Social-Ecological-Technical systems in urban planning for a circular economy an opportunity for horizontal integration

van der Leer, Janneke; van Timmeren, Arjan; Wandl, Alexander

DOI
10.1080/00038628.2018.1505598

Publication date
2018

Document Version
Accepted author manuscript

Published in
Architectural Science Review

Citation (APA)
van der Leer, J., van Timmeren, A., & Wandl, A. (2018). Social-Ecological-Technical systems in urban planning for a circular economy: an opportunity for horizontal integration. *Architectural Science Review*, *61*(5), 298-304. https://doi.org/10.1080/00038628.2018.1505598

Social-Ecological-Technical Systems in urban planning for a Circular Economy: an opportunity for horizontal integration

Janneke van der Leer[a*], Arjan van Timmeren[b], Alexander Wandl[b]

[a]*Sweco Nederland B.V., K.P. van der Mandelelaan 41-43, 3062 MB Rotterdam, the Netherlands*

[b]*Department of Urbanism, TU Delft, Julianalaan 134, 2628 BL Delft, the Netherlands*

Corresponding Author: janneke.vanderleer@sweco.nl, +31613064319

Social-Ecological-Technical Systems in urban planning for a Circular Economy: an opportunity for horizontal integration

Abstract

The Circular Economy (CE) is receiving interest worldwide as a way to overcome the currently dominating linear and wasteful production and consumption models of our society. Currently the implementation of CE thinking into practice is still in an early stage. As the main hubs of consumption and to a more limited extent also, production, metropolitan areas often are seen as crucial to achieving a successful transition towards a CE, and therefore it is necessary to find ways to integrate a CE based approach into urban planning practice. In this paper literature dealing with the concept of the CE is reviewed within an urban planning framework to examine how well integrated it is in the built environment, both vertically and horizontally, in ideas prevalent in CE literature. The paper aims to contribute to the understanding of how the concept of CE can be integrated into urban planning practice with a view to enabling urban planners to integrate CE into their work to further accelerate the implementation of CE in metropolitan areas. In this paper a framework is presented for understanding opportunities for the integration of CE into urban planning.

Keywords: Circular Economy; urban planning; integrated approach; SETS; systemic approach; Amsterdam Metropolitan Area

Introduction

Economic growth and the depletion of natural resources are interrelated developments, because the dominant process underlying growth is a linear one, which transforms resources into waste. During this process, that stretches from mining, to producing and consuming, and then disposing, value is removed from the natural environment and the value of natural resources is reduced. From the industrial revolution onward, the impacts of this depletion has mostly been neglected. Only recently, the negative environmental effects of uninhibited, linear economic growth have caught greater public attention, caused by shocking images like the pollution of

oceans by plastic. Awareness is also fostered by the growing recognition that our linear way of producing, consuming and disposing is economically unfeasible because it relies heavily on sometimes rare, but specifically geopolitically concentrated resources. The Circular Economy (CE) is the subject of growing interest worldwide as a way of overcoming the currently dominating linear and wasteful production and consumption model of our societies.

Kirchherr at al. (2017) identified more than 114 CE definitions in their literature study, which clearly shows that the concept is on the one hand widely used, but on the other hand, ill defined. This paper is based on the understanding of CE relating to an economy based on the renewability of all resources within it including energy, materials, water, topsoil (for food production) and air, while retaining or creating value, promoting positive systemic impacts on ecology, economy and society, and preventing negative impacts. A CE accommodates resources flowing through man-made and natural systems in renewable ways, creating or retaining value through slowed, closed or narrowed loops, rather than rapidly destructing value through the creation of waste. This value can manifest itself in monetary principles as well as other social, ecological or economic principles, taking account of potential trade-offs (European Comission, 2017; Ellen MacArthur Foundation, 2013).

In recent decades CE has informed an important and significant new scientific school of thought in the field of sustainable development (Murray et al., 2015). Despite this the implementation of CE worldwide is still at an early stage of development (Ghisellini et al., 2016) while there are few studies on the concepts and practices involved (Jurgilevich et al., 2016). Typically, the CE is studied and treated as an approach to more appropriate waste management (Ghisellini et al., 2016). However, the opportunities inherent in CE thinking apply to far more than optimized waste

management practices and can be used to understand and implement new models for sustainability and wellbeing with low or no material, energy and environmental negative impacts (ibid). A comprehensive definition of CE is provided by Murray et al. (2015, p. 377): “an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being”.

To realize a CE on larger scale a radical change, or even a paradigm shift, is needed (Bonciul, 2014; Lieder and Rashid, 2016). The implementation of CE theory is challenging because of the current linear mind-set and the structures in industry and society (Lieder and Rashid, 2016) and because it requires changes in different sub-systems on various scales (Van Buren et al., 2016). Metropolitan areas often are seen as crucial to achieving the transition towards a CE (Van Timmeren, 2013; Cohen and Muñoz, 2016; Owen and Liddell, 2016) as they are the main hubs of consumption and to a more limited extent also, production, while at the same time they are the environments that are faced with potential scarcities of resources and are necessarily constrained in their infrastructural capacity (McLaren and Agyeman, 2015).

Metropolitan regions can, as with every other complex system, be described by the conceptual framework of panarchy (Gunderson et al., 1995; Gunderson and Holling, 2002; Holling et al., 2002). Gunderson and Holling (2002) use panarchy as a term to describe a concept that explains the evolving nature of complex adaptive systems. Panarchy accounts for the duality of stability and change in which complex systems of people and nature are dynamically organized and structured across scales of space and time (Allen et al., 2014). It is important to find ways to incorporate a CE based approach in urban planning practice (Owen and Liddell, 2016) in order to accommodate

resources to flow through man-made and natural systems in renewable ways while creating or retaining value.

Urban planning is an integrative discipline: it needs to integrate physical, socio-cultural infrastructure, the economy and the environment into its fabric and the planning and development process (Rotmans et al., 2000; Karvounis, 2015). According to He et al. (2011) urban planning can be defined as an interdisciplinary and comprehensive approach for a balanced regional development and physical organization of space. The aim of this paper is to identify possibilities for the integration of CE principles into urban planning.

Methodology

In order to identify how to integrate a CE approach into urban planning it is necessary to understand first the integrative dimensions of urban planning. Urban planning aims to change or manage spatial development by constructing new ideas, visions, actions, means for implementation, processes and other ways of understanding (Albrechts, 2006a, 2006b). It is an integrative discipline in which often two (organizational) dimensions are discerned: horizontal integration and vertical integration (Stead and Meijers, 2009; Holden, 2012). Horizontal integration has the aim to deepen specific knowledge (Albrechts, 2006a) and emphasizes "collaboration, coordination and the building of working relationships" (Albrechts, 2006b, p. 1158) across policy domains, local agencies and departments (Hajer and Zonneveld, 2000; Stead and Meijers, 2009). Vertical integration is related to linkages between different scale levels (Albrechts, 2006b), levels of government, like national, provincial and municipal (Hajer and Zonneveld, 2000) and different tiers of government (Stead and Meijers, 2009). Figure 1 illustrates the horizontal and vertical integration in urban planning.

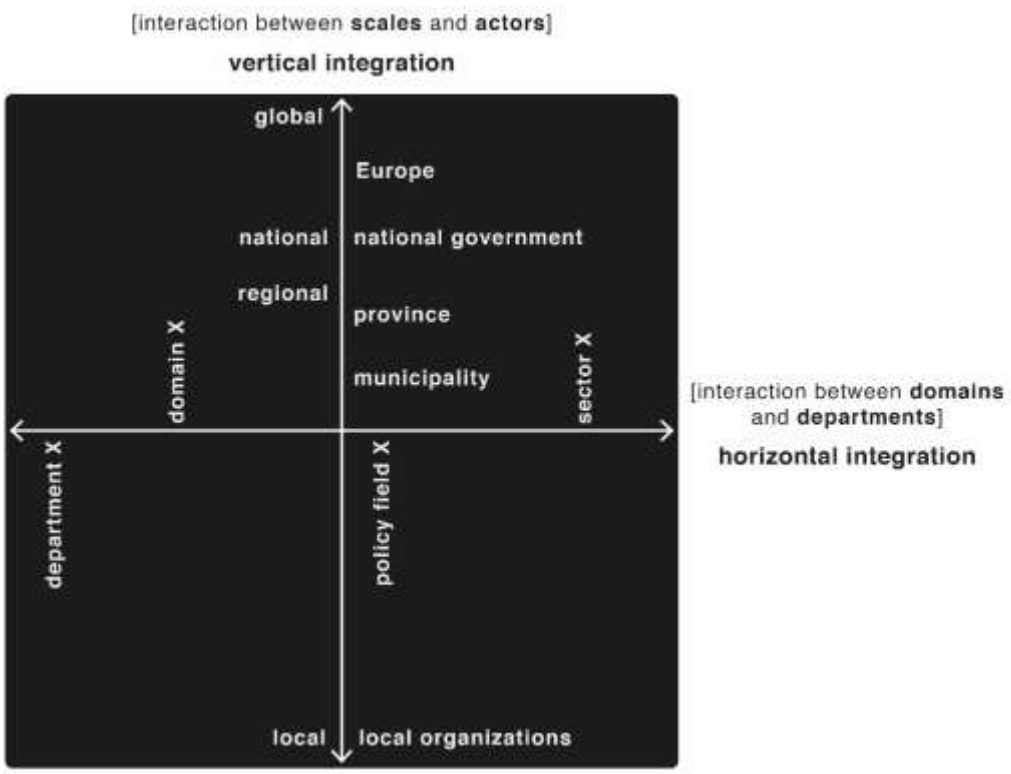

Figure 1. Integration in urban planning.

This urban planning framework is used to evaluate how the concept of CE can be integrated in urban planning, by investigating vertical and horizontal dimensions and related aspects in CE literature. Zhijun and Nailing (2007) introduced the vertical and horizontal dimension in the context of CE and stress the integration of different scale levels vertically and the integration of different sub-systems horizontally for a practical implementation of CE thinking. Based on this approach, this paper reviews the scales and approaches of CE regarding vertical integration, while for horizontal integration the sub-systems that need to be integrated are investigated. Thereafter, a framework to evaluate which aspects of integration a specific planning document might consider is presented and used to classify four existing CE urban planning documents of the Amsterdam Metropolitan Area (AMA) and its surrounding region.

Towards a framework for understanding opportunities for integration of CE in urban planning

Vertical integration of scales

CE is rooted in environmental economics and industrial ecology (Ghisellini et al., 2016). In many CE studies the concept is related to determined spatial scales and these scales are built upon known frameworks from industrial ecology (Yuan et al., 2006; Murray et al., 2015). The following three scales can be discerned regarding research in relation to CE: micro level (individual company level), meso level (eco-industrial network level) and macro level (city, municipality, province or state)(Yuan et al., 2006; Ghisellini et al., 2016).

The development of CE planning has the potential to raise awareness and creativity at a more local level, therefore, adaptive governance may be an important force in the transition to sustainable pathways in cities (Van Timmeren, 2013). A very important result of localization of CE is that the use of resources together with the problems arising from our lifestyles and consumption patterns will become more apparent and transparent to the public at large. Hence, the distance between awareness and action can be decreased. Therefore, the integration of efforts at all three scale levels is necessary for its successful implementation (Su et al., 2013). However, for material flows and systems, it is hard to determine specific scale levels. As cities are dependent on their (global) hinterland, where extraction and transformation processes take place (Barles, 2014) and for provision of resources, goods and services, it is difficult to determine which scale is specific to which flow (Weisz and Steinberger, 2010). Van Buren et al. (2016) explain that transitions not only need to take place at the regional and national scale, but also at the European and even global scale for the implementation of a successful CE. To conclude, the relevant scale to support the

development of a CE approach in urban planning depends on the resource flows and the nature of the designed interventions (Voskamp et al., 2016) and thus often multiple scales and reaches are involved.

Vertical integration of approaches

In some countries, like for instance China, the implementation of CE planning results from a top down decision making approach, while in the transition towards CE planned cities in Europe often a bottom up approach is taken (Ghisellini et al., 2016). However, for the successful implementation of CE in practice an integration of bottom up and top down approaches seems necessary (Mathews and Tan, 2011; Lieder and Rashid, 2016). It also relates to the 'Sandwich Strategy' described by Tjallingii (1996) which he asserts is necessary to provide far-reaching support of the sustainability and perhaps self-sufficiency of the various structures and infrastructures in spatial planning. His strategy distinguishes a basic layer (the users) and emphasises the importance of decentralized initiatives to solutions and environment-friendly behaviours. These decentralized initiatives are facilitated by the central government, which sets up conditions from the top-down through goal-oriented system dynamics (Van Timmeren, 2006).

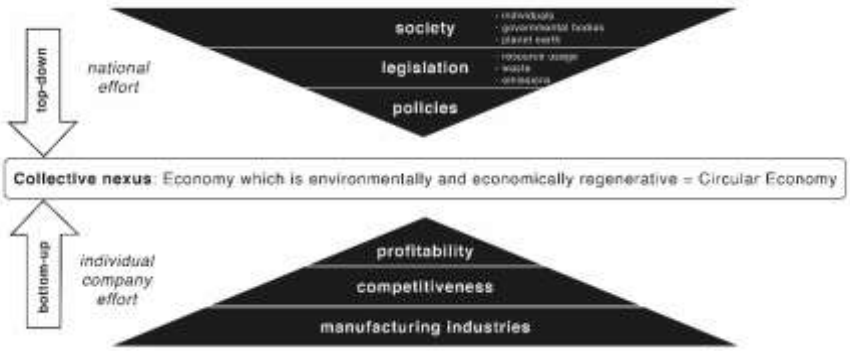

Figure 2. Proposed CE implementation strategy applying top-down and bottom-up approach, adopted from Lieder & Rashid (2016).

In the model of Lieder & Rashid (2016) seen in figure 2, a concurrent approach to implement a CE at large scales is proposed. The model is based on the assumption that "inverse motivations exist among the stakeholders of a CE which need to be aligned and converged" and is similar to the strategy by Tjallingii (1996). Lieder and Rashid (2016) see a top-down planning system as the remit of a national effort by society and governmental bodies and bottom-up activities as belonging to individuals, communities and by individual companies.

The horizontal integration of sub-systems

In recent CE literature, the integration and redesign of four sub-systems is mentioned regarding the development of CEs in cities, provinces or regions (Zhijun and Nailing, 2007; Ghisellini et al., 2016): i) the industrial system, ii) the infrastructural system, iii) the cultural framework and setting and iv) the social system. These four sub-systems together constitute a larger complex system (Dammers et al., 2014). However, Voskamp et al. (2016) suggest in line with Haken (1983) that the complexity of urban systems (related to resources) can best be described by first integrating the quantitative knowledge of resource flows into the understanding of the environmental, social and economic systems at play. Research into complex systems is often divided into socio-ecological systems and socio-technical systems. Socio-technical systems can be described as clusters of elements, like technologies, regulations, infrastructures, institutions, supply networks, markets, social practices and cultural meaning (Geels, 2005; Da Silva et al., 2012; Kern, 2012) that are constructed to be controlled (Pahl-Wostl, 2007) and that are highly institutionalized to realise societal functions (Smith et al., 2010). At the core of a socio-technical approach lie the interactions between technologies, material artefacts and human activities and actors (Mylan et al., 2016).

Socio-ecological systems can be described as human activities and associated water, energy and chemical fluxes (Ramaswami et al., 2012). Socio-ecological systems aim to integrate ecological and social sciences with a view to studying coupled human and natural systems (Liu et al., 2007). Feedback and interaction between ecosystems and humans are key in socio-ecological systems. A better understanding of the processes of human-environment interactions that affect the resource flows of cities is essential for sustainable resource management (Van Timmeren, 2006; Pahl-Wostl, 2007; Voskamp et al., 2016). As well as the suggested sub-systems in actual CE literature, concerning mainly socio-technical sub-systems, the incorporation of socio-ecological sub-systems as well, seems also relevant.

An integrative CE evaluation framework for urban planning

Based on the above ideas of the vertical and horizontal integration, a V-H CE evaluation framework is suggested for urban planning in figure 3. The framework provides an integrated multi-scale, multi-disciplinary and systemic approach in which bottom-up and top-down efforts reinforce each other. This is in line with the suggestion by Voskamp et al. (2016) that for resource-conscious urban planning a multi-scale, systemic approach is needed to provide the required information on resource flows and the interlinkages between processes and resource flows.

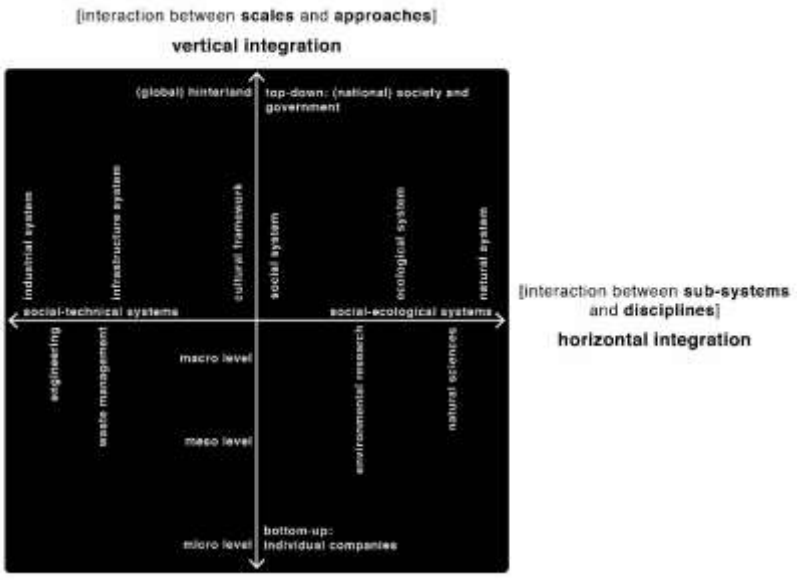

Figure 3. V-H CE evaluation framework for urban planning.

CE urban planning document analysis of the Amsterdam Metropolitan Area

In order to understand how CE focused strategies for urban planning are functioning in planning practice, four CE urban planning documents for the Amsterdam Metropolitan Area (AMA) and its surrounding region were evaluated using the V-H CE evaluation framework (see figure 4). The documents that are reviewed are:

01. Manifest: De Westas daar draait het om (Amsterdam Logistics Board, 2015),
02. Ruimtelijk-Economische Actie-Agenda 2016-2020 (Metropoolregio Amsterdam, 2016),
03. Circular Amsterdam, a vision and action agenda for the city and metropolitan area (Circle Economy, TNO, Fabric, Municipality of Amsterdam, 2016),
04. Circulair Noord-Holland, inzichten in het speelveld van de circulaire economie (Circle Economy and Province of North-Holland, 2017).

For the vertical integration of scales the documents are placed along the vertical arrow and for vertical integration of bottom-up or top-down approaches a triangle was

used in the box of the document. Horizontally the interactions between sub-systems were highlighted. The documents were analysed and key words identified in relation to the vertical and horizontal integration outlined above in CE literature, which were used to determine the position of the CE planning document in the evaluation framework.

From the analysis of the CE planning documents for the AMA and surrounding region, it becomes apparent that the vertical integration of scales is often taken into account in the documents. The meso and macro level are present in all the documents. At the same time, the integration with the (global) hinterland is often lacking in the documents. The vertical integration of top-down and bottom-up efforts are mentioned in two documents, for example through combined efforts of companies and knowledge institutions (document 02) or by industrial clusters (document 01). The other documents focus on top-down efforts only. It can be concluded that vertical integration in CE planning documents for the AMA is partly taken into account. In the horizontal dimension however, less integration is taking place. Most of the documents have a socio-technical focus and do not take the social-ecological systems or interactions into account. In document 02 and 03 some attention is devoted to ecological impacts and ecosystem services. In document 01 and 04 the focus is mainly on technical solutions related to distribution, logistics or the built environment. From figure 4 it becomes clear that the horizontal integration has not yet been sufficiently embedded in current planning documents for a CE in the AMA and surrounding region.

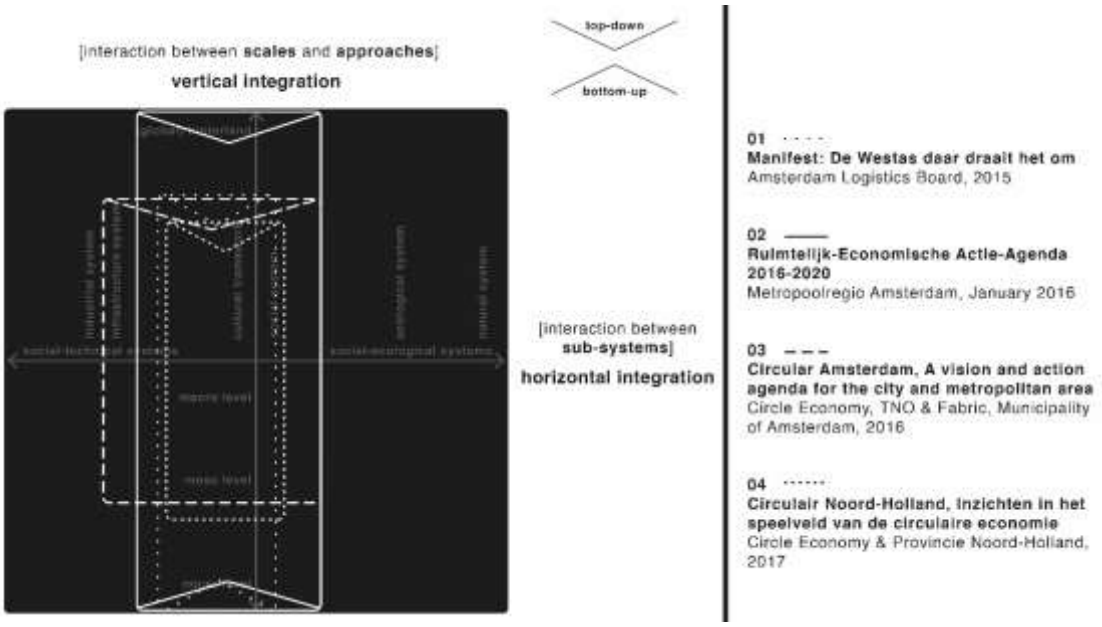

Figure 4. CE planning documents for the AMA in the C-H CE evaluation framework for urban planning.

Discussion

There is a lack of horizontal integration of sub-systems in the AMA context, and presumably in other areas as well. A next step in the development of successful CE strategies in urban planning is that the current focus on socio-technical systems of the planning documents relating to CE planning for the AMA and surrounding region needs to be integrated to a greater extent with socio-ecological principles. To analyse urban complexity Wilkingson et al. (2013) show that a socio-technical approach has been traditionally used and state that a socio-ecological approach needs to be integrated. By combining and integrating a socio-technical and a socio-ecological approach a so-called SETS (social-ecological-technical-systems) approach can be achieved, in which social, ecological and technological aspects of environmental phenomena are considered leading to a better understanding, support and management of urban ecosystems (Ramaswami et al., 2012; Groffman et al., 2016). Ramaswami et al. (2012) point out that “complex, cross-scale interactions between the natural system, the transboundary engineered infrastructures, and the multiple social actors and institutions that govern these infrastructures” are necessary for the sustainability of city systems. The main

challenge is the further development of this multidisciplinary approach, the integration of theories and methods of the engineering and design disciplines with the natural and social sciences (Groffman et al., 2016) and its implementation in urban planning practice. Our current urban systems were built upon and exist within the paradigm of waste. There are many opportunities for investment into environmental technologies to achieve a CE, such as cogeneration systems, biogas and anaerobic digesters for the purpose of harnessing essential flows of nutrients and recycling of clean water. Research into the feasibility of integrating these flows into a functioning CE within the built environment identified numerous potentially positive outcomes so long as systems are reciprocal and synergistic, building upon communities within local natural environments, in such a manner as to address issues of both horizontal and vertical integration of the systems involved. While CE planning might not solve climate change and resource scarcity, it offers opportunities for planning and design of new and existing areas based on the principle of decentralized, interconnected, polycentric circular urban systems. Not only will urban planners need to re-examine traditional political and geographic boundaries, but the scalability of solutions, infrastructure, interrelated networks and the role of public space as well.

Further research is needed to investigate how the understanding of systems can be incorporated into urban planning processes and protocols and how a SETS (social-ecological-technical-systems) approach can be taken in urban planning for a CE. In such research, the development of methods to systematically incorporate SETS into the urban planning of metropolitan areas is key.

In a resource challenged world the idea that cities are SETS is crucial in order to further accelerate the implementation of a CE, in which resources are renewable and can flow through man-made and natural systems of the city and its hinterland with

positive systemic impacts on ecology, economy and society, while preventing negative impacts.

Acknowledgements

This work was supported by the European Union's Horizon 2020 research and innovation programme under Grant Agreement no 688920. This document reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

References

Albrechts, L. (2006a) 'Bridge the Gap: From Spatial Planning to Strategic Projects', European Planning Studies, 14(10), pp. 1487–1500.

Albrechts, L. (2006b) 'Shifts in strategic spatial planning? Some evidence from Europe and Australia', Environment and Planning, 38(6), pp. 1149–1170.

Allen, C.R., Angeler, D.G., Garmestani, A.S., Gunderson, L.H. and Holling, C.S. (2014) 'Panarchy: Theory and Application', Ecosystems. Springer US, 17(4), pp. 578–589.

Barles, S. (2014) 'Urban Metabolism: Persistent Questions and Current Developments', in Ibanez, D. and Katsikis, N. (eds) New Geographies 06: Grounding Metabolism. Cambridge: Universal Wilde.

Bonciul, F. (2014) 'The European Economy: From a Linear to a Circular Economy', Romanian Journal of European Affairs, 14(4), pp. 78–91.

Cohen, B. and Muñoz, P. (2016) 'Sharing cities and sustainable consumption and production: towards an integrated framework', Journal of Cleaner Production, 134, pp. 87–97.

Dammers, E.D., Bregt, A., Edelenbos, J. and Pel, B. (2014) 'Urbanized Deltas as Complex Adaptive Systems: Implications for Planning and Design.', Built Environment, 40(2), pp. 156–168.

Da Silva, J., Kernaghan, S. and Luque, A. (2012) 'A systems approach to meeting the challenges of urban climate change', International Journal of Urban Sustainable Development, (May 2014), pp. 1–21.

Ellen MacArthur foundation (2014). 'Towards the Circular Economy: economic and business rationale for an accelerated transition'.

European Commission (2017). Towards a Circular Economy. Retrieved from: https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/towards-circular-economy_en

Geels, F.W. (2005) 'The Dynamics of Transitions in Socio-technical Systems: A Multi-level Analysis of the Transition Pathway from Horse-drawn Carriages to Automobiles (1860–1930)', Technology Analysis & Strategic Management, 17(4), pp. 445–476.

Ghisellini, P., Cialani, C. and Ulgiati, S. (2016) 'A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems', Journal of Cleaner Production. Elsevier Ltd, 114, pp. 11–32.

Groffman, P.M., Cadenasso, M.L., Cavender-Bares, J., Childers, D.L., Grimm, N.B., Grove, J.M., Hobbie, S.E., Hutyra, L.R., Darrel Jenerette, G., McPhearson, T., Pataki, D.E., Pickett, S.T.A., Pouyat, R.V., Rosi-Marshall, E. and Ruddell, B.L. (2016) 'Moving Towards a New Urban Systems Science', Ecosystems. Springer US, pp. 1–6.

Gunderson L. (2010). Ecological and human community resilience in response to natural disasters. Ecol Soc 15(2):18.

Gunderson L.H., Holling C.S., (2002). Panarchy: understanding transformations in human and natural systems. Washington, DC: Island Press.

Gunderson L.H., Light S.S., Holling C.S. (1995). Barriers and bridges to the renewal of ecosystems and institutions. New York: Columbia University Press.

Gunderson L., Allen C.R., Wardwell D. (2007). Temporal scaling in complex systems: resonant frequencies and biotic variability. In: Bissonette JA, Storch I, Eds. Temporal dimensions in landscape ecology: wildlife responses to variable resources. New York: Springer. p. 78–89.

Hajer, M. and Zonneveld, W. (2000) 'Spatial Planning in the Network Society-Rethinking the Principles of Planning in the Netherlands', European Planning Studies, (8:3), pp. 337–355.

Haken, H. (1983) Advanced Synergetics. Berlin/Heidelberg/New York: Springer Synergetics.

He, J., Bao, C.K., Shu, T.F., Yun, X.X., Jiang, D. and Brown, L. (2011) 'Framework for integration of urban planning, strategic environmental assessment and ecological planning for urban sustainability within the context of China', Environmental Impact Assessment Review. Elsevier Inc., 31(6), pp. 549–560.

Holden, M. (2012) ‘Is Integrated Planning Any More Than the Sum of Its Parts?: Considerations for Planning Sustainable Cities’, Journal of Planning Education and Research, 32(3), pp. 305–318.

Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L. and Schösler, H. (2016) ‘Transition towards circular economy in the food system’, Sustainability (Switzerland), 8(1), pp. 1–14.

Karvounis, A. (2015) ‘Urban Metabolism’, in Understanding Urban Metabolism: a Tool for Urban Planning, pp. 3–13.

Kern, F. (2012) ‘Using the multi-level perspective on socio-technical transitions to assess innovation policy’, Technological Forecasting and Social Change. Elsevier Inc., 79(2), pp. 298–310.

Lieder, M. and Rashid, A. (2016) ‘Towards circular economy implementation: A comprehensive review in context of manufacturing industry’, Journal of Cleaner Production. Elsevier Ltd, 115, pp. 36–51.

Liu, J., Dietz, T., Carpenter, S.R., Alberti, M., Folke, C., Moran, E., Pell, A.N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C.L., Schneider, S.H. and Taylor, W.W. (2007) ‘Complexity of Coupled Human and Natural Systems’, Science, 317(5844), pp. 1513–1516.

Mathews, J.A. and Tan, H. (2011) ‘Progress toward a circular economy in China: The drivers (and inhibitors) of eco-industrial initiative’, Journal of Industrial Ecology, 15(3), pp. 435–457.

McLaren, D. and Agyeman, J. (2015) Sharing Cities: A Case for Truly Smart and Sustainable Cities. MIT Press.

Murray, A., Skene, K. and Haynes, K. (2015) ‘The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context’, Journal of Business Ethics. Springer Netherlands.

Mylan, J., Holmes, H. and Paddock, J. (2016) ‘Re-Introducing Consumption to the “Circular Economy”: A Sociotechnical Analysis of Domestic Food Provisioning’, Sustainability, 8(8), p. 794.

Owen, A. and Liddell, J. (2016) ‘Implementing a Circular Economy at City Scale – a challenge for data and decision making, not technology’, in International SEEDS Conference 2016.

Pahl-Wostl, C. (2007) ‘The implications of complexity for integrated resources management’, Environmental Modelling and Software, 22(5), pp. 561–569.

Ramaswami, A., Weible, C., Main, D., Heikkila, T., Siddiki, S., Duvall, A., Pattison, A. and Bernard, M. (2012) 'A Social-Ecological-Infrastructural Systems Framework for Interdisciplinary Study of Sustainable City Systems: An Integrative Curriculum Across Seven Major Disciplines', Journal of Industrial Ecology, 16(6).

Rotmans, J., van Asselta, M. and Vellinga, P. (2000) 'An integrated planning tool for sustainable cities', Environmental Impact Assessment Review, 20(3), pp. 265–276.

Smith, A. and Stirling, A. (2010) 'The politics of socio-ecological resilience and socio-technical transitions', Ecology & Society, 15(1), pp. 1–13.

Smith, A., Voss, J.P. and Grin, J. (2010) 'Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges', Research Policy, 39(4), pp. 435–448.

Stead, D. and Meijers, E. (2009) 'Spatial Planning and Policy Integration: Concepts, Facilitators and Inhibitors', Planning Theory & Practice, 10(3), pp. 317–332.

Su, B., Heshmati, A., Geng, Y. and Yu, X. (2013) 'A review of the circular economy in China: Moving from rhetoric to implementation', Journal of Cleaner Production. Elsevier Ltd, 42, pp. 215–227.

Van Buren, N., Demmers, M., van der Heijden, R. and Witlox, F. (2016) 'Towards a circular economy: The role of Dutch logistics industries and governments', Sustainability (Switzerland), 8(7), pp. 1–17.

Van Timmeren, A. (2013) Reciprocities - a dynamic equilibrium. Delft: Sieca Repro.

Van Timmeren, A. (2006) Autonomie & Heteronomie. Delft: Eburon.

Tjallingii, S.P. (1996) Ecological conditions. Strategies and structures in environmental planning.

Voskamp, I.M., Spiller, M., Stremke, S., Bregt, A.K., Vreugdenhil, C. and Rijnaarts, H.H.M. (2016) 'Space-time information analysis for resource-conscious urban planning and design: A stakeholder based identification of urban metabolism data gaps', Resources, Conservation and Recycling. Elsevier B.V.

Weisz, H. and Steinberger, J.K. (2010) 'Reducing energy and material flows in cities', Current Opinion in Environmental Sustainability. Elsevier B.V., 2(3), pp. 185–192.

Wilkingson, C., Sendstad, M., Parnell, S. and Schewenius, M. (2013) 'Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities'.

Yuan, Z., Bi, J. and Moriguichi, Y. (2006) 'The Circular Economy: A New Development Strategy in China', 10(1–2).

Zhijun, F. and Nailing, Y. (2007) 'Putting a circular economy into practice in China', Sustainability Science, 2(1), pp. 95–101.