and toolkits has emerged over recent decades and been applied in many different contexts and at a range of scales. However, these have limited relevance to the needs and priorities of children and young people in urban settings, who may face a different range of physical hazards than in rural settings, whilst inhabiting an urban space that often provides inadequate social protection mechanisms and access to basic services. Urban structural inequality further exposes poor urban children and youth to climate change, aspects that most HVCA frameworks do not address.

Few frameworks focus on children's vulnerability and agency or are informed by sound understanding of specific child protection and wellbeing issues. They tend to concentrate on risks from environmental or technological hazards (e.g. flood, fire) and usually have less to say about other significant or widespread social threats to children in urban environments (e.g. domestic violence, bullying, and exploitation in the labour market). However, other analysis and assessment tools used for working with children consider aspects of risk and resilience and could be incorporated into HVCA or linked to it in some way: these include tools for identifying and prioritising child protection issues. Development of appropriate methods and tools can support child-centred DRR (paying specific attention to children's needs in planning and interventions) and child-led DRR (engaging children in designing, implementing, communicating and advocating for interventions) and thereby make significant, positive contributions to their resilience.

This presentation reports on the results of a project commissioned by Save the Children International which seeks to: assess the effectiveness and limitations of current HVCA methods and practice in assessing urban children's risks, vulnerabilities and capacities, and in supporting child-centred and child-led DRR; understand the roles, actions, attitudes and capacities of different stakeholders applying HVCA in urban contexts; and evaluate the potential of innovative technologies and associated approaches in supporting more effective HVCA for urban children. The research will be carried out between January and April 2017. It comprises a literature review and interviews with practitioners involved in DRR/CCA and youth-centred development, practitioners and researchers with experience of developing and testing HVCA tools, and urban practitioners in the selected countries of study (India, Bangladesh, China and Indonesia). A future phase of the work, based on these findings, will develop appropriate methods and tools for more effective child-focused HVCA in urban settings.

Urban Metabolism

(Wednesday 14th June 2017, 11:00-12:40, Seminar Suite A)

21. Peri-Urban Food Production Promoting Urban Resilience and Bridging Urban and Rural Regions

Gunilla Almered Olsson¹

¹School of Global Studies, University of Gothenburg, Sweden.

Keywords: Peri-urban Food Production; Urban Food Security; Urban-rural Resilience, Multifunctional Food Production, Social Sustainability

Abstract

The dimension of food provisioning is mostly overlooked in the discussion of urban resilience. The sustainable city is a frequently used vision but in the analysis of sustainable and resilient systems for housing, energy, waste, communication and security etc., the food security issue is most often absent. The food system in the industrial world is totally integrated in a global food system and directly linked to the globalized economic market. For efficient functioning of the global food system it is necessary to have uninterrupted and reliable access to natural resources, energy, efficient and undisturbed transportation along routes in land, water, cyber space and absence of accidents, sabotage, political and military conflicts. To the uncertainty of all those factors must be added the environmental uncertainty, e.g. climate warming, thus making food security endangered. The strong current interest in urban agriculture in many cities is partly a response to this situation although the food produced here cannot satisfy the need of the urban population. The peri-urban regions, on the other hand, often have a large potential for food production on its unexploited but currently unused agricultural land. The land here is under severe pressure for a number of different and contradicting uses. Such pressures include 1) Land for built up activities and infrastructure; 2) Natural and cultural values and protected areas; 3) Recreation (golf courses, horse activities etc); 4) Food production. The challenge for urban planning of resilient livelihoods is to find a balance between the four competing dimensions since they all include needs for human wellbeing.

The aim of this paper is to address the peri-urban land use changes in relation to food production, and to discuss the potential of increasing resilience for urban-rural regions by enhancing food production as part of multifunctional land use in those areas.

This talk will report from a case study addressing this aim in peri-urban Gothenburg, Sweden. This is a coastal city formerly dominated by heavy industries including wharfs, but today in transition to new economies. The city of Gothenburg has considerable cultural diversity, segregation problems and challenges for social sustainability but is surrounded by extant agricultural landscapes. Methods applied in the study are interviews of different groups of stakeholders including planners and mapping of historical, statistical, land use data and land use plans. Among the preliminary findings are: the unique situation in Gothenburg with a combination of considerable peri-urban land owned by the municipality and strong engagement and political will among city officials and local residents to preserve the peri-urban agricultural land and to increase the local food production. There is an increasing request for locally produced food among the urban citizens and current production is very far from the capacity of meeting this demand.

Local food production activities can produce multiple values available for citizens in the urban and peri-urban regions. Multifunctionality in protected areas that were shaped by farming activities and belonging to

the agricultural landscape include meat production from grass-fed livestock – grazing is part of the biodiversity management – preservation of biocultural values, and simultaneously facilitating visitor access for recreation purposes. Local food production is creating new job opportunities; Food production activities can be seen as arena for knowledge sharing and cultural integration between different socio-ethnic-cultural groups; Combining the urban and peri-urban food production and including adjoining rural municipalities can revitalize the region, e.g. by ‘food charters’- different types of economic agreements on food production and cultivation between consumers and producers/farmers in the near and distant peri-urban-rural regions. This creates new jobs in the rural regions and contributes to a direct link between the city and its distant peri-urban-rural regions. Food production activities increasing social and environmental sustainability have a potential for increasing resilience of urban-rural regions. Several of the above mentioned issues are considered in the ongoing work in Gothenburg on a local food strategy that started Spring 2017. Some highlights from this work will be given.

22. A Methodological Proposal to Evaluate the Environmental Footprint of Cities

Nadia Mirabella¹, Karen Allacker¹

¹Department of Architecture, KU Leuven, Kasteelpark Arenberg 1, 3001 Leuven, Belgium.

Keywords: Urban Sustainability; LCA; City Environmental Footprint; Urban Metabolism.

Abstract

Introduction

For the first time in human history, more than one person out of two is living in urban areas. Projections say that cities will continue to grow and be a pole of aggregation for human beings, especially in developing countries, with 66 per cent of human global population residing in urban areas by 2050 [1]. Many drivers are responsible for this phenomenon, e.g. the intersection between supply and offer of jobs and services, better and safer living conditions, or even a higher attractiveness in terms of social lifestyles and opportunities. Cities are complex and dense systems, they require great amounts of energy and material and they often produce huge amounts of waste in order to sustain such intensive living activity. This means that the subsequent environmental burdens are high and they are likely going to be higher in the future, if the urban population will increase at this pace. Nevertheless, the concentration of natural and human capital gives also the opportunity to cities to be drivers for change and to address more favourably the impacts on planet Earth. Holistic methodologies are necessary to understand, manage and tackle environmental pressures of urban contexts, avoiding the risk of burdens shifting both spatially and temporally. The assessment of environmental performances are usually conducted from two perspectives: top-down and bottom-up approaches [1]. Currently, carbon footprint and water footprint are the most widely used methods to evaluate the environmental performance of cities, despite their limited scope. The Urban Metabolism (UM) concept allows making an inventory of the flows into and out of the city, but it does not allow to interpret these flows in terms of environmental impacts. Life Cycle Assessment (LCA) may be considered the most comprehensive and robust holistic methodology to face this challenge, but it is not yet feasible at urban scale.

For this reason, the main aims of this contribution are to give a comprehensive insight in a selection of available methods allowing to assess the environmental burdens of cities, and at the same time to propose a new methodology to overcome the current gaps based on a combination of existing approaches.

Investigation and comparison of selected methodologies for environmental assessment

The rise of scientific consensus on human-induced climate change and the urgency to take actions against it have relatively recently led to a proliferation of standards and carbon footprint methods. Such proliferation of methods is, however, not always fruitful, but rather confusing. A standardized method is lacking to date and systemizing different approaches remains a challenging task, as no international consensus exists. Moreover, various problems encounter when trying to implement the various methods, ranging from issues related to the definition of system boundaries, to the type, source, amount and quality of available data, as well as to the allocation procedures. The heterogeneity of reporting and verification steps across the various accounting schemes create additional problems. In this context, political claims such as “climate neutral” targets can be misleading and even erroneous, and they can lose their efficacy and power towards society.

The first aim of this contribution is to explore in-depth the theoretical and practical issues with the support of a critical analysis focused on a set of selected methodologies currently available at city level, namely the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC) [2], Bilan Carbon [3], and ISO/TS 14067:2013 [4], including a comparison with the Organizational Environmental Footprint (OEF) [5]. The latter is an environmental multi-criteria assessment methodology intended for high-scale and complex

systems based on Life Cycle Thinking (LCT) with a high level of accuracy and comprehensiveness. In this critical analysis special attention is paid to the definition of the urban context and the related system boundaries, data gathering and data quality, and allocation procedures, especially the ones related to dynamic fluxes (e.g. production/consumption based approach, transportation). Final considerations are dedicated to reporting and communication issues. The selected methodologies are critically analyzed in order to identify their most important features considering LCA as a reference methodology and urban context as the system under study. These features are: i) applicability to urban context; ii) type of approach; iii) Life Cycle Thinking; iv) Impact Assessment; v) Functional Unit considered; vi) System Boundaries; vii) Inventory data; viii) Data Quality; ix) Allocation Rules x) Identification of responsible actors; xi) Verification; xii) Ancillary tools. Each method is screened highlighting strong points and shortcomings through a SWOT analysis. Based on the considerations emerged from the critical and SWOT analysis, a further investigation inside strong and working points of Urban Metabolism, Input-Output Analysis and Life Cycle Assessment and most updated and innovative researches on the topic is carried out.

The City Environmental Footprint: proposal for a new methodological approach to evaluate the urban environmental footprint

The outcomes of the previous steps served as a basis for the proposal for a City Environmental Footprint (City EF), a hybrid methodology, LCA-based, able to combine top-down and bottom-up approaches, to overcome the current limitations existing in the field of urban environmental assessment. Top-down methodologies enable to identify the main fluxes going into and out of the city (i.e. typically inventoried for the main sectors within a city). Bottom-up approaches allow for microscale analyses of various sub-systems of the city (e.g. residential buildings, infrastructure, transport, energy production, water supply, etc.) and their constituting processes and/or products (e.g. construction products, use of appliances, heating energy use, cooling energy use, etc.). The combination of both approaches allows for a more precise and detailed modelling and data inventory of the subsystems and for a more clearly identification of hotspots and opportunities for efficient and effective improvement in the city.

The City EF proposed comprises five main steps, iterative and customizable according to the needs and the specific reality of the urban context taken into account (Fig. 1). The first step entails a qualitative approach and aims at providing an overview of the dynamics inherent to the city, with the study of the historical, social, and economic background, through the support of specific urban indicators. A set of proper definitions and methodological guidelines for different urban contexts complete the qualitative step of the City EF. After that, the second step includes a quantitative approach, mainly LCA based with specific refinements for application to the urban context. These refinements comprise: functions of the system and functional unit, system boundaries, allocation procedures for production/consumption and transportation activities. Then, the life cycle inventory is organized according to the different urban subsystems identified in the qualitative step, and a proper combination of low-tech (primary data, activity data, statistics, surveys, etc.) and high-tech data (GIS, remote sensing data, etc.) are gathered to model the urban system. The fourth step is necessary to translate the inventoried fluxes in potential environmental impacts with proper impact assessment methods. Finally the fifth and conclusive step is dedicated to revisions, interpretation of results, investigations on the major hotspots. Sensitivity analysis and evaluation of alternative improvement scenarios are possible additional steps.

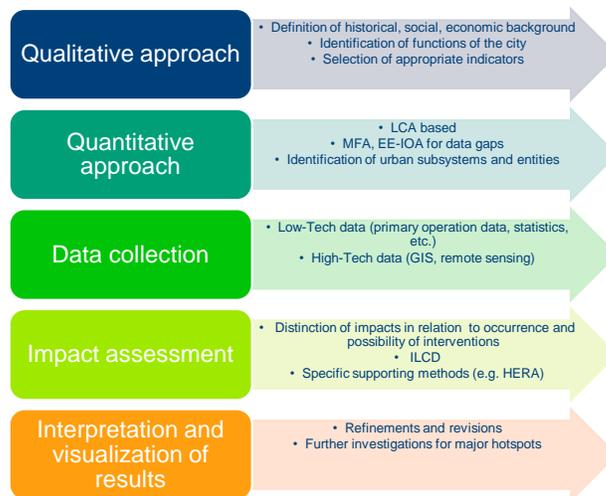


Figure 1: City Environmental Footprint, methodological details of the proposed approach

Conclusions and future outlooks

Cities are a strategic player in the path towards sustainability, but their complexities require an ad-hoc methodology to achieve the target, as no methodology to date is completely effective. This contribution shows that so far none of the selected methods can be applied as it is, but each one provides good points to start or weak points to work on. The proposed City Environmental Footprint aims at overcoming some of the macroscopic current limitations, such as: i) the assessment of potential impacts induced by urban activities; ii) the identification of the major hotspots and responsible actors; iii) the evaluation of more sustainable alternative scenarios to select the best measures from an environmental point of view. Further investigations are necessary to define and test proper system boundaries, functions and functional unit of the system, and provide methodological advancements for a more specific urban impact assessment. Finally, the methodology is intended for use by urban planners, policy makers, researchers and practitioners, in the transition for cities to a more sustainable path.

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23. Sustainable and Resilient Urban Development Pathways: the value in combining different elements to deliver truly sustainable, plan-led transformations.

Jonathan Essex¹

¹ IMC Worldwide, United Kingdom.

Keywords: Sustainability, resilience, urban, green, economy

Abstract

Urban development programmes are often labelled in different ways. For example, different aid funded initiatives and programmes focus on Smart Cities, Green Growth and Inclusive Growth.

This paper explores how Sustainability and Resilience are defined, planned and delivered in the urban context – and to what approaches are required to deliver long-term sustainability and resilience for cities as a whole. This will draw on different recent programme experience from IMC Worldwide, as follows:

Embedding urban planning and wider and strategic land-use and investment decisions – a case study in how urban strategy can set out a wider climate resilient, low carbon and inclusive development pathway.

IMC Worldwide worked with Maxlock Associates and Atkins to develop a set of urban planning design principles and a road map for the green growth of secondary cities in Rwanda. Key issues included:

- **The importance of secondary cities as alternative poles for development** to capital cities, to reduce the overall rate of population growth of urban areas so that cities can be plan-led; which enables
- **'Transit oriented development' and Compact cities** – higher density and sustainable transport solutions building sustainability into the DNA of city plans from the outset: which provides the basis for
- **Sub-regional development strategies** with stronger urban to/from rural links. The support and linkage of urban enterprises to rural supply chains is vital to ensure that urban development is founded upon sustainable prosperity and resource use.
- **Green infrastructure and green enterprises** combine to form ecological industrial development to progress in ways that leapfrog traditional infrastructure investment decision making and shift investment spending from transport to energy and water infrastructure investment where there is a positive (renewable) energy return on energy invested.

In this context Smart Cities are a sub-set, of this wider (rural and urban), plan-led development pathway that aims to be not just climate resilient, sufficiently sustainable but also inclusive.

Combining Sustainability and Resilience –of infrastructure and built environment to provide *for* all.

The resilience is used in different ways, often as an adjective to define the development **of** something (infrastructure, cities, built environment) and/or **for** someone. For example enhancing resilience for households in informal settlements is different from the resilience of urban infrastructure the nexus of wider infrastructure systems that support urban areas.

The combination of 'resilience of' with 'resilience for' and sustainability of specific elements with overall impacts provides an effective way to link together the twin objectives of making development 'green'

and making it 'inclusive'. However, by combining these together a new system property is created – green *and* inclusive sustainability – as opposed to either green *or* inclusive growth.

This part of the paper will explore a 'learning journey into the different meanings of resilience' undertaken with and for DFID (see <https://prezi.com/2ocytgalfqn7/gateway-to-resilience-resources/>). This, together a review of what climate resilient infrastructure investment means to different donors and business organisations globally, explored how resilience and climate investment are framed differently and how this is crucial in determining the resulting outcomes from investment. There is a need to extend beyond current economic approaches to prioritise infrastructure investment, for which cost-benefit analysis and return-on-investment currently dominate.

In doing so it will consider what facing up to the scale of the climate challenge means in the context of development – not just for specific countries at the front line for climate adaptation (e.g. Bangladesh, Ethiopia, small island states) but the way that sustainability and resilience is co-planned and envisioned for urban settlements worldwide.

Beyond Disaster Response, extending lessons learned from DRR into sustainable urban economies.

This last section will illustrate the challenge of expanding the focus of disaster resilience beyond immediate post-disaster needs, to deliver long-term climate resilience. This explore how a longer term focus can wider participation and opportunities to address conflict² and provides an opportunity to address not just the increasingly unpredictable, severe and increased frequency of shocks due to climate change – but use the focus on these to enhance the way the slow-onset impacts of climate change are also addressed³.

This approach shows that an adaptive transformation, that builds back not just better, but environmentally sustainably could not just better bridge the gap between humanitarian interventions and subsequent disaster recovery but provide a framework that could be applied to address the persistent and growing (social and environmental) challenge of providing a vision and sustainable future that extends to the one billion plus slum dwellers living worldwide

This means that the approach to address climate change, where the notion of a circular economy and the disaster management cycle combine to give an approach to development that is not increasing the scale and financial value of built environment at the expense of natural resources, but better integrating the two into a truly circular economy, in terms of resource use, resilience and energy.

Purpose and objectives:

1. To explore the links between objectives for green growth and sustainable development, inclusiveness and resilience in the urban context.
2. To relate the processes of planning, investment and the type of jobs and infrastructure supported.

Findings and originality:

The exploration of resilience and climate resilient infrastructure investment relates directly to the experience of developing greener urbanisation strategies. The challenge of bridging the humanitarian-to-relief gap in

² See initial discussion presented at <http://www.imcworldwide.com/news/part-1-of-2-how-can-holistic-approaches-to-drr-ensure-we-build-back-sustainably/>.

³ See initial discussion presented at <http://www.imcworldwide.com/news/how-can-environmental-sustainability-thinking-make-disaster-risk-reduction-better-part-2-of-2>.

the disaster management cycle can be met by extending the often limited notion of a 'circular economy' from resource use to energy and livelihoods.

Conclusion and impact on policy

That the system properties for a sustainable and resilient pathway for urban development depend not just on the instrumental value of different investment decisions through which the built environment is created, but the way in which these combine to enable transformation in a particular location. This means transformative sustainable urbanisation requires a plan-led approach. And one that blends the resilience of communities to adapt with investment choices to enable this to be sustained, sustainable and for the benefits to be inclusive: that is, shared by all.

24. Articulating the Circular Economy's Spatial Dimension: Two Case Studies

Julie Irene Stephanie Marin¹

¹Research Group Urbanism and Architecture (OSA) Department of Architecture, KU Leuven, Belgium.

Keywords: urban metabolism; research by design; policy; transition.

Abstract

In 2012, the Flemish Waste Agency (de OVAM) changed its policy from 'waste management' to 'sustainable materials management', shifting the focus to waste as a resource and catalyzing transition to the circular economy. In line with this policy shift, large and small scale 'circular' innovations are on the rise in Flanders. Industries develop clean technologies such as remining waste from former landfills (ELFM) or advancing recycling and reuse applications. However, in order to reach an integrated socio-ecological transition to the circular economy, more is needed than 'technofixes' (Barrez, 2016). For example, local repair cafés and no-waste supermarkets contribute to overall urban sustainability on an economic but also on a social and ecological level. *Nevertheless, the question remains how the variety of transition initiatives will physically merge in space and contribute to more sustainable and resilient 'circular' physical environments and infrastructures.*

Since 2014, the OVAM is engaging in research by design as a methodology finding out how changing urban metabolisms can drive spatial development. With this experimental policy direction, the OVAM expresses a renewed interest in the interdependency between waste and space. In collaboration with different government agency consortia, research by design is commissioned to urban design practices studying a city or region's urban metabolism in a projective way.

Research objectives and methodology

This paper analyses the incentives and drivers for research by design on urban metabolism and circular economy in two Flemish areas transitioning to the circular economy: Central Limburg and the city of Antwerp.

For both cases the planning process and application of research by design is traced and evaluated, with the objective to formulate a clear agenda for the future application of research by design in transition processes.

Through stakeholder interviews (de OVAM, Ruimte Vlaanderen, stad Antwerpen) and the study of policy documents (T.OP Limburg, visie 2050, SALK, beleidsplan ruimte Vlaanderen, VMP, strategisch Ruimtelijk Structuurplan Antwerpen, ...) the different steps in the (policy) process leading to research by design will be mapped and analyzed. The main focus will be on the integration of spatial thinking and transition in the application of research by design.

Case studies with detailed objectives and outcomes

Both studied cases express a clear ambition to couple transition to the circular economy simultaneously to restructuring space. In other words, to use the transition to more circular resource flows (a healthier urban metabolism) as a lever to transform settlement patterns and infrastructural systems. On the contrary, the motive to approach this question through the study of the urban metabolism, is quite different for both cases.

Case study one, the Central Limburg region, suffered an economic decline with the announcement of the closure of one of the region's main employers, Ford Genk. In 2013, a spatial revitalization program (SALK)

was launched to incentivize and support Limburg to transition to its next economy focusing on industry 4.0 and circular economy. At the same time the spatial development department (RV) launched a territorial development program T.OP Limburg, connecting spatial questions to the economic SALK agenda. Within T.OP Limburg, research by design has played a major role since the beginning. In 2015, RV and OVAM commissioned a study to redevelop the Ford Genk site as a hub for circular economy, departing from principles of urban metabolism.

Case study two, the City of Antwerp, is actively taking a role in directing resource flows imposed on the city from the 'top-down'. Traffic and resource flows linked to international trade via the harbor or the congested ring road extend city boundaries but highly impact the city's livability. The study of the city's metabolism aims to add a spatial development layer to Antwerp's spatial structure plan (2006). The research by design study is commissioned by a consortium of the City of Antwerp, Ruimte Vlaanderen, de OVAM and the port of Antwerp.

Potential development impact

Based on the critical study and evaluation of the application of research by design in two case studies, this paper aims to outline an agenda for the application of research by design in planning processes of transition to the circular economy. It aims to clarify the potential role urbanists or urbanists in research by design on urban metabolism could play. It aims to articulate clear questions and problem statements around urban metabolism and circular economy's (potential) spatial dimension.

Recommendations for future research and application: hypothesis

Research by design's future application in transition processes should be understood as an out-of-the-box method gaining insight in complex development questions through creation of spatial future imaginaries. The future imaginaries have the capacity to integrate and synthesize social and ecological parameters in the transition to a circular economy, while accelerating transition itself. Through the coproduction of future imaginaries, stakeholders are invited to rethink their changing role in a transitioning society, projecting new types of coalitions and spatial outcomes of the –future- circular economy. Through coproduction of these future imaginaries with stakeholders and experts, urban design can integrate different social groups, circular economy scales and models and ecological challenges while connecting spatial development to economic redevelopment.

New Methods

(Wednesday 14th June 2017, 9:30-10:40, Seminar Suite B)

25. Strategic transitions: Examining the role of standardised green infrastructure evaluation in sustainable neighbourhood masterplans

Rosalie Callway¹, Tim Dixon¹, Dragana Nikolic¹

¹School of Built Environment, University of Reading, United Kingdom.

Keywords: Sustainable Neighbourhoods; Green Infrastructure; Strategy-as-practice; Evaluative Practice; Masterplanning.

Abstract

Research objectives and methodology

This research project examines the role of BREEAM Communities, a standard evaluative framework that aims to promote 'sustainable neighbourhoods' within larger-scale mixed-use development projects. The standard carries an implicit assumption that the enactment of various evaluative practices will enable the rationale refinement of design decisions that will support the creation of a more sustainable neighbourhood development. What is less certain is the degree to which these evaluative practices and decisions are embedded in the transition from design to construction and use. To examine the assumption of embeddedness throughout the masterplan journey a broad question is addressed:

How does a standardised approach to evaluation contribute to sustainable neighbourhood masterplanning?

The research adopts an empirical lens to operationalise this question, taking one issue from BREEAM Communities to consider whether and how, the standard contributes to a more integrated approach to green infrastructure evaluation within neighbourhood masterplanning.

Three objectives are addressed:

1. Practice: To examine empirically how evaluative processes are applied and understood by various actors at different phases of masterplanning, with a particular emphasis on green infrastructure
2. Integration: To study how green infrastructure is evaluated and reflected in masterplan visioning, design and construction decisions, contrasting sites with and without BREEAM Communities certification, considering:
 - a. The prioritisation of four distinct sustainability aims: ecosystem services, social inclusion, financial viability and infrastructural integration (how, why, what, and by who)?
 - b. How does green infrastructure evaluation interact with other evaluative practices and wider masterplanning activities?
3. Implications: To consider the potential lessons for BREEAM Communities and masterplan practice, as well as theoretical contribution of the research

This research is somewhat less concerned with what is being evaluated and more concerned with the processes of evaluation, examining the 'how' and 'why' evaluation and decision making processes are enacted through 'praxis'. It aims to contrast how it is practiced in different neighbourhood masterplanning projects and whether this corresponds with how it is idealised in BREEAM Communities and by literature.

As such it is necessary to empirically examine how both BREEAM Communities and evaluative processes are understood and practiced by the various actors involved. Therefore the research questions and objectives are strongly focused on the people and processes behind evaluation, and adopts Strategy-as-Practice theory as a core analytical framework.

Tracing the journey, from neighbourhood vision and design to construction and use, there may be a shift from strategic idealised values to pragmatic practice. This highlights a need to examine what role evaluative practices may play in that transition. The research uses a mixed method approach, combining literature review, semi-structured interviews, informal observation and analysis of public documentation. It asks whether and how evaluations are used to inform and shape masterplan decisions and practice relating to green infrastructure along the masterplan journey. It aims to make the role of evaluative practices more explicit and clarify the intentions and experiences of different interest groups in the process.

Case studies

The research examines evaluation of one issue addressed in the BREEAM Communities (BC) standard, green infrastructure (SE11), through an empirical study of six UK neighbourhood developments. Three broad types of neighbourhoods have been analysed: two inner city urban infill sites; two urban estate regeneration projects; and two rural-urban extensions. In each neighbourhood type, one of the sites has applied BREEAM Communities, so there are three sites that have applied BC and three that have not. The sites are all at similar stages of development, with an outline masterplan and at least one phase having completed a detailed plan and either under construction or already in-use. Each site carries certain unique contexts; historic, geographic, demographic, and in terms of the actors involved, such as whether they are privately-led or publically-led or a collaborative partnership. Nevertheless, the underlying processes are sufficiently similar to allow a degree of comparison and empirical learning.

The study considers the potential implications of the analysis for neighbourhood masterplanning practice, policy making and theory. The findings relate to four challenges for BREEAM Communities: the boundaries, reflection and reflexivity, ownership and agency, and negotiation of evaluative practices within masterplanning. These factors are considered with regards to how they may in turn affect the embeddedness and influence of evaluative practices upon decision-making. It outlines some potential lessons for the BREEAM Communities standard, including addressing procedural gaps such as post-occupancy appraisal, and considers neo-institutional limitations and conflicts.

Potential development impact

Adopting the EPSRC's 'Pathway's of Impact' model, the research aims to impact the following areas:

- **Environment:** the research seeks to refine BREEAM Communities, broadening its definition of 'green infrastructure' in order to improve opportunities for neighbourhoods to benefit from the multi-functional nature of ecosystems, as well as enhancing green and blue ecosystems for their own right.
- **Society:** contribute to public policy by addressing national and local government roles in setting masterplan boundaries e.g. clarifying Post Occupancy Appraisal within local planning processes. It also highlights opportunities to improve local ownership and emergent values in neighbourhood design, e.g. designing more adaptable public realm and semi-private green spaces.
- **Economy:** highlight specific opportunities in BREEAM Communities to enhance the promotion of the green economy. For example, stimulating local dialogue and activities around productive, connected and biodiverse green infrastructure; as well as pointing to the incorporation of a clear definition of sustainable value management in the standard.
- **People:** consider opportunities to enhance the skills of masterplan practitioners, through offering recommendations about how evaluative practices can be used to better drive sustainable masterplan decision-making, making core values and evaluative procedures more transparent, reflexive and synergistic.
- **Knowledge:** add to academic knowledge, linking 'Strategy-as-Practice' (SaP), institutional and urban design theories, focusing on 'intra' and 'extra'-strategic evaluative practices, which have been less researched through SaP. It will contribute to technical knowledge regarding BREEAM

Communities, with specific recommendations seeking to make it more salient to masterplanning practitioners.

Future research and application

The further application of this research will include a multi-actor dialogue to consider the wider sectoral relevance of this empirical study. Future research will be also required in a number of areas, including (but not only):

- challenges with transparency and negotiation of evaluative compromise;
- examining further the dynamic and transaction nature of evaluative practices, how and why these change over time;
- the processes of defining and operationalising sustainable value management.

26. Development of Social Capital Management Approach with Residents Participation using Improved Resource Generator Method

Hideaki Kurishima¹, Akifumi Nakamura¹, Hidefumi Kurasaka²

¹ Shibaura Institute of Technology, Japan;

² Chiba University, Japan.

Keywords: Stock management, social capital, resource generator, residents participation, Yachiyo City

Abstract

1. Background

It is extremely important to appropriately maintain and manage various underlying stocks at the community level and hand them over to future generations for a sustainable society (Kurasaka et al. 2016). Underlying stocks are natural capital, manufactured capital, natural capital, and social capital. It is also pointed out that these stocks can reduce vulnerability and increase community resilience (Mayunga 2007). Therefore, grasping and managing these stocks leads to the sustainability and resilience of cities. In our research project, we have been developing an implementable stock management approach at the municipal level in Chiba Prefecture.

Especially, we are paying attention to social capital among various stocks. In recent years, a wide variety of disciplines and decision-makers have become more interested in social capital among the stocks. According to Putnam (2001), social capital is defined as "social networks and the norms of reciprocity and trustworthiness that arise from them". Social capital has attracted so much attention because it is expected to increase the efficiency in the society, and have a positive effect on the decrease in unemployment rate of the region, good health of residents and safety improvement, which can lead to the increase in the people's happiness level as well as activation of the region. In other words, the effects generated by "norms of network and interdependence" are expected.

On the other hand, there are some challenges in management of social capital. The first challenge is definition of social capital. The second challenge is quantitative and qualitative understanding of social capital. There is great variability among measurement methods, effects expected, and scales applied which have been used by researchers in previous research. Actually, the research on social capital has only just begun, and it is hard to say that there is enough accumulation of research to provide a comprehensive perspective to integrate such variability. In other words, we should develop a approach to measure social capital for management. The third challenge is how to manage social capital. It is difficult to estimate the future state of social capital with a forecasting approach, unlike the material stock.

2. Objective and study area

Based on the above, the purpose of this study is to develop an approach to measure and manage social capital. We apply this approach to measure and manage social capital in Yachiyo City, Chiba Prefecture. Yachiyo City is a dormitory suburbs of Tokyo metropolitan area.

3. Methodology

This study defines social capital as "the social relations (networks), and their benefits". We have reviewed various methods to measure social capital, and adopt resource generator method. A resource generator is a method of asking interviewees about the existence of acquaintances from whom they can get cooperation, and about the relationship with them, by preparing about 30 items (resources) which require cooperation

of others. In previous research (Kurishima et al. 2014), researchers have created a list of resource items (hereinafter called as a "resource list"), but it is possible that these resources are not necessarily important for local residents. Thus, we first conduct a group interview with local residents about the resources required in the future. Next, based on its results, we create a resource list. Moreover, we conduct survey with this resource list, and grasp the current state of social capital. Finally, we plan and hold a citizen workshop to revitalize the network of people with little social capital.

4. Result

4-1. Result of group interview

In previous research (Kurishima et al. 2014), the adopted resources were mainly instrumental resources such as "ask to take care (temporarily) of your parents or children", "ask someone to drive to destination (hospital, station, etc.)" and "ask someone to support when you are sick or have a disability". However, in our group interview, many expressive (emotional) resources such as "gain energy from someone" and "listen to your problems and complaints" have been also suggested. In addition, we created the resource list of 30 items based on the results of the group interview. The 16 items of the 30 items were common with previous studies. Many of the newly added were expressive resources.

We conducted survey in January 2016 with this resource list, and grasped the current state of social capital. As a result, the following was made clear:

- (1) It is difficult to access money-related resources and highly specialized resources.
- (2) Women have more accessible resources than men.
- (3) Accessible resources are greatly reduced for those older than 70 years.
- (4) Accessible resources of people living in aging public apartment estate were less than in other areas. Especially, people living alone in apartment have significantly fewer accessible resources.

4-3. Workshop to revitalize social capital

Based on this result, we planned a citizen workshop to revitalize the network of people with little social capital. In November 2016, we held a workshop by middle and high school students who are citizens of the future. In July 2017, we are planning to hold a stakeholders meeting to discuss the specific measures of social capital maintenance for the future.

5. Summary and future plans

This study at present can be summarized as follows.

- (1) Social capital management approach was proposed.
- (2) The resource list to measure social capital was set based on group interview with local residents.
- (3) The current state of social capital was measured by improved resource generator method, and weak points of social capital were made clear in Yachiyo City.

From now on, we are planning to hold a stakeholders meeting to discuss the specific measures of social capital maintenance for the future.

27. Towards Liveable Cities – Designing and Trialling Radical Interventions

Chris Rogers¹, Joanne Leach¹, Jon Sadler¹, Dexter Hunt¹, Christopher Bouch¹, Anthony Hargreaves¹, Susan Lee¹, Jonathan Ward¹, Marianna Cavada¹, Nick Grayson^{1,2}, Martin Locret-Collet¹

¹ University of Birmingham, United Kingdom;

² Birmingham City Council, United Kingdom.

Keywords: Liveability, Aspirational Futures, City Interventions, Societal Wellbeing, Planetary Wellbeing

Abstract

We are told repeatedly that we cannot go on living as we are if we are to meet global targets for CO₂ (80%), water (67%) and waste reduction, and resource rapidly growing populations, with the vast majority living in cities. A major concern is that our quality of life will suffer in making the necessary changes, and therefore engineering changes to our way of urban life without addressing this concern is almost certainly doomed to failure. The implication of all this is that attitudes and behaviours must change, both rapidly and radically, if we are to meet carbon targets, avoid other forms of planetary damage and conserve essential resources – living as we are and scaling back simply will not work, and reliance on technology to save us is an unacceptable philosophy. Liveable Cities aims to demonstrate that there are ways of making this change, without adversely affecting our quality of life, by transforming the engineering of cities.

Liveable Cities is researching an alternative approach to the engineering of cities and using examples to demonstrate how it can be achieved:

- We are establishing alternative aspirational visions of future city living that are outcome focussed, visions which embrace individual and societal aspirations and wellbeing.
- We are creating a comprehensive city assessment methodology, both to establish how cities are performing currently and to explore how they are likely to perform in the future if radical interventions are made to move us towards the aspirational visions of future city living.
- We are focussing in particular on the liveability criteria of individual and societal wellbeing and planetary wellbeing, notably low carbon living married to resource efficiency and resource security.
- Given that engineering is about conceiving, planning, designing, putting into operation, monitoring and adjusting interventions in existing systems, while implementation requires the design and operation of appropriate governance systems (embracing all forms of formal and informal governance, including user attitudes and behaviours, and societal norms), we are researching the full dimensions of these engineering processes in relation to city systems.
- We are exploring radical city interventions via a series of thought experiments, and drawing from this learning we are creating and testing conceptual designs of interventions in case study cities.

This paper will, using an example intervention, provide a description of the Liveable Cities methodology.

Waste and Water Treatment

(Wednesday 14th June 2017, 11:00-12:40, Seminar Suite B)

28. Microbial Fuel Cells for the Production of Electricity and Biogas from Organic Waste in Cities

Enrique Lopez Arroyo¹, Jingyuan Shi¹, Paul Helier¹, Ilan Adler¹, Luiza Campos¹

¹UCL, United Kingdom.

Keywords: Water, Energy, Nutrients, Recycle, Organic

Abstract

Introduction

Both, the generation of clean energy and the treatment of municipal organic waste that otherwise will pollute the environment, are the main drivers for the development of Microbial Fuel Cells (MFCs). MFCs are a type of electrochemical converters that use microorganisms as mediators to directly produce electricity from organic matter¹. They can use organic waste as fuel to produce electricity. It is estimated that over 80 per cent of wastewater resulting from human activities is discharged without any treatment². There is interest in the use of MFCs for the treatment of wastewater (WW) not mainly because they can produce electricity from waste but because it has been demonstrated that by using MFCs it is possible to treat the WW anaerobically and obtain hydraulic retention times (HRTs) similar to those of activated sludge treatment (in the range of 10H)³. Therefore, reducing the cost of the biological treatment by avoiding the need of aeration and decreasing the amount of sludge produced. Aeration in Spain was reported as 1% of the country's electricity consumption⁴. The biomass production yield within an anaerobic MFC is lower (0.07 – 0.22g per g COD) than that of an aerobic reactor (0.4 g per g COD). The average cost of disposing of sludge in Europe was reported as €600/tonne¹.

In a MFC organic matter (OM) is used as electrons donor, these electrons are transferred to the anode electrode and from here they travel to the cathode electrode (generating a current in the process) where they meet their protons and the final acceptor of electrons. The reaction in the cathode when oxygen is used as final acceptor of electrons is:



Anaerobic digestion (AD) of OM has developed into a technology that is used to produce bio-methane at industrial scale. AD is used to treat organic residues and it is effective at relatively high concentration of OM (15- 60% dry matter). It is not effective for the treatment of WW with low OM content, because of this, at the end of the AD process the effluent (digestate) still contains OM (around 5% dry matter content). Activated sludge is the traditional way of treating WW with this ratio of OM. However, as mentioned before, the use of MFCs allows the anaerobic treatment of the OM in WW and it could be possible to combine AD with MFC to further reduce the OM of the AD effluent previous to discharge. By combining AD and MFCs it would be possible to produce both electricity and biogas. The scientific literature about the use of MFCs for the treatment of WW is extensive⁵⁶⁷, however, there is not much information about the use of MFC in an anaerobic set up with high OM content and the simultaneous production of electricity and biogas. Methane production combined with WW treatment has been combined in a microbial electrolysis cell (MEC) but not in a MFC⁸. One of the advantages of using MFCs is the direct electricity production (without the need of burning a fuel). It is necessary to understand how the integration of a MFC into an AD reactor will affect the production of biogas in terms of volume and composition. The microgeneration of biogas and

Results

Preliminary results show no significant differences between the two types of reactors in terms of biogas production and composition. At the end of the biogas production the values of methane, hydrogen, carbon monoxide, carbon dioxide, oxygen and hydrogen sulphide were similar. As shown in table 1 and in figure 1.

| Biogas production and composition in the six AD reactors. | | | | | | |
|---|---------|---------|---------|-----------|-----------|-----------|
| Reactor/Parameter | 1 (AD) | 2(AD) | 3(AD) | 4(AD-MFC) | 5(AD-MFC) | 6(AD-MFC) |
| Biogas (ml) | 4160 | 4400 | 4500 | 4480 | 4255 | 4520 |
| CH ₄ (ml) | 2688.3 | 2681.93 | 2984.9 | 2988.62 | 2790.595 | 2641.57 |
| CO ₂ (ml) | 1176.16 | 1228.52 | 1314.95 | 1309.37 | 1254.24 | 1276.28 |
| O ₂ (ml) | 9.84 | 10.8 | 11.7 | 9 | 12.6 | 9.5 |
| H ₂ S | 0.03422 | 0.00069 | 0.049 | 0.0062 | 0 | 0.025 |
| CO | 0.02715 | 0.03924 | 0.03545 | 0.02406 | 0.043865 | 0.03744 |
| H ₂ | 0.0205 | 0.03426 | 0.0378 | 0.0297 | 0.049875 | 0.0361 |

Biogas production AD (1,2,3) and AD-MFC (4, 5, 6)

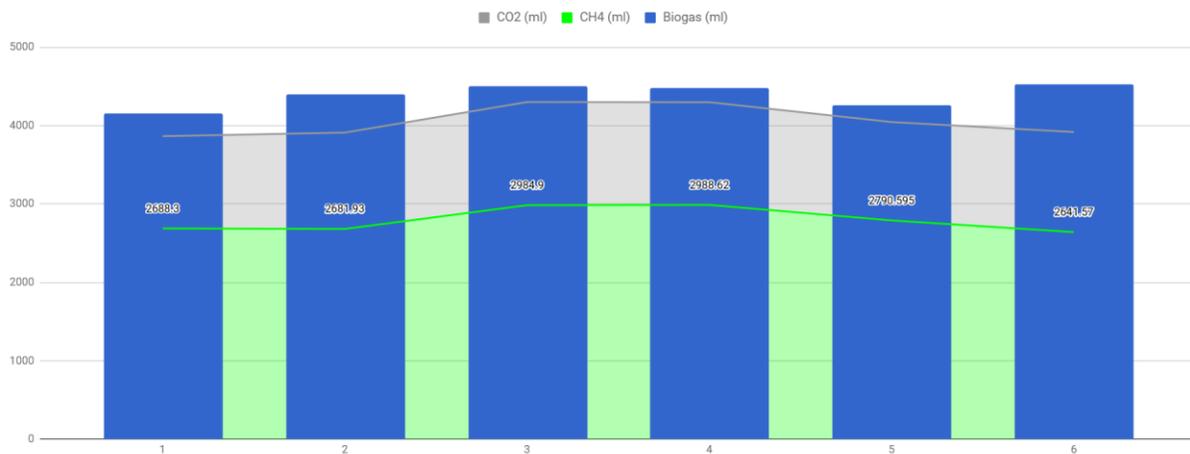


Figure 2 Biogas (blue), methane (green) and carbon dioxide (grey) production from the AD reactors (1, 2 and 3) and the AD-MFC reactors (4, 5 and 6).

The voltage decreased gradually during the experiment, the three MFC reactors had an initial potential difference of (0.9V, 0.98V and 1.2 V), fifteen days after the beginning of the experiment the voltage of the same reactors was of 0.325 V, 0.31 V and 0.323 V respectively. Figure 2 shows the potential difference of each of the three MFC reactors though a period of 7 days.

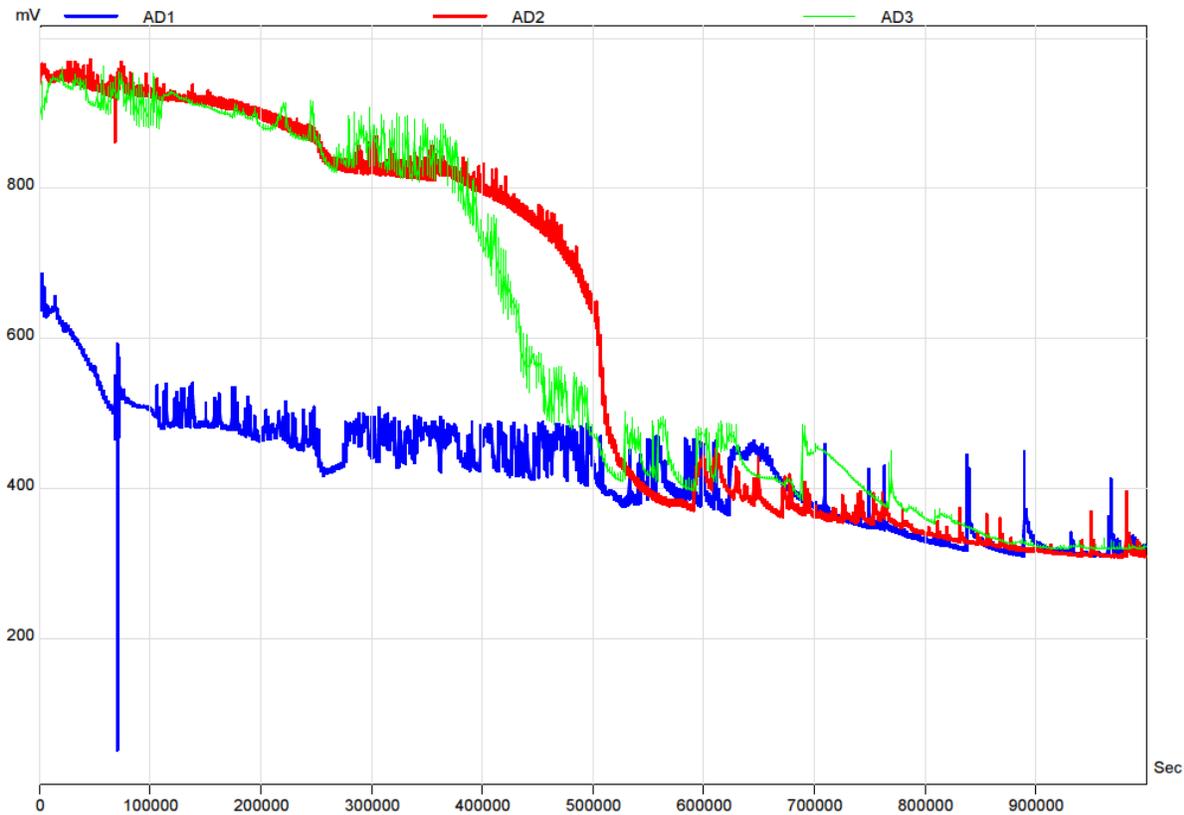
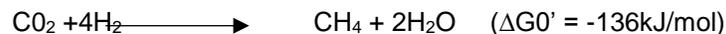


Figure 3 Potential difference (mV) of the three AD-MFC reactors in operation over a ten day period (s). The graph shows a part of the experiment, the initial voltage of the reactors was 0.9V, 0.98V and 1.2 V and by the end of the experiment 0.325 V, 0.31 V and 0.323 V respectively.

Discussion

Microorganisms capable of producing methane are classified in three groups depending on the molecule they use as electrons donor, the fuel molecule can be hydrogen, methyl or acetate, the most common group of methanogens are those using hydrogen as fuel. Given that the fuel provided has a limited amount of hydrogen a competition for this molecule between the MFC and the methanogens would have been expected, however, hydrogen and methane values appear similar at the end of the AD process.



The similar values of biogas produced in terms of volume and composition show that the integration of our MFC in the AD had no significant effect and that it would be feasible to produce electricity and gas simultaneously without one affecting the other. This lack of an evident impact in the performance of the AD reactor could be explained by: the small size of the electrodes when compared to the total volume of the reactor, the fact that the MFCs were one chamber MFCs and therefore the electrons did not abandoned the reactor. And because an open circuit voltage set up was used with no resistance between the electrodes. A new set up with a larger electrode surface area per volume of reactor needs to be performed, graphite brush electrodes have been shown to be more efficient when compared to graphite rods (used in this experiment) or graphite felt¹³. Different types of ceramic materials have been tested as electrode materials, the use of non-expensive ceramic materials could further reduce the cost of constructing electrodes with extensive surface area¹⁴.

The initial voltage within the MFCs of around 1.2 V (similar to those obtained using an aerobic cathode). The decrease in potential difference could be linked to the decrease of oxygen availability and the use of other substances as final electron acceptors¹⁵.

Conclusions:

More work needs to be done in order to understand the interactions between the AD reactors and the MFCs a larger anode surface area, an external resistance and a separated cathode chamber need to be used to assess the impact that a MFC has over the biogas production in an AD reactor. Moreover, glucose needs to be compared with other feedstocks, in order to assess the effect of the MFC over the digestibility of organic matter which has an effect over biogas production. Although more work needs to be done, results so far indicate that the presence of the MFC does not stop biogas production and that it is possible to combine the production of electricity and biogas.

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29. Improving Management of Container Based Sanitation Systems in Urban Off-Grid Living and Working Environments

E. Mackinnon¹, I. Soumpasis², N. Sawant², L. Ciric¹, P. Parikh¹, L. C. Campos¹,

¹ Department of Civil, Environmental and Geomatic Engineering, UCL, Gower Street, London WC1E 6BT, United Kingdom;

² Unilever Safety and Environmental Assurance Centre (SEAC), Colworth Science Park, Sharnbrook, MK44 1LQ, United Kingdom

Keywords: urban; sustainable; container based sanitation; public health risks; exposure risk factors; faecal waste management; waste-to-value; resource; circular economy.

Abstract

Introduction

In the last decade significant advancements have been occurring in the space of sanitation. The container based sanitation (CBS) system reflects innovative approaches to urban and onsite sanitation management. CBS is a waterless system (source separated but not uniquely) that collects and aggregates faecal and urine waste from several individuals for various waste processing modalities (Tilmans et al. 2016). The CBS system (figure 1) optimizes the value of the waste as a resource by adopting circular economy waste treatment business models.

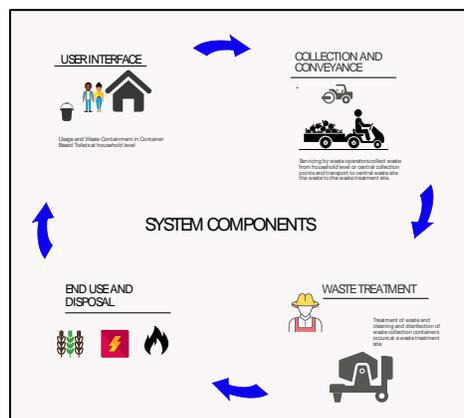


Figure 4: Container Based Sanitation System

Developing risk management frameworks which addresses the key risks related to microbial hazards in faecal waste is necessary to support sustainable scale up and commercial viability of this technology. Although the focus is traditionally in using this technology in the global south to address the 'sanitation crisis', the waste to value concept is increasingly popular in Western contexts (e.g. boats, music festivals). Container based sanitation seems an attractive technology for high density urban areas where pit latrines or conventional sewers may not be adequate e.g. slums, and for emergencies such as refugees and internally displaced person (IDP) camps. However, understanding the current scale and use of CBS systems in urban off-grid environments in developed context may inform international policy.

Research Aim and Objective

The aim of this study is to evaluate the current state of the CBS system service chain in London. The work explores CBS usage and operation on canal boats who are increasingly turning to an on-board compost toilet to manage human waste, including aspects of storage, collection, conveyance, treatment and potential end use. The objective is to develop an understanding of current scale and use of CBS systems in urban off-grid environments including exposure groups and associated exposure risks.

Research Outcomes

1. The scale of the CBS service chain and the system components encountered in London
2. A set of hazardous exposure events, pathways and evaluated overall exposure risks
3. The critical control points and control measures to mitigate exposure risks
4. The social and technical mechanisms that are factors associated with exposure risk in CBS service chain
5. Recommendations of potential viable end use that can be yielded from human waste by-product from CBS systems in developed country scenarios.

Methodology

Based on the theoretical perspective of research, the researcher to consider the human dimensions of exposure risk defined as an “assembly of characteristics and attitudes in organisations and individuals” and is “attitudinal as well as structural” referring to non-tangible aspects of risk and safety culture.(Hurst 1998).

The overall methodological approach is based on the Sanitation Safety Plan (SSP) Framework (WHO 2016) and Participatory Rapid Sanitation System Assessment (PRSSA) (Campos et al. 2015).

To deliver outcome 1

- An online structured survey using the web based service “survey monkey” will target canal boat owners to describe and quantify the current types of CBS technology and processes on boats, as well as a structured “attitude” survey concerning public health risks.

To deliver outcome 2 and 3

The SSP framework comprising four steps of system mapping, hazard analysis, exposure assessment and risk management will be applied using the following methods for data collection:

- Qualitative data collection methods including Participatory Focus Groups Discussions (FGDs), key informant interviews (KIIs) and preliminary workshops of key stakeholders in the CBS will inform system mapping, identification of hazardous events and exposure pathways.
- Qualitative risk ranking of the likelihood of exposure events will be determined using a risk matrix and participatory risk ranking exercises and inform the exposure assessment.
- Structured surveys can support exposure assessment.
- Secondary health data will contribute to the exposure assessment and hazard analysis.
- Quantitative data collection and relevant sources includes the Facebook forum “canal boats and off grid living group”. Transcripts from this forum space will be analysed to elucidate information pertaining to exposure assessment and risk factors.

To deliver outcome 4

- A relevant literature review will inform indicators for visual risk survey. Exposure risk factors will also be explored through the use of in depth interviews, attitude surveys of users and ‘operators’ and visual surveys developed with pre-defined risk factors boats.
- Analysis of interview and online transcripts conducted using program software (NVIVO) Coding (Conceptual and Bucket Coding).

To deliver outcome 5

- An online structured survey to describe and quantify the current types of CBS technology and processes on boats, as well as end-uses and disposal.

Potential Development Impact

The research outcomes support sustainable and resilient urban systems. The scale up and adoption of this technology is encouraged via describing typologies of hazardous and exposure risks and relevant control mechanisms for CBS systems in relevant context in urban scenarios. Moreover, adapting the SSP develops the assessment process under the SSP framework itself. Alongside this, an improved understanding of social and technical mechanisms that influences exposure risks will inform better risk management strategies, and can be compared with other CBS systems.

The research aims to evaluate the sanitation innovation around new treatment technologies and circular economy waste business models for CBS systems; currently not represented in academic literature. The waste-to-value sanitation innovations can process human by-products to yield four major types of by-product. These by-products can contribute to renewable supplies (energy, fertilizer, fuel, novel protein sources). Waste to value systems implemented at scale could reduce greenhouse gas emissions and be a source of green energy supply. Human waste can be processed to bio-fertiliser, increasingly crucial in a global economy which predicts peak phosphorous production around 2030 (Cordell et al., 2010).

Recommendations for future research and application

- Case/control studies exploring impact and role of socio-technical factors of CBS service chain, in particular different technologies and design at user interface, transport, conveyance and collection
- Cost benefit analysis of waste to value sanitation systems comparative to traditional sewered scenarios
- Integration of container based waste management with urban architecture and design to support urban waste management and urban food production

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30. Human Waste Management, Storage and Disposal in Nigeria: Implications to Residential Apartments in Ikeja, Lagos

Bolawole F. Ogunbodede¹

¹University of Lagos, Nigeria.

Keywords: Human waste, Storage and Disposal, Residential Apartment.

Abstract

Human waste is as important to mankind as life itself. Human faeces and urine are products of every living being. As people feed for survival, the process of digestion leads to the production of human waste. With human wastes generation put at 123.6grams of faeces per day, and Lagos being a Mega city with a population of more than fifteen million, the human waste generated can be viewed as significant. How the generated human waste is handled vis-à-vis the design and placement of structures, and the available infrastructure for storage and transportation of this waste is worthy of assessment. This paper examines the methods through which human wastes are collected and disposed in Ikeja. It also assesses placement of septic tanks in residential quarters. The case study has the three classified residential zones of high density, medium density and low density. Sample frame was based on the number of buildings. Questionnaires were administered on the basis of one person per building, with streets randomly selected within a radius of less than 1 kilometre. Findings through field work and analysis of questionnaires reveal that, residents across the density zones rely basically on septic tanks for human waste storage, which from time to time requires self-sponsored evacuation. Access to water is also through privately sunk bore-holes and wells. The respondents are not exposed to educative programmes on sustainability, though they have the knowledge of environmental sustainability. It is recommended that septic tanks and soakaways be kept at appropriate distances to boreholes and wells, to prevent water contamination. Government agencies are meant to provide a viable central sewage system and adequate access to portable water, failure of which water borne diseases become rampant.

31. Urban-Rural Interactions and Surface Water Management in Xochimilco, Mexico City

Garcia Alba Garciadiego¹

¹ UCL, United Kingdom.

Keywords: Xochimilco, UNESCO, Urban surface water, Management Plan, urbanization.

Abstract

Session aim & learning objective

Mexico City's water system is increasingly complex, yet it shows a poor surface water management. Mexico City imports and exports water from outside its watershed, raising concerns about the efficiency of water services provided to its population. Still, the existing surface water within the city is neglected as there are few or any management plans. Despite the fact that this city is located in what it used to be a group of lakes, now only a small portion of surface water remains in the south of the city, which is under high risk of disappearing in the near future.

Aquatic systems and a series of garden islands, known as chinampas, can be found in in the Xochimilco and Tlahuac municipalities. These areas provide a unique environment for the city as biodiversity hubs, while the chinampas, reminiscences of the ancient form of agriculture, provide a considerable amount of food the capital city. However, this site suffers from several problems, such as lack of water, subsidence, and water pollution, as a result of historical decisions. Still, this area is very important for the city because its agriculture character and its historic and cultural value, and it is included in the UNESCO World Heritage List, within the historic centre of Mexico City.

This area is in danger of disappearing as it is continuously affected by uncontrolled urban sprawl that grows over the agriculture land and water channels. Many projects have been implemented in order to save this World Heritage site, but they have failed to achieve a sustainable solution. Even the UNESCO sponsored Project for Xochimilco (PUX), which comprised a group to specialists to create a Management Plan in 2004-2006, has failed to be implemented. Hence, this paper aims to answer:

- Why do these urban projects fail to achieve a solution?
- Why was the Management Plan not implemented, even when it was supported by an international agency?
- Is it possible to learn from previous project experiences in order to achieve successful ones in the future?

Outline of workshop content and format

The reason that the PUX project was chosen as a case study is that it involved the participation of UNESCO, the municipal government, and other agencies, and it elaborated methods to induce long-term results, like public participation (local communities and experts) and the creation of an independent administration body to coordinate all the agencies related to the site. Despite all efforts to create a framework that overcomes political time barriers, this project was not implemented once a new ward major started to govern. Hence, this paper analyses from the Transition Theory perspective, the case of the UNESCO Project in Xochimilco (PUX).

In order to recreate the story of the UNESCO Project in Xochimilco (PUX), three forms qualitative information was gathered and compared, in order to achieve reliability and replicability: interviews, academic papers, and archives. First, 17 semi-structure in-depth interviews were performed with participants who were highly involved with the project, four members of the community, three politicians,

three academics, six members of the UNESCO team and a member of ICOMOS—the agency in charge to report the UNESCO about the heritage site condition. One politician and the ICOMOS member were not involved during the PUX design phase, yet they are currently active members of their respective agencies and they were quite informed about what was the project about. The academic papers and newspapers are used to study the context of this project and delimitate the regime and the landscape.

Future application of outcomes

Xochimilco and its surrounding heritage area cannot be understood from a single point of view. This area was comprised of a series of historical decisions that created a very complex area, while many ongoing processes continue to modify the area. Even though some projects aim to provide an integral solution, they miss allocating all the factors that influence the project itself from a contextual reality. The failure to implement the UNESCO's Management Plan shows highly uncoordinated government agencies, especially from one electoral cycle to another. Still, the community remembers this project with some enthusiasm as they felt empowered during their participation.

Most of the participants claimed that the lack of government will is what is undermining the projects, while most of them deny having any kind of trust in the authority to provide a solution for the degrading environment. On the other hand, even with political desire to maintain the aquatic system, it seems that the municipalities' political structure are not able to support environmental conservation practices. "Xochimilco is overstudied" as one of the participants claim. I would like to add to that observation, it is also over intervened, as there were implemented big projects as the 1989 Xochimilco's Ecological Park, and small projects as current chinampas ground re-posting. Still, urban intervention projects tend to be diminished because of the lack of coordination among governmental agencies while the area is degrading in a considerable rapid pace.

Workshops

1 Urban world 2050: exploring policy research needs to realise the ‘urban opportunity’

Amy Kirbyshire¹, Rebecca Nadin¹

¹ Overseas Development Institute, United Kingdom.

Keywords: Urban, Resilience, Policy

Abstract

In a rapidly urbanising world, there is an important opportunity to lock-in a more resilient urban future. In this workshop participants will discuss opportunities and inroads for research to maximise influence on policy and processes in support of this goal.

2. Community Partnerships for Green Infrastructure in London

Sarah Bell¹

¹CEGE/Engineering Exchange, UCL, United Kingdom.

Keywords: Collaborative, communities, STEM, green infrastructure.

Abstract

Session aim, including learning objective

The workshop will present key outcomes from the NERC-funded project 'Community Partnerships for Green Infrastructure in London' which will run January – April 2017. Led by the Engineering Exchange at UCL and working in partnership with Energy Garden, Just Space, and the London Sustainability Exchange (LSx), the project will deliver a series of outputs to support broader community engagement with Green Infrastructure research and policy in London.

Session attendees will gain a better understanding of some of the challenges and initiatives for implementing green infrastructure in London, which – depending on the project's research outcomes – could include parks, gardens, street trees, wetlands, green roofs, green walls, rain gardens, green belts and a range of other ecological measures to improve environmental quality. Attendees will also receive examples of methods for community research partnerships.

Outline of workshop content and format

The session will comprise an introduction to the state of current research on green infrastructure as a means of improving air quality and other wellbeing metrics in cities from Sarah Bell, Director of the Engineering Exchange, and other UCL academics involved in the project. This will be followed by community partners talking about their projects, which will come out of a community research forum to be held 28th Feb. We will also show a series of short (3-minute) videos with a range of individuals outlining relevant current green infrastructure issues related to their area of expertise. Finally, we will present findings from our report synthesising current scientific evidence and identifying evidence gaps relating to the costs, benefits and risks of GI in London, for a community-based audience.

Future application of outcomes

Green Infrastructure is an important policy area in London's planning (including the Mayor's London Plan and the GLA's Sustainable Drainage Plan), and community groups and citizens interested in, for example, urban air quality or flooding will find it beneficial to better understand the issues in order to be able to more effectively engage with the latest scientific evidence. The workshop will be an opportunity to increase understanding of this critical current issue for urban development while widening the research impact.

3. Living Well Together? Exploring Social Relationships in Sustainable and Resilient Communities

Saffron B Woodcraft¹, Nikolay Mintchev¹, Nicola Bacon², Constance Smith¹

¹UCL, United Kingdom; ²Social Life, United Kingdom.

Keywords: Collaborative, communities, STEM, green infrastructure.

Abstract

The importance of social inclusion and cohesion and the quality of social relations in cities has once again come to the fore in light of Brexit, the growth of far-right populism in Europe and Trump's promise to Americans that "You're not forgotten anymore"⁴. Sustainable Development Goal 11 - *Make cities inclusive, safe, resilient and sustainable* - recognises that creating opportunities for inclusion and participation in job markets, education and health systems, social and civic life, and urban governance are as essential to the prosperity and sustainability of cities as addressing ecological and resource use challenges.

UCL's Institute for Global Prosperity proposes a panel to examine what it means to live well together in the city. The panel will feature research and practitioner papers that focus on the nature of social relationships in supporting sustainable and resilient communities. We submit this proposal under the USAR theme - Achieving both sustainable and resilient cities. The panel will feature five 15-minute papers (abstracts below) followed by a panel discussion. An invitation to chair the panel has been extended by IGP to Ben Rogers, Director of the Centre for London. If accepted, the panel will require a room with a computer and projector for visual presentations.

Paper 1: What is the good life in East London? Examining links between inclusive change and sustainable and resilient places

East London is undergoing rapid social, economic and physical changes associated with the Olympic legacy and wider processes of urban regeneration. This paper draws on original qualitative data - collected in 2015/16 - to explore what a sustainable and prosperous community means to people living and working in three neighbourhoods around the Olympic Park. Residents' accounts of 'the good life' describe the symbolic and social value of local relationships and how people connect 'a sense of community' to local notions of prosperity. Yet the research identifies how the pace of change is putting a 'sense of community' under pressure and generating uncertainty and anxiety about the future. We compare the aspirations of SDG 11 with the tensions our interviewees recount between people wanting change and improvements in quality of life, yet feeling that current models of property-led urban regeneration are undermining social inclusion and community cohesion.

Paper 2: Sustainable community relations and the imagination at work

Robust and resilient community life is a central aspect of urban sustainability and the opportunities for flourishing that cities offer to their residents. One of the standard ways of measuring the quality of communities is through the concept of social capital, which in turn is defined as trust in others and/or civic engagement. However, this narrow approach to measuring the quality of community relations obscures the importance of the way in which people imagine and represent the community that they live in. Drawing on

⁴ From Donald Trump's speech at the Lincoln Memorial on the eve of his inauguration, January 19 2017.

original interview data from the London Borough of Newham, this paper argues that for Newham residents there are two local communities which exist simultaneously, but which are imagined as fundamentally different – one is resilient and cohesive, while the other is fragile and fragmented.

Paper 3: What can we do to build social relationships as well as homes?

The importance of good social relations among people living in local neighbourhoods is well recognised, contributing to wellbeing, reducing fear of crime and helping build local resilience. But creating relationships between people from different backgrounds is in practice more difficult than encouraging those who already have a lot in common to get to know each other. Social Life works with councils, community organisations and property developers and this paper will explore what we have learnt about working with different stakeholders involving in shaping the built environment about what can help residents get to know people they might not usually meet, building Robert Putnam’s “bridging social capital” and what gets in the way.

Paper 4: Sensory notation toolkit - evaluating the social impact of urban interventions

Measuring the environmental sustainability or energy efficiency of cities is now relatively straightforward, but evaluating the social and personal wellbeing impacts of the built environment is more difficult. If we agree that community integration and social cohesion are crucial to achieving sustainable and resilient urban systems, then it becomes imperative to understand how such social relations and behaviours are influenced by the built world around us. This presentation will present a new toolkit for use by councils, planners, architects and communities themselves. It enables users to record and reflect on the sensory impact of different urban spaces, from parks to bus stations to streetscapes. This participatory tool can be integrated into monitoring and evaluation frameworks to assess user experience of urban spaces and to systematically record the relationships between the built environment and social and psychological wellbeing.

Paper 5:

This paper will be given by either Lucia Caistor-Arendar, Associate at Architecture San Frontières (ASF), or a speaker from the New Economics Foundation (NEF), about practical work with communities to build local resilience through grassroots initiatives. Lucia works on the Resilience by Design Programme. Lucia will talk about her work on grassroots community resilience initiatives in Portugal and Colombia. NEF runs several research and practice projects examining links between local economic development and community resilience.

4. What Will You Do When the Lights Go Out? Multimodal Infrastructure Resilience to Black Sky Hazards Workshop

Benjamin James Axelsen¹ , Geoff Darch¹ , Anthony Concannon¹ , Janvi Shah¹

¹Atkins, United Kingdom.

Keywords: Resilience, Black Sky Hazards, Risk Based Asset Management, Cascading Failures, Infrastructure

Abstract

Session Aim

To develop the dialogue about infrastructure resilience requirements to cascading failures resulting from black sky hazards.

Learning Outcomes

- To enhance understanding of black sky hazards and the challenges associated with cascading failures that they present to cities and infrastructure
- To provide an appreciation of the range of guidance and best practice available relating to infrastructure resilience
- To provide opportunity for shared understanding and discussion on current levels of multi-modal and cascading failure infrastructure resilience
- To facilitate shared discussions focussed on identifying resilience based solutions that can be utilised to enhance multi-modal preparedness to black sky hazards

Outline Workshop Content & Format

Black Sky Hazards are described as an emerging, natural and malicious national scale hazards that could cause long duration power outages over large regions, with associated cascading failures of all lifeline infrastructure⁵.

The workshop will be delivered by colleagues from Atkins that are currently involved in researching and developing innovative solutions to infrastructure risk and resilience. This workshop is aimed at colleagues from both industry and academia with a focus on utilities, energy, telecommunications, financial services, transport, urban planning, national and local government.

In the globalised world that we live in which is becoming increasingly interconnected we are also becoming progressively vulnerable to local, national or even international shocks that disrupt access to power. With increased dependency on electricity to sustain daily life, for example the current trajectory towards future developments into Connected Autonomous Vehicles (CAV), it won't be long before we are living in a science fiction world.

In the midst of technological development and innovation we need to ensure that we embed resilience at the heart of this advancement. It is important that we not only identify lessons from historic incidents and capture new knowledge from experts but that we actually implement that understanding to retrofit resilience where required and ensure in future resilience is designed into projects from the outset. With the vast array of opportunities for discussion and collaboration, now more than ever we should be facilitating this conversation to ensure that plans don't only aim to win awards for design but facilitate continued enhancements in safety and productivity in daily life.

⁵ Black Sky Infrastructure Risk and Resilience Workshop, UK Collaboratorium for Research in Infrastructure and Cities (UKCRIC), London, 2016.

The workshop will focus on the guidance provided in the Cabinet Office 'Keeping the Country Running'⁶ regarding the 4 R's of resilience:

- Resistance
- Reliability
- Redundancy
- Response and Recovery

The workshop will detail the range of cascading impacts to infrastructure that we can expect from major natural and malicious threats to understand where we need to focus our future development and how we can better connect resilience across sectors. The 4Rs then not only enable us to better define and review what we need to consider when developing independent infrastructure resilience, but also define the journey we should be taking to establish interconnected infrastructure resilience.

The workshop's aim will highlight how resilience should be an essential benchmark within infrastructure and cities; utilising the Asset Management lifecycle from concept design, build and life of infrastructure through to its retirement for a new solution. We understand that resilience can be and is often cut from development or build stages of projects due to funding challenges and that this can transfer through the life of the asset presenting a challenge to justify asset maintenance or even organisational resilience to support the asset.

We understand that this is a key challenge facing many organisations not only across the UK but also around the world and is only going to increase. We therefore propose that there is a need for a risk based approach to infrastructure resilience that supports organisations in better understanding the interconnected risks it faces and prioritising funding to maximise multi-modal resilience within the resources available.

Whilst no organisation will ever be "resilient" it is a journey that we need to continue on not only independently but across our infrastructure sectors. Developing understanding and utilisation of risk based resilience will ensure we give ourselves the best possible chance of surviving or responding to the crisis to return to a "new normal" as quickly as possible.

Format

The workshop format will be divided into three main sections:

1. Workshop Introduction
An overview of black sky hazards and infrastructure resilience to understand the challenges and opportunities available for developing infrastructure resilience.
2. Scenario Based Discussion
Provision of a range of scenarios to facilitate discussion about current resilience solutions in place for known risks and identification of areas for future joined up working to embed resilience.
3. Identification of Key Learning and Recommendations
Opportunity to share key themes and learning points raised within the discussion that can be taken forwards

Future Application of Outcomes

There are a number of proposed outcomes associated with the workshop:

- The workshop will be used to inform the ongoing work within Atkins to better understand the risks and impacts associated with infrastructure and the types of resilience solutions required.
- The workshop findings will be published as a white paper to provide a knowledge base for academia and industry.

⁶ Cabinet Office (2011) Keeping the Country Running: Natural Hazards and Infrastructure.

- The workshop will be used to facilitate bringing together a group of stakeholders that can better understand the issues associated with Black Sky Hazards and Multi-Modal Infrastructure Resilience to take it back to enhance either academic or industry applications.
- The workshop will provide academics and industry the opportunity to develop multi-modal networks to enhance understanding and future opportunities for collective working on infrastructure resilience.

Posters

(Wednesday 14th June 2017, 13:45-15:00)

1. Solar Home Systems (SHSs) as Viable, Clean Energy Access Options for Off-Grid and ‘Under the Grid’ Populations: a Case Study of Rwanda.

Iwona Bisaga¹

¹ UCL, United Kingdom.

Keywords: Solar Home Systems, alternative energy access, off-grid energy, Rwanda.

Abstract

Modern energy services are essential for countries’ socio-economic development and for human well-being. They are also necessary for the provision of other services, including water and sanitation, healthcare, mechanical power, agriculture, education and telecommunications. However, despite the important role energy plays in ensuring everyday basic needs are met, 1.2 billion people (or 17% of global population) currently live without access to electricity and further 2.7 billion lack improved cooking facilities (SE4All, 2015). Sub-Saharan Africa and Asia are home to over 95% of those with no access to electricity.

The urgency of the situation has contributed to increased efforts in addressing the energy poverty challenge in the last few years. The role of decentralised energy solutions in reaching universal access has gained recognition both from the private and public sectors, offering a more cost- and time-effective option than extending grid connections for providing access not only to rural populations where the demand and willingness to pay tend to be lower, but also to city dwellers living ‘under the grid’ who cannot afford to connect to the national network or are unable to do so due to their land status (Hirmer and Cruickshank, 2014; Bhattacharyya, 2013; Batchelor et al., 2014).

In the fast growing market of decentralised energy systems, stand-alone PV Solar Home Systems (SHSs) and solar lamps are among modern solutions which have quickly grown in numbers across the developing world, substituting expensive and inefficient sources like candles and kerosene used to power homes and businesses (Scott and Miller, 2016; Chaurey et al., 2012; Lighting Africa, 2011). These non-renewable sources can cost African families as much as \$70 – 110 USD per year and it is estimated that on average low-income Africans spend between \$13.2 – 17.3 billion USD on these fuels annually (Energy Map, 2016). Due to a sharp fall in PV technology prices (up to 50% in the last few years), solar energy has become an attractive and affordable option for off-grid and ‘under the grid’ populations (Halder and Parvez, 2015; Friebe et al., 2013).

This research shows how off-grid solar solutions are a viable green infrastructure option for urban and peri-urban populations. It demonstrates how they can either replace unreliable grid connections, compliment them and be used as a back up, or provide first time access, all in a clean, reliable manner. Users’ attitudes and motivations are discussed, and needs and aspirations regarding grid access are looked at in order to better understand whether such solutions are perceived, and have the potential, to be implemented long-term. Based on empirical research conducted between June-November 2016, evidence shows that majority of users, based on their experience, see SHSs as a permanent and reliable solution for their energy access, despite having relatively little understanding of solar energy (how it works etc.).

2. The Air Travel Experiences of Wheelchair Users

Andrew Philip Davies¹, Nicola Christie¹

¹UCL, United Kingdom.

Keywords: disability, flying, access, manual handling, wheelchair

Abstract

Air travel has grown steadily in the region of 5-6% every year since 1970 meaning that in the UK alone, over 600,000 people use flying as a means of transport every day. Disability rates are also increasing in the UK, with nearly 13 million people having one. Air travel for the mobility impaired has been relatively unexplored, this study aimed to fill that gap by exploring the experiences of severely disabled flight passengers and recommend service improvements. This study used qualitative semi-structured interviews with eight participants. Key findings showed notable issues with the manual handling of people with disabilities, including the equipment used in this process and accessing the toilet on the aircraft. Recommendations included developing consistency, further disability training and a review of the equipment involved.

Introduction

The World Health Organisation (WHO) states that there are over a billion people with a disability, equating to just over 15% of the world's total population (2011). It has been estimated that 30% of a population will have access requirements at any point in time, and most people will have a disability at some stage during their life (Darcy & Dickson 2009). Accessibility is largely related to those with disabilities, however, as a broader concept it should be thought of being something that benefits or applies to everybody. The aviation industry is a truly global industry and travelling by air has never been more popular. Global air travel growth rates have been in the order of 5–6% per year in the period 1970–2000; air transport volume is now five times as large as it was in 1970 (Gössling & Peeters 2007). More people are travelling by air than ever before, whether they have a physical condition or not.

Methodology

Qualitative Research Design

The research was devised using three approaches of qualitative research; narrative research, phenomenology and ethnography (Creswell 2012). A harmony of these three elements was chosen as narrative research is collecting data as a story, phenomenology is the study of human experiences whilst ethnography is the study of people or cultures to try and understand their values or beliefs. O'Day & Killeen showed this method is recommended for studying disabled groups because there is more to understanding the needs of the people with disabilities than a health issue interacting with an environment (2002).

Participant Recruitment

Participants were recruited through contacts of the author and expanded by snowball sampling, designed to result in a homogeneous sample as the research centred around participants being full time wheelchair users who have flown recently. Participants were approached to participate by means of an email and were offered the chance to withdraw at any time. Eight participants agreed to offer their experiences of air travel in a semi structured interview.

Topic Guide

A semi-structured topic guide was formulated into three sections: 'Individual Characteristics' that obtained basic data about the participant whilst allowing time for interviewer and participant to build a rapport whilst establishing that they were suitable to participate in the study. 'Travel Characteristics' which aimed to

establish frequencies and to gauge whether class or haulage had an impact on the disabled traveller's experience. 'The Journey' was the main aspect of the study and was divided into subsections: Booking air travel; Getting to the airport; Checking in; Security; Shopping, restaurants and duty free; Getting to the gate; Boarding the plane; On board the plane; Disembarking and Overall experiences of flying. The topic guide concluded with the opportunity for participants to suggest service improvements to the aviation industry and whether they would like to comment on or add any other thoughts and opinions they had.

Interview Analysis

The interviews were analysed using thematic analysis. The transcripts were manually coded into themes and subthemes within the framework of the topic guide manually. Whilst software was available for thematic analysis, a manual approach was taken as the author conducted all of the interviews and was familiar with the central themes occurring throughout. Another experienced researcher also coded a transcript to ensure consistency.

Results

Individual Characteristics

Three females and five males took part with the age range from 24 to 69. The average age of a participant was 48.00 years old. Two of the participants were disabled from birth, whereas the other six had acquired their disability, five of them describing themselves as having tetraplegia (a loss of function in all limbs) and one as paraplegic (a loss of function in two limbs, normally the legs) (NHS Choices 2016). The average length of disability was 34.31 years including those born with disability and 23.08 years amongst participants with acquired disabilities. Half of the participants described themselves as using a manual wheelchair and the other half use a powered wheelchair; in addition, four of the participants have the need for a full time personal assistant.

| Participant | Age | Gender | Length of Disability | Disability Type | Personal Assistant | Chair Type |
|--------------------|------------|---------------|-----------------------------|------------------------|---------------------------|-------------------|
| A | 69 | Male | 69 Years | From Birth | No | Powered |
| B | 36 | Male | 18 Years | Tetraplegia | Yes | Powered |
| C | 45 | Female | 14 Years | Tetraplegia | Yes | Powered |
| D | 53 | Male | 40 Years | Paraplegia | No | Manual |
| E | 30 | Female | 20 Years | Tetraplegia | Yes | Manual |
| F | 67 | Male | 67 Years | From Birth | No | Manual |
| G | 60 | Male | 40 Years | Tetraplegia | Yes | Powered |
| H | 24 | Female | 6.5 Years | Tetraplegia | No | Manual |

Table 1 Participant Characteristics

Boarding the Plane

Several participants drew attention to a preference of being boarded first, allowing them extra time to get seated comfortably without experiencing embarrassment and humiliation in front of other passengers. Participants felt that poor communication by the staff or lack of organisation led to physical and emotional distress:

‘... because there is a lack of communication, no one holds the boarding of the rest of the passengers to wait for you to get on, which is just really embarrassing and humiliating. But no one wants to be stared at while they are just trying to get on a plane, to transfer into a seat, so that is all pretty horrific.’ [Participant H, Female, 24, Manual Wheelchair User]

Manual Handling Issues

Manual handling takes place from the door of the aircraft or the scissor lift to the seat, which had caused physical pain to some participants who have felt that this was the worst experience of flying:

‘They have to lift me into an aisle chair and then take me down the aisle in this chair then lift you across three seats so you’re at the window seat, two people lifting, and it’s caused me a lot of pain and problems. It’s the worst part.’ [Participant C, Female, 45, Powered Wheelchair User]

‘... then they manhandle me then they get me down through the aircraft up the aisle, and they manhandle me into my seat, lifting again, which is incredibly painful, and that is what happens.’ [Participant G, Male, 60, Powered Wheelchair User]

Equipment Issues

In addition to widely reported poor manual handling by the staff, participants reported issues with the equipment that the staff had to use, in particular the aisle trolley and arm rests on the aircraft. The aisle trolley was described as being small, uncomfortable and having poor support from the straps. Some armrests were described as being fixed on some aircraft, which added another level of complication:

‘Yeah, I mean, actually getting onto the plane, you transfer onto a very, very small chair now. You know, I’m not exactly huge myself, I’m only about five foot tall, and how somebody bigger than me copes I’m amazed because I find it... The chair is tiny, you know, it’s very often not padded and it opens you up to all kinds of sort of cuts, bruises or sores or whatever just getting onto this little chair.’ [Participant D, Male, 53, Manual Wheelchair User]

Feelings about Boarding

Participants were asked how they felt when boarding the plane and a large range of emotions and feelings were described including vulnerability, humiliation, stress, anxiousness and physical pain:

‘Horrible. Painful, crying sometimes, almost crying, incredible pain. I feel beaten up, I feel horrible.’ [Participant G, Male, 60, Powered Wheelchair User]

‘... I feel most of the times I have boarded a plane I have felt a bit embarrassed, a bit humiliated, and I have been angry at people for that.’ [Participant H, Female, 24, Manual Wheelchair User]

On Board the Plane

Following the procedure of boarding the aircraft, participants were asked to describe experiences associated with being on board the aircraft including going to the toilet and whether they had any problems at certain points in the flight.

Accessing the Toilet

One of the biggest issues that wheelchair users faced whilst travelling by air is going to the toilet. Participants overwhelmingly stated that they had never even tried going to the toilet as they felt it was an impossible task:

'These are real issues. And that's one of the reasons I don't fly more. It's a personal hygiene issue, it's nothing to do with flying here ... the wheelchair accessible toilets on some flights are not accessible to me because I cannot get into them and I need to be lifted into one of these other chairs again' [Participant A, Male, 69, Powered Wheelchair User]

Strategies to Avoid Using the Toilet

Due to a lack of accessible toilets on aircraft, some participants reported methods they used to avoid using the toilet including fasting and catheterisation:

'... If I go on a long haul flight, I have to use an internal catheter, because I just know there is just no way I can get into the toilet. I would just not drink beforehand, and kind of risk it in a way. Yes, which does make me kind of anxious about the flight, I am going to the toilet every ten minutes up towards ... before we are boarding, because I am conscious that I can't go on the plane.' [Participant E, Female, 30, Manual Wheelchair User]

Discussion

The study has explored the experiences of people travelling as a wheelchair user by aircraft and revealed many negative experiences interspersed with some positive ones as can be seen in the Figure below:



Figure 1 Quick Referral Guide of the Flight Journey with Positives and Negatives

The results obtained through the qualitative research concurred with previous research whose results showed that wheelchair users reported the boarding procedures with being able to go on first and come off last being an advantageous in giving them more time to do what they need to do without the feeling of being pressured by others, however the majority of physical barriers occurred when boarding and leaving the plane as staff were reported as not always knowing how to appropriately manually handle wheelchair users in and out of their seats and that a combination of the arm rest not always being able to be lowered and poor manual handling can cause severe pain as well as pressure sores. The on board experience of flying was where emotional differences were found because going to the toilet was the biggest problem as getting to the toilet meant using the aisle trolley, which is not suitable for the toilet on board. As a consequence of being unable to go to the toilet, previous studies reported the use of catheters, diapers and fasting in advance of flying. This study included a variety of wheelchair users from different geographical areas of England with varied sociodemographic characteristics, including different causes of being in a wheelchair. Whilst relevant to the British population, there could be cultural differences between other countries although this is proving more unlikely given the results identified in previous studies in different countries (Chang & Chen 2010; Chang & Chen 2011; Poria et al. 2010; Saari 2015)

Recommendations to the Aviation Industry and Potential Impact

The experience of boarding the aircraft was regarded as being a negative experience, and the following recommendations are suggested to make it easier for the wheelchair user:

Standardising Procedures

- There is too much confusion between the airlines about where wheelchair users should sit and although from a safety perspective sitting next to the window makes sense, it is impractical for the manual handling team if they have to lift over three seats.
 - The airlines should collaborate to agree upon a preferred seating choice for wheelchair users.
 - Upgrade them to a business class seat if they are unsold as those seats are larger and offer a greater degree of flexibility in terms of seat manipulation.
- Staff need to enforce the policy that wheelchair users should board the plane first and return the wheelchair to the door of the aircraft during disembarkation.
 - Staff need to be trained to take greater care and have a greater understanding of the humiliation and embarrassment that is experienced by wheelchair users boarding the aircraft.
 - Airports should provide specialist disability teams so that the procedure of boarding and disembarking the aircraft is standardised across all UK airports.
- A set of standardised guidelines should be co-produced with wheelchair users so that the procedures are streamlined and consistent.

Toilet Issues

- Access to the toilet on aircraft or a perceived lack of access to it needs to be addressed by the industry as a whole and should be considered in the design of new aircraft and in particular long haul aircraft.

Manual Handling and Equipment

- Equipment used to aid wheelchair users on and off the aircraft should meet certain standards:
 - The seat should be padded and/or have pressure relieving qualities so it is comfortable.
 - The seat should be engineered to enable it to be adjusted to match the height of a wheelchair or the seats on the plane.
- New methods of manual handling need to be investigated as an alternative to manual lifting such as the Eagle 2, which is a medical grade hoist that allows people with reduced mobility to be taken

on and off the plane with the assistance of two people using limited physical manual handling (Haycomp 2016).

The interventions suggested should be implemented to remove the struggles that wheelchair users encounter whilst travelling by air.

Implications for Future Research

There is scope for further research in this field. It is vital to establish the difficulties the aviation industry has aiding wheelchair users to understand both groups issues so that the best possible solution can be found. Observational research should be carried out to establish the strengths and weaknesses of staff that help those with disabilities in real time. To overcome the toilet issues, a series of laboratory experiments or computer aided modelling should be investigated in collaboration with wheelchair users. Ultimately, it is crucial to do further research in all aspects of disability air travel as very little has been carried out to date.

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3. Application of Risk Perception Theory for City Resilience: A Case Study of Newcastle, UK

Maiko Ebisudani¹

¹Newcastle University, United Kingdom.

Keywords: city resilience, risk management, risk perception, sustainability

Abstract

In order to further develop a more holistic conceptualization of resilience, multidisciplinary approaches are considered necessary. With regard to the definition of resilience, it is generally stated as a system's ability to respond and recover from disturbances (Fisher et al., 2010), but different research disciplines have considered this from slightly different perspectives. Holling (1996) originally defined resilience in two ways, namely, engineering and ecological resilience. While engineering resilience is the more traditional of the two and focuses on recovery and constancy, ecological resilience focuses on system persistence and robustness to disturbance. Essentially, engineering resilience aims to maintain the efficiency of a function, whereas ecological resilience focuses on maintaining the existence of a function. These two contrasting approaches are fundamental paradigms of resilience (Holling, 1996). As the world faces more and more uncertain and interacting risks (Davoudi et al., 2012), it is desirable to pursue the dynamic challenge of integrating both paradigms to strengthen communities' capacity to manage resilience. Therefore, this study redefines resilience as a community's ability to cope with the multiple risks that it might face.

Ebisudani and Tokai (2016) have developed a measurement framework for city resilience by demonstrating the application of the theory of risk perception. It utilizes risk characteristics studied by Slovic (1987) in order to organize multiple risks. The first application of this framework was customized for Suita City in the Osaka Prefecture of Japan. The framework provided evidence that multiple risks can be prioritized, and also gives overall suggestions to local policy planners: what kinds of risks a community is facing; and where to start considering how to manage resilience. In order to test and develop the framework further, the proposed study is customized for the city of Newcastle, UK for comparative analysis. Thus, the specific objectives involved are to (1) identify multiple risks for the selected study area by reviewing literature and holding discussions with local experts and public workers; (2) prioritize risks using principal component analysis (PCA) in conjunction with the experts' perceptions [these two steps are based on Slovic's theory of risk perception (1987)]; and (3) capture the causal relationships among risks by applying the decision-making trial and evaluation laboratory (DEMATEL) analysis technique.

As a result, 12 risks were identified, and subsequently, PCA analysis prioritized the risks. Lastly, the application of DEMATEL analysis revealed the greatest cause-effect relationships among the risks. The framework proves that multiple risks can be prioritized and gives overall suggestions of what kinds of risk a community is facing; where to start considering how to manage resilience; and which functions/services a community should improve to boost resilience. The identification, prioritization, and visualization of significant risk relationships completed in this study can support decision-making processes in strengthening community resilience. The development of this framework will be able to help understand the procedure for building community resilience in order to improve existing regulations and strategies.

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4. Re-growing the Kathmandu Valley: research methodology

Amara Roca Iglesias¹

¹Architecture of Rapid Change and Scarce Resources, London Metropolitan University, United Kingdom.

Keywords: Urban agriculture, Renaturing cities, Civic engagement, Research methodology, Kathmandu

Abstract

Introduction to the setting

Rapid urbanisation has transformed the Kathmandu Valley into one of the fastest-growing metropolitan regions in South Asia. The Valley is an urban assemblage anchored on a core city surrounded by suburban areas and satellite cities and towns whose economies are becoming highly integrated (Muzzini and Aparicio, 2013).

The Kathmandu Valley farming community, known collectively as Jyapu (Bharat, 2011), have traditionally supplied the city market with much of its fresh vegetables but the loss of fertile farmland to residential and commercial uses has impaired their ability to feed the current valley population (Haack and Rafter, 2006).

As Toffin (2013) states the steady urbanisation of the Kathmandu Valley has had a considerably negative impact, producing traffic congestion, atmospheric pollution, and a total collapse of the former fragile ecological equilibrium between the city and its territory. The urban development pattern in the Valley is environmentally unsustainable (Muzzini and Aparicio, 2013).

Hypothesis

Despite constant changes in the physical and cultural landscape of the Valley there are still plots of land available within the city core areas, such as the Bagmati riverbanks, that could be used for urban farming. As they have farming knowledge and time (high unemployment rate) urban migrants living near these riverside plots already cultivate some land here and they could do more, becoming a key resource for food production in the urban zones.

If development is seen, as argued by Sen (1999), as a process of expanding the real freedoms that people enjoy, with appropriate institutional arrangements, the activity of urban agriculture could also be a way of fostering civic engagement by residents (including landless citizens) providing access to wider opportunities available within the city, strengthening, for example, individual capabilities, initiatives and skills

Research question

Could the physical and institutional topography of the Valley be adapted and transformed to include more productive urban landscapes within its current physical and cultural topography and thereby contribute to the making of the city?

Methodology

Physical and cultural surveys, open interviews and small-scale interventions were used to record the thoughts and stories of local residents, enabling them to inform the architectural speculations (developed during a MA by Project, 2014-2016). This bottom-up and hands on approach, combined with top-down conversations (with public authorities and academics) to find out which are the constraints and limitations for these proposals to flourish, led to the identification of 6 latent live projects related to urban horticulture during my 3rd field trip (1st as PhD student) in November 2016. The live projects are understood as research methods and will be the scenarios to test ideas, encounter resistances, make accommodations, validate proposals and extrapolate conclusions. In addition, as a way of understanding the farming practices existing within the Valley, I collected productive landscapes to analyse for developing a more focused line

of enquiry for future field trips. This poster presents the research methodology I have developed to collect data for proposing a new balance between urbanisation and nature in the Kathmandu Valley.

5. Multi-Hazard Vulnerability Assessment of School Infrastructure – the case of Cagayan de Oro, Philippines

Arash Nassirpour¹, Carmine Galasso¹, Dina D'Ayala¹

¹UCL, United Kingdom.

Keywords: Multi-Hazards, Vulnerability Assessment, Rapid Visual Survey, School Infrastructure, Philippines

Abstract

The Philippines is one of the most hazard-prone countries in the world. It is regularly subject to various hazard-events, inflicting loss of lives and costly damage to the country's infrastructure. In particular, the Philippines straddles a region of complex tectonics, exposing the country to large and damaging earthquakes. For example, the most recent earthquake, the M 7.2 Bohol earthquake (2013), damaged more than 73,000 structures, of which more than 14,500 were totally destroyed, including several schools. According to UNICEF, 275,855 school children were affected by the earthquake. Similarly, several areas characterized by high wind and heavy rain exist along the northeast Philippine Sea coast. In 1991, a flash flood killed around 8,000 people and destroyed many structures in Leyte Island. Furthermore, Typhoon Haiyan (2013) was one of the strongest tropical cyclones ever recorded, which devastated several portions of the country, killing at least 6,300 people and damaging 3,171 schools. The recent history of reported damage and destruction indicates the substantial vulnerability of the country's infrastructure, particularly schools, to different forms of natural hazards.

Schools play a critical role in the education of the next generation and one of the most vulnerable part of the society due to their age and their developmental stage. A safer school can save valuable lives of children, provide a safe haven for the local community, serve as a temporary shelter and help to bring normalcy back to society in times of disaster. Taking into consideration the high probability of occurrence for any type of natural hazard in the Philippines, vulnerability of the school buildings should be of high priority for the governmental authorities and first responders. Considering the large number of existing school infrastructure and their geographical distribution, appropriate tools and approaches are required to address the prevailing vulnerabilities of Philippine's school infrastructure.

The main aim of this study is to develop a methodology for a rapid yet reliable visual vulnerability assessment of school infrastructures against the most common natural hazards of the Philippines. As part of this objective, a rapid visual survey form is proposed. In addition, a mobile application has been developed to assist the surveyors for assessing the school building in a more efficient way. Furthermore, a preliminary investigation is conducted on 115 schools, in the city of Cagayan de Oro to relate the collected data to vulnerability indices to swiftly determine the safety level of the considered buildings. Cagayan de Oro is a highly urbanized first class city with over 602,000 citizens and multi-hazard profile of earthquakes, floods, cyclones, tsunamis, among others. The city has established a full-time unit in charge of disaster preparedness, response, recovery and mitigation.

The proposed method represents a first step toward a detailed multi-hazard vulnerability assessment of school infrastructure. This can allow decision-makers to quickly identify the most vulnerable structures among the surveyed stock, guide more detailed data collection and structural assessment procedures, and ultimately plan further rehabilitation measure or if necessary replacement.

6. Assessing Building Response to Flooding and Climate Change: Developing Multi-Sensor Moisture Measurement Methodologies

Scott Allan Orr¹

¹University of Oxford, United Kingdom.

Keywords: flooding, non-destructive techniques, surveying, building materials, traditional construction

Abstract

Urban infrastructure is at risk from increased severity of natural disasters, such as flooding, and more frequent and intense weather events. Materials such as brick, stone, mortar and concrete are present in buildings spanning the gamut of architectural history. Due to their porous nature, most processes affecting their strength, appearance, and hygrothermal properties are caused—or supported—by water. Diagnosing patterns and time scales of moisture movement following natural disasters or intense weather events is imperative to characterising a building's resilience to a changing climate and informing sustainable maintenance. Current non-destructive technologies that infer moisture contents from physical properties cannot accurately identify levels of moisture at depth over time. This project addresses this gap through a multi-sensor approach to moisture monitoring. Specifically, by employing microwave field moisture sensors, infrared thermography, and high-frequency radar to monitor drying patterns of building façades following a period of intense wetting. This approach capitalises on the unique spatial scales and resolutions of commercial devices while compensating for fundamental limitations of the techniques. To produce useful output that informs management decisions, data fusion algorithms are explored that streamline information into a single output.

Of specific interest is developing in situ techniques that are adaptable to complex building scenarios that incorporate a range of materials: for example, the assessment of mortar performance in traditional masonry constructions. Although radar is typically used to investigate sub-surface features and material interfaces, this work demonstrates the novel technique of feature identification in localised traces to identify surface moisture at a high spatial resolution. This can be combined with grids of multi-depth microwave moisture measurements to elucidate moisture movement through masonry systems – something that most stand-alone techniques smooth over.

Developing robust moisture monitoring methodologies that can diagnose patterns and time scales at various depths is a fundamental component of informing sustainability and resilience in the face of an uncertain and rapidly changing climate.

7. AfriCity – Adaptability, Food Security, Risk, and the Right to the City in Sub-Saharan Africa: Towards Sustainable Livelihoods and Green Infrastructure

Alexandra Titz¹, Fred Krüger¹

¹FAU University of Erlangen-Nürnberg University, DE.

Keywords: Just city, resilient and resourceful city, green infrastructure, sustainable livelihoods, Sub-Sahara Africa

Abstract

In the wake of rapid social and economic transformation, peri-urban and urban dwellers in eastern and southern Africa are experiencing hitherto unprecedented challenges. The combined effects of escalating demand for land, services and housing and a dwindling availability of spaces with sufficient access to safe food, water, income and mobility opportunities are producing a multitude of detached or fragmented urban quarters and of lifeworlds marked by uncertainty, insecurity, vulnerability and unsustainability. Attempts to capture 'the city' by means of urban governance have so far been mostly either spatially or socially selective, ineffective or non-existent due to a lack of institutional capacities and resources.

Enabling citizens to better adapt to new and increasing challenges is closely linked to them being able to pro-actively shaping their own urban lifeworlds, and adopting and appropriating public and green spaces in the city. These linkages between social and environmental change, green urban infrastructure, and an inclusive, resilient and resourceful city have so far largely been neglected in urban studies and geographical development studies. The urban context of Sub-Sahara Africa has almost entirely been ignored in this regard.

The poster explains the three thematic dimensions which form the core concepts of the AfriCity research project:

- 'Just city' and 'right to the city' approaches.
- Resilient cities – a notion which we are not at all happy with though, as cities cannot be resilient, really. It is citizens, if at all. We prefer to talk of resourceful cities and will briefly outline this in the poster.
- Adequate and equitable green infrastructure, reaching beyond more conventional concepts of 'infrastructure' and including ideas of inclusive and sustainable cities.

The AfriCity project explores the causes and effects of environmental change and resource use in Sub-Saharan African cities, considering rapid social and economic transformation processes and their external and internal drivers, and assesses the barriers for potentials of social adaptability in the context of risk, resilience and resourcefulness. The project examines new concepts of sustaining urban livelihoods through the lens of rights-based concepts and 'green urban infrastructure': It will pick up on these important debates and carefully study the potentials of green urban infrastructure for equity, ownership, livelihood sustainability, and just, inclusive and resourceful cities in sub-Sahara Africa (with case studies in Malawi, South Africa and Tanzania). The project intends to contribute to a better understanding of the ambiguous, and often conflicting, articulations in shaping the just city in the Global South, and in eastern and southern Africa in particular.

8. Affordable housing and climate change: An interdisciplinary focus

Andrew Jack Venning¹

¹University of the Sunshine Coast, Australia.

Keywords: compact city, vulnerability, meaning, law

Abstract

Research objectives and methodology

Climate change presents challenges for the provision of affordable housing in South East Queensland (SEQ) that is exacerbated by rapid population growth, increasing wealth inequity and ageing population (ABS 2014, LGAQ 2013). However, in compact residential developments, planners, decision makers and legislators are bound to a stationarity assessment that neglects climate change vulnerability. To understand this research problem, three research questions were posed: RQ1; What are the objectives of Queensland affordable housing (QAH)? RQ2; What is the relative climate change vulnerability of the QAH cohort and the extent of constraints on QAH objectives in light of that vulnerability? RQ3; How may legal instruments enhance QAH objectives and restrain climate change vulnerability? This study embraced an interdisciplinary lens that encapsulated natural science, social science and law (e.g. climate change science, built environment science and planning law). The thesis adopted a research paradigm that is structured with an interpretivist theoretical perspective, multiple realities, knowledge construction and a multi-method praxis with a comparative case study as the primary method. The comparative case study comprised three built environment developments in SEQ, namely: 1) Halcyon Landing (20 hectare site, elderly community); 2) Caloundra South (2310 hectare site, a compact city) and 3) Fitzgibbon Chase (122 hectare site, a diverse community). Data was collected through secondary sources and field visits, and includes statutory and policy documents, QAH based study projects and court cases that are explored and interrogated through document, thematic, text and statutory analyses.

The research design is not structured on positivism but is formulated on philosophical assumptions that allows legitimate and creative transdisciplinary, qualitative research, which brings a breadth of findings, albeit with a reduced depth of findings. The author claims it is not methodological anarchy but merely within the accepted research scholarship, where validity is replaced by credibility, reproducibility replaced by transferability and objectivity replaced by confirmability.

Objectives of comparative case study

To illustrate regardless of scale, contemporary compact built environments in SEQ are far from immune to climate change vulnerability and therefore, the QAH cohort will experience uncomfortable burdens both in their magnitude and manifestations in light of that vulnerability. To ameliorate QAH cohort vulnerability requires the utility of a successfully tested three step inquiry and assessment, legal model, coupled to a non-stationarity assessment, to design two legal mechanisms. These two legal mechanisms with their prescriptive measures are framed to the Queensland statutory planning regimen. The Queensland planning regimen is an ideal vehicle that is far superior to QAH planning policy alone for implementing adaptation measures that remove or at least minimise climate change vulnerability for the QAH cohort. The legal system has a strong framework to establish principles to affect the necessary legislative reforms for the formulation and implementation of adaptation strategies to protect the rights of the disadvantaged (McDonald 2011, Craig 2010).

Outcomes of comparative case study

Outcome of RQ1

The response involved an analysis of housing affordability projects funded by Australian governments, State and local government policy, international policy documents, and a key descriptor construct for each of the three built environments, in conjunction with concepts, theory of built environment science and research scholarship. The revealed eight QAH objectives are: *safety; security; choice; access; wellbeing; inclusion; liveability* and *affordable* that are consistent with international and domestic notions of affordable housing.

Outcome of RQ2

The analysis for this response was performed through a comparative, integrated vulnerability assessment based on an analysis of a climate change vulnerability framework that has three determinants of exposure, sensitivity and a five capitals, adaptive capacity. The findings from this analysis showed that whilst the QAH cohort have a diminished financial capital, shared experiences and common norms improves social capital and offsets their climate change sensitivity. Supported by this analysis is the determination for the extent of constraints on QAH objectives, which form the foundational basis for a non-stationarity assessment. It is an invitation for the role of law supported by a legal model (as discussed above), which is the response to RQ3.

Outcome of RQ3

Utilising a three step inquiry and assessment, legal model that is informed by a non-stationarity assessment, two legal mechanisms are designed; one mechanism to enhance QAH objectives and the second, to restrain climate change vulnerability in the residential phase of the built environment. The first legal mechanism is formulated with two prescriptive measures: i) QAH objectives are framed as physical manifestations of congruence affordances (physical entities that are representative of QAH objectives) in the statutory Local Planning Schemes and ii) embedding eleven policy components from the SEQ Regional Plan 2009- 2031 in the Queensland State Regulatory Provisions and the Object clause provision of the *Sustainable Planning Act 2009* (Qld). The second legal mechanism grasps the prescriptive measure of facilitative regulation that frames physical object, procedures and implementation processes as statutory provisions in the *Body Corporate and Community Management Act 1997* (Qld).

In addition, further research findings suggested that community inter-tensions, which arise between individual communities' quotidian external activities are diminished by an engineered greenspace network and with diminishing inter-tensions comes an improved social capital for communities in the QAH cohort.

Potential development impact

The contribution of knowledge from this research is the connection of the natural and social sciences to better understand the concept of affordable housing within a climate change context. In addition, this research demonstrated that the role of law implemented through two legal mechanisms for the Queensland planning regimen, enhances housing affordability objectives by reducing climate change vulnerability in compact, low-income built environment communities.

Recommendations for future research and application

Building on the research findings in this thesis and continuing with a similar transdisciplinary approach in light of climate change vulnerability, a study could be established that has a distinct focus on the three forms of bonding, bridging and linking in social capital based on one local government jurisdiction and a single community. This approach could provide further knowledge with a greater depth of findings on the social and physical links between built environments, a single community and advance the theory of law, including other common law jurisdictions such as UK, USA, Canada, NZ and India.

Exploring and examining through a transdisciplinary window of interpretivism, absent of strict ontological and epistemological stances may not be one of methodological rigour but presents a landscape of

opportunity for future innovative research and a breadth of findings. This thesis establishes a research platform for more general applications to urban and built environments other than dealing with anthropogenic effects of climate change and vulnerability.

Other studies could migrate from this transdisciplinary approach and not include the discipline of law but continue with the social and natural science disciplines to build on the knowledge of this study's findings between neighbourhood communities and the built environment. Future research need not necessarily be tied to the interdisciplinary climate change research and the built environment but is transferable to Human Geography studies, where place describes space and with a recognition of an interconnection to law (Bartel et al. 2013).

Law and justice are two distinct, intertwined entities, from which studies could be created that explores the utilitarian benefit and anthropogenic exploitation of an environment through interventionist reforms. This type of study could also explore the social and wealth inequities that are more apparent in contemporary Australia and the USA where regional areas are experiencing diminishing employment, an influx of low socioeconomic groups, coupled with an ageing population growth.

9. A Critical Review on the Improvement of Neighbourhood Sustainability Assessment Frameworks

Qi Zhang¹, Esther Hiu Kwan Yung¹, Edwin Hon Wan Chan¹

¹The Hong Kong Polytechnic University, HK.

Keywords: Neighbourhood, Neighbourhood Sustainability Assessment, Improvement, Sustainability, China

Abstract

To optimize the Neighbourhood Sustainability Assessment (NSA) framework, frequent version updates were done in most countries which aim to improve local sustainability by evaluating the neighbourhood development. However, a number of these updated frameworks were still recently criticized for underperforming in the social and institutional sustainability, limited guiding effects on practical projects as well as very few corresponding mechanism for local adaptability and participation. Thus, this study firstly aims to examine the recent improvement of five NSA frameworks in the United Kingdom, Germany, Japan, the United States and Hong Kong in terms of scope coverage of the framework. It secondly aims to ascertain the barriers which hinder the improvement of local adaptability and actual guiding effects of NSA frameworks. This research mainly involves intensive literature review on the version updates, especially the frequently ignored social and institutional sustainability aspects, of selected frameworks to investigate the general and common changes of sustainability scope. It also identifies the obstacles affecting the applicability and effectiveness of NSA frameworks in an analytical way. The authors argued that the social and institutional aspects as well as local adaptability of the NSA frameworks should be given more concern if sustainable development is expected to be further facilitated with the aid of development evaluation. With this research, the few up to date literature on the improvement of NSA frameworks, especially the ones in Asia, would be enriched and another contribution to establishing the NSA framework in China by considering relative global trend and experiences could be made.