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# From Metropolis to Allotment: Scaled System Thinking in Advancing Landscape Studio Knowledge

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## Abstract

Current local-scale changes in the landscape interweave with larger forces of globalization, time-space compression and media proliferation altering the face of landscape, both rural and urban, around the world. These larger forces span all sectors of human activity and inform a new cultural economy of space, creating new landscape spatialities that require a reformulation of landscape definitions, as well as new conceptual models and methodological approaches for landscape design (TERKENLI 2005). Design studios are essential experiences in the education of students in architecture, landscape architecture, and urban design in order to cultivate their basic design competency. The approach used in design studio teaching is generally to present students with problems encountered in the real world – often wicked problems embedded in the interlinking land hierarchical systems in space and time which always present considerable challenges. Thus identifying and utilizing appropriate methods for design is of critical importance in design pedagogy. This paper reports on our experience in teaching landscape studios using the scaled system thinking approach, which encourages students to produce robust design strategies to address the design problem at different spatial scales from metropolis to allotment. Students' gain and loss are discussed using their studio work. Our focus is that the theoretical approach of scaled system thinking can help students systematically conceptualize and realize evidence-based design solutions that will better support sustainability and liveability in our increasingly urbanised world.

## 1 Introduction

Landscape planning and regional design starts with questions about human occupancy of places and regions around the globe. Enriched by solid grounding in professional practice and the real world, landscape planning and regional design depends on the cultures of other aligned professions such as geography, ecology, urban design and planning, real estate development, and law (NASSAUER 2006). The outcomes of landscape planning are ultimately critical to the improvement of human quality of life in an increasingly urbanised world. Therefore, understanding how the landscape and its broader context operate is a precondition for landscape planning and regional design professionals to create good design solutions to ensure liveability and sustainability (STEINITZ 2012). However, the interrelated nature of urban and natural systems at all scales is still only becoming apparent to landscape architects and to the scientific community, as the recent interest in 'biocomplexity' and 'system thinking' demonstrates (ERVIN 2014). In this paper, we describe the formu-

lation of the ‘scaled system thinking’ approach and its application in teaching postgraduate landscape studios to addresses the issues that landscape architect students (and practitioners as well) today are being increasingly challenged to better understand the complexity of the site and its context across scales – ecology, geography, hydrology, economics, politics, traffic, building systems, urban forms, and other areas of expertise before developing design solutions. In studio teaching, the scaled system thinking approach drives students to reposition relationships and tensions among all elements in land systems across several spatial scales from global, national, metropolitan level down to local and site level, which are to be considered and integrated to inform design strategies.

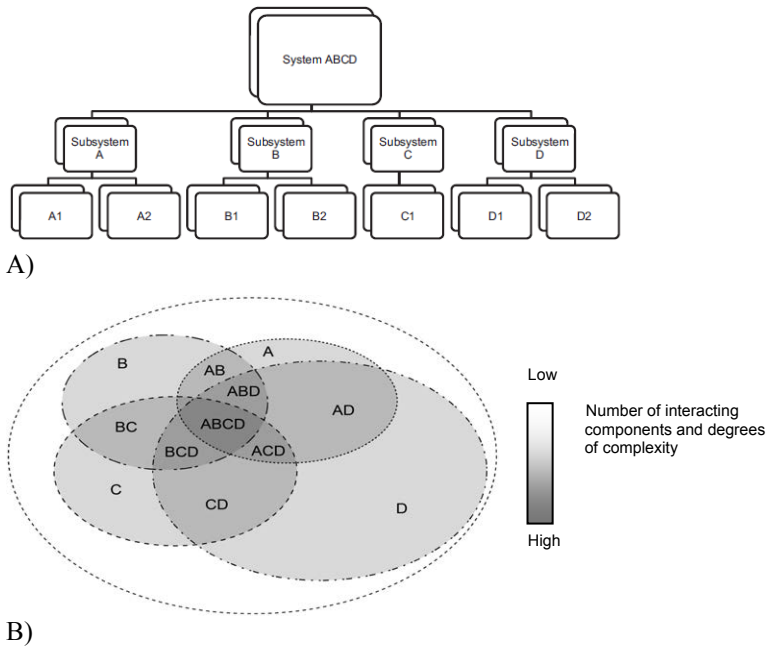
## 2 Theoretical Basis for Scaled System Thinking

The conceptualisation of scaled system thinking rests on 1) complexity, 2) system thinking, and 3) scale thinking.

### 2.1 Complexity

Complex system theory attempts to reconcile the unpredictability of non-linear dynamic systems with a sense of underlying order and structure (LEVY 2000). Landscapes are complex systems because they are characterized by a large number of diverse components, non-linear feedback loops, scale multiplicity, and spatial heterogeneity. Complexity often results from the nonlinear interactions among a large number of components which frequently lead to emergent properties, unexpected dynamics, and characteristics of self-organization and living systems (PRIGOGINE 1997, LEVIN 1999). The subject of geodesign involves investigating the spatiality of living systems, such as human societies, where land is a limited resource providing various services supporting existence. Due to the multiple nonlinear feedbacks between management, productivity, environmental quality, and human well-being, complexity is an inherent property of landscape systems.

Design students may understand the linear system or *complicated* system but typically have difficulty understanding nonlinear *complex* systems (Fig. 1) because they do not reason or structure information the way scientists or ecologists can. Scientists develop particular ways of knowing, such as the ability to perceive underlying patterns in structure and function within ecosystems, or the perception that ecosystems are dynamic and complex, having multiple causes and effects (BOEOR et al. 2001). The key to understanding landscape complexity is to understand the *interaction* focuses, for example, biocomplexity generally focuses on diverse species and the interactions among them (ERVIN 2014); ecological complexity focuses on diverse species and their interactions with their environments (GORSHKOV et al. 2004); landscape complexity focuses on the interaction of all biological, ecological, cultural, political and socioeconomic components in human societies (WANG et al. 2011). Students must recognize that the interlinked spatial and temporal landscape components play central roles in landscape production, identity and consumption.



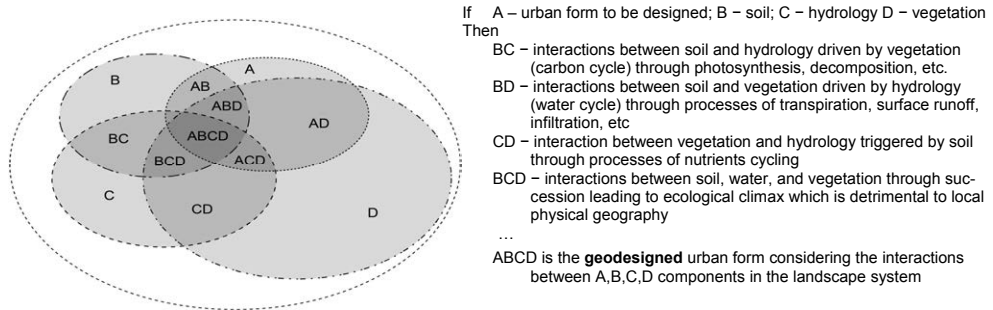
**Fig. 1:** Difference in interactions between (A) *complicated* system and (B) *complex* system (Source: WILLIAM 2002)

## 2.2 System Thinking

Within a complex system, efforts focusing on isolated problems within the larger system are of little use to decision makers. System approaches – engineering models, analysis platforms, and assessment tools predominantly targeting tightly defined engineered systems – have been applied to help landscape design and management since the 1960s (CHANG et al. 2011). For example, in biodiversity conservation planning, system approaches suggests creatively examining other land uses, near and far from reserves, as well as other plausible landscape matrix futures. This approach draws on both conservation biology and landscape planning (as well as a panoply of fields including landscape ecology, hydrology, and economics) to frame questions both broadly and plausibly (NASSAUER 2006).

For students studying landscape architecture, urban design and regional planning, it is fundamental to understand “systems” – not just the definition of the term as “a group of interacting, interrelated, or interdependent elements forming a complex whole” – but what MEADOWS (2008) has called “Thinking in Systems”. System thinking in landscape planning and design means designers and planners have to understand the intrinsic connections between habitats and the extensive matrix of human-dominated land uses, suggesting unexplored problems and potentials for landscape change, such that a change model could be proposed and its impact be evaluated (STEINITZ 2012). The interactions between basic landscape components such as soil, hydrology, and vegetation (Fig. 2) are fundamental and must be fully understood before any design solutions can be created. Geodesign must recognize the established relationships among all these interacting components in the land sys-

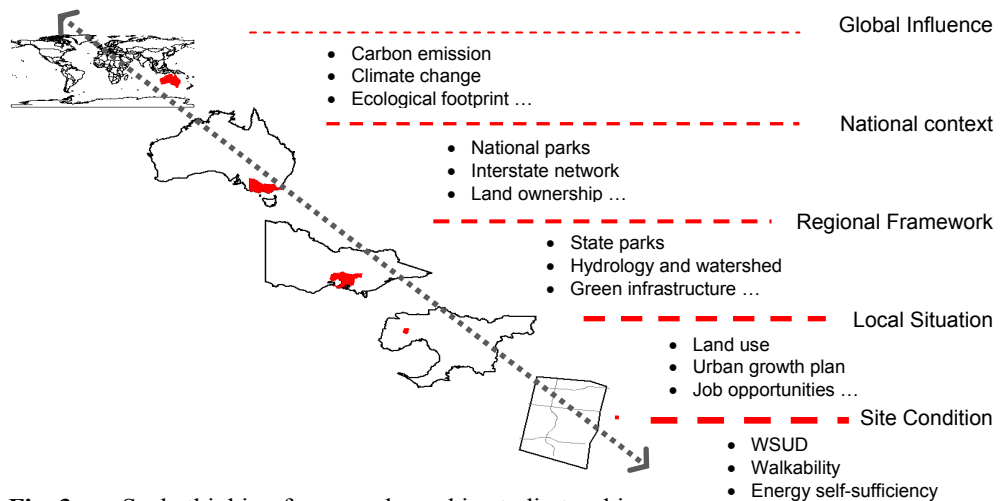
tem and seek design solutions (for example, urban form which could be component A) that would exert the least negative impact on the ongoing interactions in the landscape.



**Fig. 2:** System thinking approach to understanding interactions between different components in the landscape

### 2.3 Scale Thinking

Landscape ecological research has demonstrated the need for multi-scale analyses (TURNER 1989) that takes into consideration the scale and resolution of their inputs, and of the processes being evaluated. In landscape architecture, scale thinking examines interactions in the land system at the site level, local level, regional level, national level, and even global level (Fig. 3). Scale thinking is essential to gaining a holistic understanding of the site and its broader context. In landscape studio, design students will normally engage system thinking at a particular spatial scale as shown in Fig. 3, e.g. they understand the interacting ecological, geophysical, and socioeconomic forces that shape the production of landscape at a certain scale. However, they generally fail to recognise how these very forces are simultaneously functioning at other scales, let alone relate these cross-scale functions to gain a holistic understanding of broader interrelated landscape processes and their potential influences on the design solution.

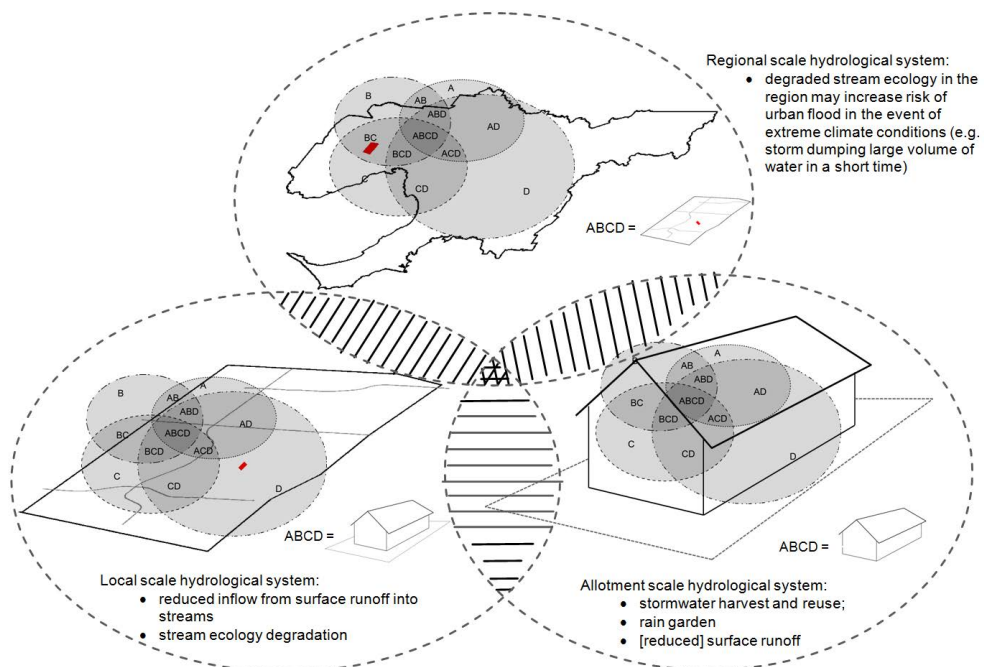


**Fig. 3:** Scale thinking framework used in studio teaching

## 2.4 Scaled System Thinking

Scale thinking is frequently perceived as a ‘linear system thinking’ approach. Before the term geodesign was coined, the regionally informed landscape planning approaches that were articulated in the 1960s renaissance by Phil Lewis, Ian McHarg and Carl Steinitz exemplify multiscalar systems thinking. These approaches integrated biogeophysical and human factors to analyze and re-envision regions as functioning ecological and cultural systems, and were widely adopted to develop plans for wildlife refuges, national parks, national and state forests, metropolitan regions, counties, and entire states or provinces (NASSAUER 2006). However, in multiscalar thinking, the dynamic linkages between different scales (which are critical to inform more holistic design solutions) are ignored, intentionally or unintentionally. Scaled system thinking approaches not only understand the relationships between landscape components at each different spatial scale, but also aspire to visualise these processes and linkages across their nested scalar hierarchy, and relate these interrelated cross-scale functions to each other to inform design solutions.

An example of water sensitive urban design (WSUD) to illustrate scaled system thinking is given in Fig. 4. Scaled system analysis models have to take a holistic perspective of all relevant design issues; but not just focus on isolated problems within the larger system; otherwise it would be of little use for decision makers to make any realistic and sustainable design and planning decisions.



**Fig. 4:** Scaled system thinking approach as applied to WSUD. Shaded areas are linkages of interactions between hydrological systems of different spatial and temporal scales. In this sense, scaled system thinking is an approach to address system of system thinking across scales.

In short, scaled system thinking is a “system of multiscale system thinking” approach; where system thinking and scale thinking are embedded. System thinking is used to address interactions within a landscape system at one scale. Scale thinking is used to address these interactions at each level of their nested scalar hierarchy. While recognizing system thinking works at the system of each individual scale, scale thinking typically ignores the linkages between different scales of system thinking. The scaled system approach aspires to engage performative geodesign by focusing on the linkages between multiscale systems.

### 3 Teaching Scaled System Thinking in Landscape Studios

At the University of Melbourne, the delivery of what can be broadly described as geodesign teaching occurs over the 2 year of the Master’s program in two sequenced design studios. These studios nominated as *Speculations* (Studio 3) and *Strategies* (Studio 4) seek to introduce students to both broad regional and urban scale and to local design detail scale through a variety of digital platforms and tools.

#### 3.1 The Landscape Studios at the University of Melbourne

The *Speculations* Studio requires landscape architecture students to imagine critical issues for design strategies and concepts in international places that they are unfamiliar with. Based upon a studio premise which describes the intersection of ecological and social issues and landscape events, participants are encouraged to find an urban environment anywhere across the globe according to a perceived need for landscape intervention. Over the past years studio frameworks have included; Water landscapes for coasts and catchments, redemptive landscapes, productive landscapes, and urbanism. The primary challenge is to approach given urban situations in unfamiliar environments selected and devised by the student group primarily through accessing readily available digital mapping and global positioning systems. They quickly begin to understand that it is possible to access a wide variety of research, documentation and data on the landscape dynamics of their chosen cities and indeed search into extensive site details. The sequencing of the *Speculations* Studio overview approach is regarded as a valuable precursor to the *Strategies* studio where such knowledge based upon a range of published mapping techniques supports the more intensive instruction in GIS and more readily recognised geodesign approaches and tools. We suggest that conceptual geodesign teaching can utilise a variety of sources from the general to the specific.

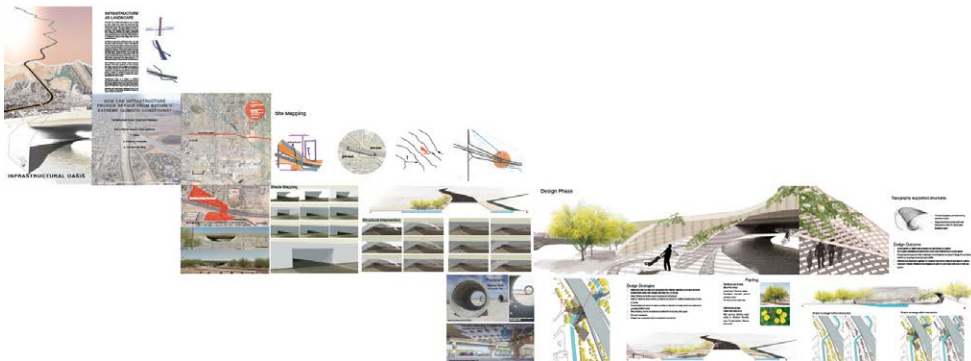
The *Strategies* studio is more typically an instructional GIS based landscape planning studio applied to the Melbourne metropolitan area as the case in general alongside examining a specific suburb suitable for future urban growth. In particular, this regional design studio is intended to introduce the conceptual framework for regional landscape planning framed by landscape design principles, together with a working knowledge of the mapping and analysis tools applied to landscape planning and design. The goal is to introduce basic GIS applications, the fundamentals of overlay analysis for landscape assessment, and planning decision making for the ideal form of suburban development which incorporates social, cultural and economic concerns. Students also develop a deeper understanding of the processes for broad scale landscape planning to inform strategic and effective urban growth management. The internal studio sequence includes environmental evaluation, goal setting,

strategic vision, site planning/design and the consideration of implementation, management and sustainability issues and the class serves as a first chance for students to apply GIS to work on a practical project, while also serving as their first experience at integrating GIS into design decisions.

### 3.2 Student Projects

Challenging the norms of current landscape practice into production, the 2014 *Speculations* studio asked students to define the notion of production and urbanism in order to develop a brief into the expanded productive landscape beyond (but not excluding) urban agriculture and vegetable gardens. Students in Melbourne identified places including the arid car lands of Phoenix, the unloved Klang River of Kuala Lumpur, the lowlands adjacent the main Mumbai airport and the Rio favelas as sites for social, ecological and economic production.

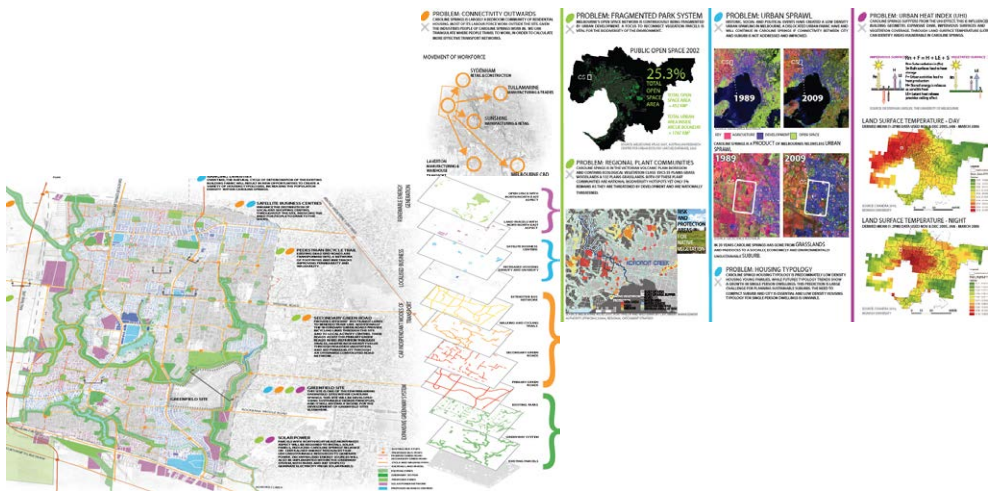
Systems design thinking at regional, urban and local scale enabled students to visualise and map site-specific areas within a city-wide context through the layers of physical, material and ephemeral knowledge. They were surprised to realise that accessible data was easier to find than they first imagined, and they usually quite successfully provided multi-scalar plans, sections and visual constructions of the layers of information required to propose quite detailed design interventions within broader regional/urban plans. A student proposal for Infrastructural Oases for Phoenix (Fig. 5) utilised available documentation, contour mapping and Google-based imagery to develop a series of shade structures for freeway bridges over the extensive canal system.



**Fig. 5:** Student project from *Speculations* studio (Image by Kate GRANT, MLA class of 2014; Studio Instructor: V. LEE)

Reflecting upon the range of design outcomes from the studio is it useful to consider how these projects might be resolved if the students had access to GIS systems and thinking prior to the studio. Indeed the Water Landscapes Studio undertaken in 2011 occurred in a sequence where all students had undertaken GIS. While the results utilised GIS mapping and interpretation in analysing and resolving their design strategies, and contributed to greater sophistication in representation, the quality of their speculative and relational thinking and proposals for interventions into critical landscapes appeared equally comprehensive.

While students demonstrated considerable system thinking skills in *Speculations* studio, the *Strategies* studio exerted greater challenges in scale thinking and scaled system thinking. Most students can understand the nonlinear interactions between landscape components at one scale (system thinking, such as these layers of information stacked in Fig. 6); they may also be able to create thematic maps showing landscape characteristics across different spatial scales (scale thinking, e.g. layer stacks at different scale in Fig. 6), but typically they are not able to conduct scaled system thinking which involves intriguing multiple nonlinear interactions and feedbacks between landscape production, management, and consumption across time and space. Although the early dialogue regarding the geodesign methodology and framework (STEINITZ 2012) has clearly endeavoured to show that geodesign is an activity (or class of activities) that can happen at different scales, the strong association with GIS seems to turn much of the attention back to larger landscapes and regions (TULLOCH 2013). In addition, many landscape architecture students enter the studio with considerable skills in CAD, but their spatial literacy is limited. Shifting back and forth between residential allotment scale to regional landscape requires a serious change in approach and thinking, which remains as a challenge in design studio.



**Fig. 6:** Student project from *Strategies* studio (Image by Louis KRISTIC, MLA class of 2014; Studio Instructor: S. CHEN)

## 4 Conclusion and Outlook

In summary, the scaled system approach 1) recognizes that interlinked spatial and temporal systems play a central role in landscape production, reproduction, identity and consumption; 2) identifies key linkages between landscapes at different scales to inform different design methods; 3) integrates systems thinking across all aspects of the design process as informed by the findings of scientific research, and 4) utilizes multi-scale dynamic simulations in the process of evaluating impacts of proposed designs. However, embedding information-based, scientifically informed simulations into design evaluation – or what SIMON (1996) called

the “test” phases – of design is among the pressing challenges, and opportunities, for the evolution of landscape architecture and geodesign in this century (ERVIN 2014). Fortunately, the recent advancements on Big Data research, data mining, and computing technology are all critical in realising these geodesign goals, particular the goal in cross-scale dynamic simulations and evaluating impacts of design intervention.

Design thinking methods are the most essential component in landscape architecture studio teaching; however, what methods we teach our students remains a question. While we recognize that the challenges to design with complexity are overwhelming, the scaled system thinking approach presented in this paper, together with tools such as scaling ladders (WU et al. 1999) can help simplify the complexity of systems (and system of systems) under study, enhance ecological, geophysical, and cultural understanding, and, at the same time, minimize the danger of intolerable error propagation in translating information across multiple scales. Therefore, new strategies that transcend disciplinary boundaries and motivate students to think critically about the dynamic relationship between space, time, and our social practices are highly needed. Geodesign research and education should be broadened and involve the fields of arts and humanities, especially diverse, creative design practices. Geodesign practices should attempt to integrate multiple, alternative human conceptualizations of space and time with the key issues related to spatial data representation, analysis and visualization for design decision making. In this regard, scaled system thinking approach can be applied to attain geodesign aspirations as it takes a holistic perspective of all relevant design variables across time and space; but it must focus beyond isolated problems within the larger system if it is to operate as a critical tool to support decision makers in their decision-making processes towards realistic and sustainable design and planning.

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