Crafting Sustainability Visions -

Integrating Visioning Practice, Research, and Education

by

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ABSTRACT

Sustainability visioning (i.e. the construction of sustainable future states) is considered an important component of sustainability research, for instance, in transformational sustainability science or in planning for urban sustainability. Visioning frees sustainability research from the dominant focus on analyzing problem constellations and opens it towards positive contributions to social innovation and transformation. Calls are repeatedly made for visions that can guide us towards sustainable futures. Scattered across a broad range of fields (i.e. business, non-government organization, land-use management, natural resource management, sustainability science, urban and regional planning) are an abundance of visioning studies. However, among the few evaluative studies in the literature there are apparent deficits in both the research and practice of visioning that curtails our expectations and prospects of realizing process-based and product-derived outcomes. These deficits suggests that calls instead should focus on the development of applied and theoretical understanding of crafting sustainability visions, enhancing the rigor and robustness of visioning methodology, and on integrating practice, research, and education for collaborative sustainability visioning.

From an analysis of prominent visioning and sustainability visioning studies in the literature, this dissertation articulates what is sustainability visioning and synthesizes a conceptual framework for criteria-based design and evaluation of sustainability visioning studies. While current visioning methodologies comply with some of these guidelines, none adhere to all of them. From this research, a novel sustainability visioning methodology is designed to address this gap to craft visions that are shared, systemic,

principles-based, action-oriented, relevant, and creative (i.e. *SPARC* visioning methodology) and evaluated across all quality criteria. Empirical studies were conducted to test and apply the conceptual and methodological frameworks — with an emphasis on enhancing the rigor and robustness in real world visioning processes for urban planning and teaching sustainability competencies. In-depth descriptions of the collaborative visioning studies demonstrate tangible outcomes for: (a) implementing the above sustainability visioning methodology, including evaluative procedures; (b) adopting meaningful interactive engagement procedures; (c) integrating advanced analytical modeling, sustainability appraisal, and creativity enhancing procedures; and (d) developing perspective and methodological capacity for long-range sustainability planning.

DEDICATION

Dedicated to my loving wife, Chloe, for her unfailing support.

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CHAPTER 1

INTRODUCTION

Visioning: A valid inquiry for sustainability

Envisioning how a desirable future might look is a long-standing effort in human evolution and social change. Utopian thought and visions provide direction for actions and behavior; moreover, they create identity and community. Sustainability visioning—the construction of sustainable future states—is considered an important component of sustainability research, exemplified in planning for urban sustainability and in transformational sustainability science. Visioning frees sustainability research from the dominant focus on analyzing problem constellations and opens it towards positive contributions to social innovation and transformation. The more complex and persistent the problems are, the greater the need for societies to articulate and consolidate visions to guide social-technological transformations (Dreborg 1996; Höjer 2000; Raskin et al. 2002).

For complex systems, such as human dominated systems, we almost never understand all the factors that are involved, the dynamic pathways they will take, or the eventual outcomes. The malaise created by this expectation of the unexpected, even with in-depth analysis, can force practitioners and researchers into questioning the usefulness of long-range planning (Shipley 2006). It is not surprising that influential scholars such as Lindblom (1959; 1979) have emphasized incremental "muddle through" approaches over holistic long-term understanding. Examples of the limitations of incremental approaches are all around us in the decision-making outcomes of corporations, cities, nations, and the world. Instead of abandoning approaches to understand long-range futures, sustainability science emphasizes systems-based and goal-oriented processes to guide transformational change. Accordingly, the discourse on sustainability and sustainable development has recognized that positive visions about our societies' futures are an influential, if not indispensable stimulus for transformational change (Han et al. 2012; Wiek et al. 2012)..

Primary goals and scope

This dissertation articulates what sustainability visioning is, a conceptual and a methodological framework for sustainability visioning, and findings of collaborative, empirical studies. The overarching goals of this work are 1) to develop a research agenda for the applied and theoretical understanding of crafting sustainability visions, 2) to develop a research practice framing for conducting collaborative sustainability visioning, and 3) to enhance the rigor and robustness of visioning methodology. These goals shape the objectives and approaches described throughout this dissertation. Additionally, contributions of this research to sustainability education are highlighted with the perspective of training future generations of sustainability researchers and practitioners.

A core focus is on the conceptual framing and design of sustainability visioning in the existing literature and proposed novel methodological frameworks for conducting sustainability visioning. Empirical studies were conducted to test and apply the conceptual and methodological concepts with an emphasis on enhancing the rigor and robustness in real world visioning processes for urban planning and teaching sustainability competencies. Conducting this empirical work in real world settings impedes the use of pristine experimental designs, but allows for greater reflection on the adaptability, applicability, and flexibility of the approach. Major departures from the conceptual and methodological framework are identified and discussed.

The use of visioning is prominent in urban planning and sustainability visioning as a critical tool used to guide transformational changes regarding how our cities are structured, how they function, and how they are governed (Wiek et al. 2012). With the majority of the global population now living in cities, urban development is a decisive factor in the well-being of societies worldwide. Given the importance of urban sustainability and the prominence of visioning in urban planning, there is a focus on urban planning in the empirical work presented here. However, sustainability visioning is pertinent to a wide range of contexts (e.g. business, government, and non-profit institutions). For this reason, much of the conceptual and methodological research is intended to be applicable to a broad range of contexts.

Research to meet these goals

Synthesis of quality criteria and design guidelines

Guidelines and theoretical underpinnings for crafting and evaluating sustainability visions are scattered over different strands of literature. One research objective was to review this body of knowledge to inform the development and evaluation of sustainability visioning processes, specifically examining for methods, tools, and procedures and approaches to combine them to craft high quality sustainability visions. This review was established from a broad literature search across both research studies and the practice of visioning. An inductive synthesis was conducted to develop a conceptual framework for criteria-based sustainability visioning and to describe where further emphasis is needed to guide future visioning endeavors.

Proposing a methodological way forward

Visioning methodologies have been designed that comply with some of the currently recognized quality criteria. However, there is not a single method that adheres to all of these criteria. A visioning methodology is constructed from a setoff design guidelines, based on a synthetic review of quality criteria. This methodological framework is intentionally designed to support the integrative dynamic and collaboration between sustainability researchers and practitioners and as a foundation for much needed cross-study comparisons to further develop evidence-based approaches for sustainability visioning.

Empirical application and evaluation for urban sustainability

Empirical examples are provided throughout each of the chapters to illustrate the implementation of visioning in practice, research, and education. The principle empirical work conducted provides an in-depth description of a collaborative visioning study with the City of Phoenix Planning Department in support of the City of Phoenix General Plan update. General objectives for this collaboration included: (a) implementing the above sustainability visioning methodology, including evaluative procedures; (b) adopting meaningful interactive public engagement procedures; (c) integrating advanced analytical and creative planning approaches from practice and research; and (d) developing perspective and (methodological) capacity for long-range sustainability planning.

Systems modeling of sustainability visions

In visioning studies some quality criteria are better represented than others; few studies focus on rigorous procedures for systemic and coherence of the crafted visions. Systems modeling approaches are explored to support participatory visioning in emerging sustainability plans, programs, and education. The objective of articulating sustainability visions through modeling is to develop shared visions that are robust, viable and resilient. The approach is largely assembled from visioning processes (resulting in descriptions of desirable future states generated from stakeholder values and preferences) and participatory modeling processes (resulting in systems-based representations of future states co-produced by experts and stakeholders). Vision modeling ensures that future desirable states are free from vague and conflicting goals and provide a means to explore (potentially unanticipated) outcomes and the long-range viability of dynamics resulting from the complex interaction among envisioned goals. This builds upon the methodological framework to further advance systemic perspectives and methodological capacity for crafting and assessing sustainability visions.

CHAPTER 2

QUALITY CRITERIA FOR VISIONS AND VISIONING

IN SUSTAINABILITY SCIENCE

Introduction

Antoine de Saint Exupéry wrote in *Citadelle* (1948): “Quand tu veux construire un bateau, ne commence pas par rassembler du bois, couper des planches et distribuer du travail, mais reveille au sein des hommes le desir de la mer grande et large. [If you want to build a ship, don't start with collecting wood, cutting the plank and assigning work, but awake in people the longing for the wide and open sea. (*own translation*)]” The power of imagining a desirable future seems to be as old as humankind itself. The wishes, dreams, and positive visions a society shares are at the core of its identity. Visions direct planning, decisions, actions, and behavior. Utopian thought from Plato and Thomas More to Aldous Huxley and Ernest Callenbach has transformed individuals and inspired social change (van der Helm 2009). Most innovation and intended change is, to some extent, based on a vision of a desirable future state.

We use the general term “vision” in this article in reference to a *desirable state in the future* (Constanza 2000; Kemp and Martens 2007; Oels 2009). As such, visions are a subgroup of scenarios (*possible* future states) and demarcated from predictions (*likely* future states). Further, a vision is different from the pathway that leads up to the vision. Accordingly, *visioning* is the *process of creating a vision*, i.e. *a representation of a desirable future state,* as opposed to scenario building (*possible* future states), forecasting (*likely* future states), and backcasting (*pathways* to desirable future states). Visions can be operationalized in specific (qualitative and quantitative) *goals* and *targets* (Wiek and Binder 2005; Rockström et al. 2009).[1]

As our societies struggle to fulfill human and social needs without detrimentally impacting other societies or compromising the viability of supporting ecosystems, calls are repeatedly made for visions that can guide us towards sustainable futures (Olson 1995; Kates et al. 2001; Raskin et al. 2002; Swart et al. 2004; Carpenter and Folke 2006; Brewer 2007; Rockström et al. 2009). As Constanza (2000) wrote: "The most critical task facing humanity today is the creation of a shared vision of a sustainable and desirable society, one that can provide permanent prosperity within the biophysical constraints of the real world in a way that is fair and equitable to all of humanity, to other species, and to future generations." Psychological and sociological research on visioning suggest that abstract principles and guidelines for what we should be doing (i.e. push factor) seems to be less motivating for making significant progress towards sustainable action than inspirational visions (i.e. pull factor) (Shipley and Michela 2006; van der Helm 2009). The old saying, slightly modified, "where there's a *vision*, there's a way" seems to hold true for sustainability visions too.

The role of visions in sustainability research and problem solving has been recognized and visioning has been integrated in comprehensive procedural frameworks leading from problem definition to strategy implementation (Ravetz 2000; Newman 2005; Komiyama and Takeuchi 2006; Weaver and Rotmans 2006; Morioka et al. 2006; Olsson et al. 2008;

[1] Different terminologies are being used in the literature. For instance, visions are also called "normative scenarios" defined as "scenarios which are constructed to lead to a future that is afforded a specific subjective value by the scenario authors" (Swart et al. 2004, p. 141), or, in short, "they portray futures that *should* be" (Nassauer and Corry 2004, p. 344). We incorporate this literature in the following review, but we adhere to the terminology proposed above.

Loorbach 2010; Videira et al. 2010). Visions and visioning are a particularly important component of *transformational* sustainability science conceptualized as scientific and collaborative endeavor with the intent to mitigate complex sustainability problems and to directly contribute to real-world sustainability transitions (Wiek et al. 2012; Han et al. 2012). Creating and crafting sustainability visions fulfills an important function in research, planning, and decision-making for sustainability as it provides a key reference point for developing strategies to transition from the current state to a desirable future state, actively avoiding undesirable developments. In addition, participatory visioning activities fulfill several process-level functions, including building capacity, empowering stakeholders, creating ownership, and developing accountability.

This recognition has led to an amplification of visioning activities in various societal fields related to sustainability, most prominently, within the domain of planning and planning research (Shipley 1999; Shipley and Michela 2006; Iwaniec and Wiek in review). Cities, companies, and organizations around the world develop their sustainability visions to guide investments, politics, and action programs, or at least to promote a sustainability attitude. A variety of visioning approaches have been made available in journal articles, handbooks, and reports to support these efforts, including Backcasting (Robinson 1982; Holmberg and Robèrt 2000; McDowall and Eames 2007; Eames and Egmose 2011; Quist et al. 2011), Future Workshop (Jungk and Müllert 1987; Eickhoff and Geffers 2007), Future Search Conference (Oels 2009), Community Visioning (Okubo 2000), Sustainability Solution Space (Wiek and Binder 2005), Visioneering (Kim and Oki 2011), and other approaches (Costanza 2000; Shipley 2002;

Raskin et al. 2002; Kemp and Martens 2007; Newman and Jennings 2008; Potschin et al. 2010). We consider in this article both visioning in research as well as in practical problem solving for sustainability.

However, some studies suggest that visioning practice lacks a sound theoretical base and methodology (Shipley 2002; Shipley and Michela 2006; van der Helm 2009). Initial evaluative studies allude to deficits in (sustainability) visioning processes, including lack of public involvement, intransparency, and extractive engagement techniques; as well as deficits in resulting visions, including absence of system relationships, inconsistencies among vision statements, as well as reliance on insufficient sustainability concepts (Helling 1998; Ravetz 1999; Wiek and Binder 2005; Loorbach and Rotmans 2006; Shipley and Michela 2006; Sondeijker et al. 2006; Newman and Jennings 2008; van der Helm 2009; Kallis et al. 2009; Binder et al. 2010; Sheate and Partidário 2010; Scott et al. 2011). Van der Helm (2009), for example, points to the contested guideline that visions need to be "realistic." Widely used as a phrase in academic literature (4,000 hits on Google scholar) and societal discourses (194,000 hits on Google), the idea of "realistic visions" is deemed self-contradicting in visioning literature: visions ought to be idealistic, free, open, innovative, and, in fact, *not* (too) realistic. Wright (2010) and others have provided proposals for how to reconcile the tension between realism and idealism in visioning.

A key challenge is that quality criteria for sustainability visions and guidelines for how to rigorously craft such visions are scattered over different strands of literature and some are still insufficiently developed. This article does *not* provide an evaluative study on the state-of-the-art in (sustainability) visioning. Instead, the article reviews visioning literature and synthesizes a set of quality criteria that is intended to inform students, researchers, and professionals on sustainability visioning methodology for research, planning, evaluation, and education. We first synthesize general insights from visioning studies; second, we introduce a set of ten quality criteria for sustainability visions derived from the literature and organized along three axes ('backbones'); third, we derive design principles for visioning methods from the quality criteria; and fourth, we illustrate the design principles with exemplary empirical visioning studies. We finally discuss the state of sustainability visioning research against the review insights and draw conclusions for methodological research and education.

General insights from visioning approaches

Contributions from various strands of literature propose quality criteria for (sustainability) visions that can inform evaluation and design of visioning studies and methodologies. The reviewed visioning approaches include: Backcasting [visioning part] (Robinson 1982; Holmberg 1998; McDowall and Eames 2007; Eames and Egmose 2011), Community Visioning (Okubo 2000), Future Search Conference (Oels 2009), Future Workshop (Jungk and Müllert 1987), Imagination Studio (Eickhoff and Geffers 2007), Integrated Assessment [visioning part] (Ravetz 2000; Weaver and Rotmans 2006), Leitbild Concept (Potschin et al. 2010), Sustainability Solution Space (Wiek and Binder 2005), Sustainability Choice Space (Potschin and Haines-Young 2008), and Visioneering (Kim and Oki 2011). While focusing on sustainability, we review influential visioning approaches from other fields as well (e.g. Senge 1993; Okubo 2000; Potschin et al. 2010). We also include insights from a small number of influential sustainability vision studies

(Meadows 1996; Costanza 2000; Bossel 1998; Raskin et al. 2002; Newman and Jennings 2008) and evaluative studies on sustainability visioning (Shipley 2000; Shipley and Michela 2006; van der Helm 2009).

Modern visioning approaches emerged during the 1980s and 90s with the incorporation of systems thinking and participatory engagement. Robinson (1982) developed *Backcasting* as a novel approach to address the future of energy; its use has been expanded to a variety of issues over the last thirty years (e.g. Holmberg 1998; James and Lahti 2004; Swart et al. 2004; McDowall and Eames 2007; Eames and Egmose 2011; Robinson et al. 2011). Backcasting includes, as its first step, the creation of a desirable future state ("normative scenario"); the approach emphasizes a systemic perspective as potential pathways are modeled backwards from the vision to present-day conditions. Recent applications of the backcasting approach have further developed the prioritization of sustainability criteria (McDowall and Eames 2007) and the framing of visioning activities for broad participatory engagement (Eames and Egmose 2011). Jungk and Müllert's (1987) *Future Workshops* emphasize the importance of participatory engagement and motivation in developing shared visions. The approach has further been developed as *Imagination Studio* (Eickhoff and Geffers 2007) further enhancing the visioning process' broad community involvement and focus on creativity. Senge (1993) is credited for his role in mainstreaming organizational visioning. With a special emphasis on the importance of systems thinking and motivation, this approach also emphasizes the role of team learning and shared leadership in corporate visioning. *Community Visioning* (Okubo 2000) is a generalized approach that followed up on a number of visioning processes in planning (Ames 1993; Nelessen 1994; Walzer 1996) that emphasized sequential steps to crafting shared community-oriented visions. Contemporary use of the *Leitbild-process* (Potschin et al. 2010) incorporates both systems thinking and participatory engagement as essential criteria to collaboratively developing normative future states.

The role of sustainability in visioning has been largely directed toward the normative exploration of future states (desirability), the evaluation and assessment of visions, and the development of the visioning process. Meadows (1996) was an early pioneer in outlining a sustainability visioning approach and used the example of ending world hunger to highlight the importance of systems thinking, transitioning from diversity to agreement, and integrating creative processes and analysis. Bossel (1998) and later Raskin et al. (2002) propose a sustainability visioning methodology based on systems theory that links quantitative modeling and tangible multi-part narratives for exploratory communicative purposes. Approaches to evaluating visions include Costanza's (2000) game theory approach to creating consensus around shared visions, as well as Weaver and Rotmans (2006) work in applying systems-based *Integrated Assessments* to sustainability visions and exploratory policy development. The *Sustainability Solution Space*, developed by Wiek and Binder (2005), is a methodology for evaluating vision coherence using consistency analysis. The approach has been used in developing similar visioning methods such as the *Sustainability Choice Space* (Potschin and Haines-Young 2008). The *Future Search Conference* (Oels 2009) is based on public engagement and capacity building with a large number of diverse stakeholders. Newman and Jennings (2008) describe the development of sustainable visions for cities and put special emphasis on tangible and relevant visions that are explicitly developed through community engagement and the use of sustainability principles. *Visioneering* (Kim and Oki 2011) is a visioning approach that emphasizes systems-based, purpose-driven, and tangible constructs of sustainable future states.

Quality criteria for sustainability visions

Based on this initial review, we inductively derive and specify a set of quality criteria that can be used for the evaluation and design of sustainability visioning approaches and studies. In summary, sustainability visions display ideally ten synergistic quality features (Tab. 1); they ought to be: visionary, sustainable, systemic, coherent, plausible, tangible, relevant, nuanced, motivational, and shared.

Visionary. Not all statements or narratives are visions. A vision describes a *desirable* state in the *future* (Constanza 2000; Kemp and Martens 2007; Oels 2009). Thereby, a visionary statement or narrative entails elements of (aspirational) surprise, utopian thought, far-sightedness, and holistic perspective (Dreborg 1996; Höjer 2000; Raskin et al. 2002). In addition, a vision needs to comply with further specifications as determined in the visioning process (e.g. specific temporal and spatial scope). The quality criterion of being visionary articulates the basic normative quality of a vision.

Sustainable. Sustainability visions are a *specific type* of visions. These visions ought to be not only desirable but to guide us towards *sustainability*; thus, we expect sustainability visions to comply with multiple value-laden or normative principles; in short, with sustainability principles (Holmberg and Robèrt 2000; Newman and Jennings 2008). Cherp et al. (2004), Gibson (2006), Jordan (2008) and others have proposed and synthesized sustainability principles. Newman and Jennings (2008) provide an overview of normative reference points for sustainability visions, including needs, ethics, or identity. The most prominent principle from the Bruntland Report states that sustainable development “meets the needs of the present without compromising the abilities of future generations to meet their own needs” (WCED 1987, p. 43); in short, the principle of intergenerational equity. For example, a sustainable vision of an urban water system adheres to this principle by envisioning that water is available, accessible, and affordable for all residents in sufficient quantity and quality (without over-exploitation or contamination) over the long term (Wiek and Larson 2012). The second most prominent sustainability principle is the *triple bottom line* commitment to balance social and economic needs with the carrying capacity of the natural environment (Elkington 1998). Surrounding both of these prominent principles are discussions on “weak” vs. “strong” sustainability and other controversies (Connelly 2007). An increasing number of sustainability scholars and professionals argue that radical transformations are needed to achieve sustainable systems and dynamics (Hopwood et al. 2005; Smith et al. 2005). Thus, more comprehensive sets of sustainability include: socio-ecological system integrity; livelihood sufficiency and opportunity; resource maintenance and efficiency; social and cultural civility (Gibson 2006). The sustainability criterion can help to actively avoid visions that violate important values of justice, integrity, or even viability.

Systemic. System thinking has advanced our concepts of reality for the purpose of better orientation and decision support. Key devices of system thinking are models (in a broad sense). Models represent qualitatively and/or quantitatively how interdependent parts of systems behave holistically, rather than independently or in linear cause-effect relations. The same idea can advance future-oriented thinking in general, and visioning in particular (Meadows 1996; Bossel 1998; Swart et al. 2004; Wiek and Binder 2005; Kim and Oki 2011). A vision model, or *systemic vision*, represents the individual parts of a desirable future state not independently but as interconnected through underlying systemic relationships (Bossel 1998). A systemic vision links the different pieces, i.e. goals and targets, in a way that the vision tells us how the desirable future state 'works'; or, in other words, how the goals and targets relate to and affect each other. This does *not* necessarily imply that the pieces nicely fit together (see coherence criterion below); yet, it does tell us how the pieces are *interlinked* (what are drivers, what are impacts, what are indirect and 'hidden' connections, what are dynamic feedbacks, etc.). For example, a systemic vision of a company does not only describe a list of goals; instead, it explains how the company is structured and functions in the envisioned future, i.e. how the different sub-systems, including R&D, distribution, public relations, etc., are organized, governed, and interlinked. Systemic visions provide us with more accurate and rich representations of desirable future states, which is in stark contrast to lists of seemly independent goals and issues ('laundry lists'). Systemic vision can be created, explored, and get represented through game-like tools ("epistemic games", "serious gaming"); examples for urban vision tools are *SimCity* or *Urban Science* (Gaber 2007; Bagley and Williamson Shaffer 2009).

Coherent. Closely related to the former principle is the guideline that sustainability visions should be internally consistent or coherent; in other words, a vision should be composed of compatible goals and free of inconsistencies and conflicts (Wiek and Binder 2005; Grunwald 2007; Potschin et al. 2010). Incompatible or conflicting goals would provide an ambiguous direction and might lead to conflicting or, at least, non-synergistic developments in the real world (when the vision gets implemented) that might undermine the overall aspirations of the vision. For example, a coherent vision of a healthy community that successfully mitigates childhood obesity aligns healthy diets and physical activities for children with favorable food systems, incentives, social norms, and political programs. An incoherent vision instead might include healthy diets and physical activities for children, but does not or not sufficiently include goals for food production, incentives, etc. that are favorable to healthy diets and physical activities. The pursuit of such an incoherent vision might fail to mitigate childhood obesity. The concept of internal coherence does *not* suggest visions should avoid complexity, i.e. by having vague targets or by generalizing issues such that tradeoffs and conflicting values are not apparent, which might lead to the *appearance* of coherence. This principle calls for the need to elaborate on and reconcile obvious tensions. Yet, coherent visions engage and reflect complexity while justifying why certain inherent tensions and heterogeneity are desirable (or, at least, not adverse). For example, a coherent vision for a city should account for the heterogeneity among community goals, such as abundant open space *and* dense neighborhoods. A coherent vision includes these inherent tensions and elaborates on how a city will be spatially heterogeneous with respect to density, and identifies where neighborhoods desire to preserve their lower density communities and where neighborhoods desire increased density. Coherent vision can be created, explored, and get represented through game-like tools ("epistemic games", "serious gaming") as mentioned above.

Plausible. The criterion of plausibility has several origins, including strategic planning and future thinking, but has recently been specifically developed for visions by Wright

(2010) under the concept of "real utopias". Widely used as a phrase in academic literature (4,000 hits on Google scholar) and societal discourses (194,000 hits on Google), the idea of "realistic visions" is deemed self-contradicting in visioning literature: visions ought to be idealistic, free, open, innovative, and, in fact, not (too) realistic (van der Helm 2009). Wright (2010) and others have provided proposals for how to reconcile the tension between plausible and visionary in visioning. Wright (2010) acknowledges that the phrase seems "like a contradiction in terms" (p. 5). But he suggests utilizing the productive tension between what is possible and what is desirable – based on the insight that "what is pragmatically possible is not fixed independently of our imaginations, but is itself shaped by our visions" (ibid.). Or, as Brewer (2007) proposes: "No one can predict the future, but we can invent and make the future […]. Inventing and making however mean thinking clearly about where we wish to go" (p. 160). Yet, "where we wish to go" ought to be bound by and grounded in 'reality' to some extent – otherwise, Wright (2010) argues, visions might "lead us astray, […] or […] lead us towards some unforeseen abyss" (p. 6). In addition, plausible visions are usually the ones on which consensus or agreement might be reached (see shared criterion below) (Smith et al. 2005). Plausible visions that are grounded in 'reality' entail elements that (a) have been implemented in the past, or (b) elsewhere in the world, or (c) have been demonstrated realizable (concept proof), often through a pilot project or an extended peer-review process. All three features refer to some level of empirical evidence that the vision in pursuit is feasible and will be able to deliver on its promises; in short, the criterion of plausibility aims at evidence-based visions, at least to some extent. For example, a vision of a community center that offers services assumed to mitigate community tensions needs to be based, at least to some extent, on evidence about the services' mitigation potential (relying on insights from intervention research). Wright (2010) provides a series of examples for plausible visions, including a vision for city budgeting (realized in Porto Alegre, Brazil), a vision for corporations of worker cooperatives (realized in the Basque region, Spain), and a vision for income distribution (pilot program in Namibia).

Tangible. Visions need to be made tangible in order to become meaningful. If they remain abstract, visions do not convey what they entail and imply. The principle of specificity has two functions: first, to enable comprehension of the vision, and second, to provide clear guidance through reference points for designing, monitoring, and evaluating policies and programs (Ravetz 2000; Smith et al. 2005; Gibson 2006; Berke et al. 2006; van der Helm 2009). For example, a tangible vision of a public health clinic entails a great deal of details on the health services provided through the main facility, campus activities, and community partnerships; the vision is being specified to enhance comprehension by different stakeholder groups and to support the design of the services (Wiek et al. 2012). Abstract values and broad goals might provide an initial orientation but they cannot substitute for a tangible vision (Smith and Wiek 2012). Similar to the plausibility criterion (and all other criteria), the criterion of tangibility requires subtle application. A tangible vision is not a suffocating corset that determines each and every detail; it still leaves room for inspiration. But it provides enough substance for imagination to flourish. A key to specifying a vision is the provision of qualitative and/or quantitative targets, thresholds, tipping points, or other normative reference points (Meadows 1996; Uyesugi and Shipley 2005; Wiek and Binder 2005; Rockström et al. 2009). A specific target of a *sustainability* vision should indicate a *sustainable* state, not simply a reference state, for instance, a comparative benchmark such as 'better than last year' or 'better than our competitors' (Wiek and Binder 2005). The justification of sustainability targets ought to rely on sustainability principles (see sustainability criterion above). Specific targets give substance to the vision; yet, they need to get contextualized and embedded through narratives, stories, and visuals to make them experiential and meaningful. Visuals are widely used to make visions tangible, sometimes in conjunction with "iconic places" (Shaw et al. 2009; Uyesugi and Shipley 2005; Iwaniec and Wiek in review); this practice refers back to the meaning of "vision" – *seeing* the desirable future state. A subset of quality criteria applies to visuals that illustrate visions (Sheppard 2001).

Relevant. Visions need to spell out what they promise to, request from, and imply for 'me' and 'us' if they ought to matter to the people they imagine a desirable future for. The diverse visions of material fluxes, greenhouse gas emissions, GDPs, energy systems, nanotechnologies, buildings, cities, and so forth need to envision: who is doing what in the envisioned future, where, why, how, and with what impacts (Meadows 1996; Wright 2010; Wangel 2011; Wiek and Larson 2012). Depending on the scope of the vision, we may even more profoundly envision, who we will be as a society and as human beings (what our skills, needs, fears, dreams, and values will be). Real people, their actions and activities, their roles and responsibilities, their motives and rules – all of these aspects make a desirable future state relevant. They enrich the systemic representation of the vision (see systems criterion above) and also make it more tangible (see specificity criterion above). Cash et al. (2003) introduced *salience*, i.e. relevance for stakeholders and decision-makers, as a key criterion for "knowledge systems for sustainable development." The criterion applies to visions as a particularly important type of sustainability knowledge. A relevant/salient vision is, for example, a vision of nanotechnology that spells out – besides the spectrum of nanotechnologies and their functions – who is using them; who benefits from them; who is involved in innovation and governance; what are the underlying motives and intentions of the actors; what are envisioned roles and responsibilities; and so forth. These questions can be linked to the criterion of sustainability (see above) (Wiek et al. 2007).

Nuanced. Visions are composed of various elements and not all of them are of equal desirability. Thus, a vision needs to reflect nuances of value-laden perspectives, which is usually captured through priorities (Trutnevyte et al. 2011). Priorities simplify the vision by separating different clusters of desirability, which makes it easier to comprehend complex visions (McDowall and Eames 2007). Priorities also provide guidance in subsequent stages of research and decision-making (what to focus attention and resources on and in what sequence). The quality criterion of being nuanced is closely linked to the criteria of being shared (mapping out diversity among stakeholders) and motivational ('low-hanging fruits' for initiating vision implementation); it also works in support of the coherence criterion (as it suggests trade-offs).

Motivational. Unlike general scenarios (being representation of *possible* future states), which are primarily designed to inform people about uncertainty, visions are supposed to be inspiring and, at best, motivating towards the envisioned change (Swart et al. 2004; Smith et al. 2005; van der Helm 2009). Visions ought to create buy-in and acceptance of the proposed changes, spark the further development of the vision, and even motivate active participation in the implementation process. Visions and scenarios fulfill therefore complementary functions (Brown et al. 2003; Wiek et al. 2011). Scenarios are productive constructs if they enable us "to think the unthinkable" (Brewer 2007), in other words, to prepare us for surprises and in particular, what might go wrong. Visions, instead, should encourage us to envision and pursue what we want (in a rich sense). Yet, visions and scenarios both ought to 'uncouple' people from established paths of reasoning, imagining, and communicating (van de Kerkhof and Wieczorek 2005). Thereby, the criterion of being motivational for change is linked to the criterion of plausibility (see above). Motivation for change requires vision elements that challenge established assumptions, open up new perspectives, and are generally thought-provoking; yet, visions need to remain in the domain of plausibility in order to be more than fantasies and daydreams – the central message needs to be that the envisioned change is, at least, "potentially possible" (van der Helm 2009). Also, an important motivational component is to see one's own role in the vision (link to the relevance criterion; see above). While the vision content is important for becoming inspirational and motivational, the vision *format* is equally important. Future-oriented research has demonstrated that narratives, stories, games, videos, and other 'engaging' forms of communication are usually more conducive to spark inspiration than traditional forms of academic communication such as articles, reports, or policy debriefs (Sheppard 2005; Salter et al. 2009; Robinson et al. 2011). Research on the question in how far such inspiration translates into motivation for change is still at an early stage and therefore inconclusive (Bagley and Williamson Shaffer 2009; Nilsson 2010).

Shared. As visions are being designed to "converge our actions into a desired direction" (van der Helm 2009, p. 99), visions need to display a critical degree of convergence themselves. This does neither imply unanimous consensus nor immediate emergence of agreement. In fact, diversity in and of visions has been pointed out frequently (van der Helm 2009; Hjerpe and Linnér 2009), in particular in the context of socio-technical visions (e.g. Smith et al. 2005; McDowall and Eames 2007) and urban visions (e.g. Guy and Marvin 2000; Aurigi 2005; Eames and Egmoses 2011). The dominant paradigm of building collective orientation has been and still is the model of consensus building (Susskind et al. 1999). More recently, this assumption has been challenged based on the argument that mapping out diversity of positions and preferences yields important insights, increases mutual understanding, and enables more informed negotiations (van de Kerkhof 2006). Thus, mapping out diversity can fulfill an important function on the way to a shared vision. Smith et al. (2005) and Quist et al. (2011) highlight the role visions play in transition management and discuss the issues of diversity and negotiation; yet, they also acknowledge the need for a vision that a critical number of stakeholders can agree on in order to create a common reference point for action. In this process, sustainability principles, systems understanding, etc. get mapped out, specified, and negotiated (see coherent criteria above). A shared vision displays an enhanced level of legitimacy – another important criterion of "knowledge systems for sustainable development" (Cash et al. 2003).

Table 1 Key features and sources of the quality criteria for sustainability visions

	Quality Criterion	Key Features	Sources
1	Visionary	Desirable future state; with elements of (aspirational) surprise, utopian thought, far-sightedness, and holistic perspective	Dreborg 1996; Höjer 2000; Raskin et al. 2002
2	Sustainable	In compliance with sustainability principles; featuring radically transformed structures and processes	Holmberg and Robèrt 2000; Newman and Jennings 2008
3	Systemic	Holistic representation; linkages between vision elements; complex structure	Meadows 1996; Bossel 1998; Raskin et al. 2002
4	Coherent	Composed of compatible goals (free of irreconcilable contradictions)	Wiek and Binder 2005; Potschin et al. 2010
5	Plausible	Evidence-based – informed by empirical examples, theoretical models, and pilot projects	Wright 2010; Wiek et al. 2012
6	Tangible	Composed of clearly articulated and detailed goals	Ravetz 2000; Wiek and Binder 2005
7	Relevant	Composed of salient goals that focus on people, their roles, and responsibilities	Cash et al. 2003; Wangel 2011; Wiek and Larson 2012
8	Nuanced	Detailed priorities (desirability)	Trutnevyte et al. 2011; McDowall and Eames 2007
9	Motivational	Inspire and motivate towards the envisioned change	Swart et al. 2004; Smith et al. 2005; Helm 2009
10	Shared	Display a critical degree of convergence, agreement, and support by relevant stakeholders	Smith et al. 2005; van de Kerkhof 2006; Kruetli et al. 2010; Quist et al. 2011

As indicated above, the ten quality criteria of visions are closely linked and 'work together'. They should not be pursued in isolation but in support of each other. The quality criteria constitute three 'backbones' or axes of a quality vision (Fig. 1): a *normative* axis that is centered on the basic desirability of a vision as well as, more specifically, on sustainability and ensures that the vision is grounded in comprehensive sustainability concepts; a *construct* axis that includes the systemic, coherent, plausible, tangible features and makes sure that the vision is accurately constructed accounting for complexity, coherence, evidence, and specificity; and a transformational backbone that includes the relevant, nuanced, motivational, shared features and ensures that the vision is conducive to real-world change.

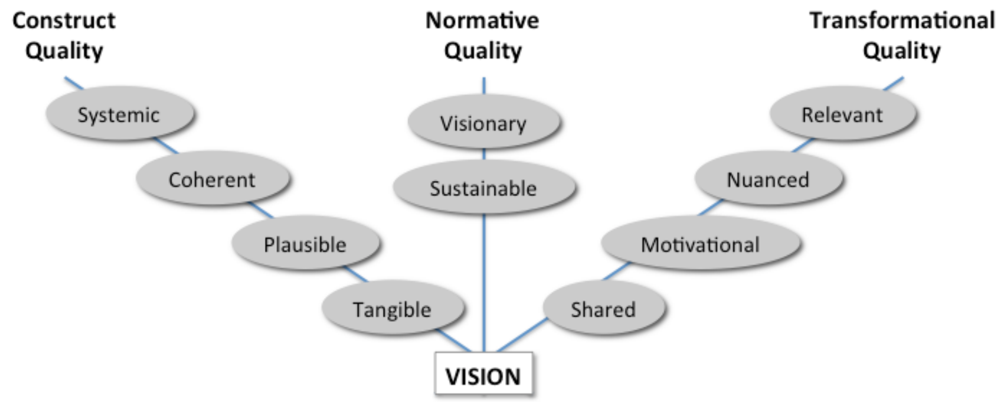


Fig. 1 Normative quality, construct quality, and transformational quality as backbones of a sound sustainability vision

Design guidelines and components for sustainability visioning methodology

The quality criteria compiled above can be used as design guidelines for visioning methodology. The guiding question is: What methods, tools, and procedures need to be employed, and how do they need to get combined in order to be capable of creating high quality sustainability visions (i.e. visions that comply with the compiled quality criteria)? In correspondence to the quality criteria, we have compiled below methods, tools, techniques, and procedures for constructing and evaluating high quality sustainability visions drawing upon different strands of literature. The quality criteria function not only individually but also in conjunction as design guidelines. Therefore, some of the design guidelines below do not refer to only one specific quality criterion but cut across several or all of them.

Sustainability visioning methodology ought to meaningfully combine and iteratively apply: creativity techniques and visualization techniques; as well as methods for sustainability assessment, system analysis, consistency analysis, plausibility appraisal, target specification, actor-oriented analysis; and embedded in participatory settings.

The first five design guidelines apply to the entire visioning process or several of the vision quality criteria.

Meaningful Sequence. The compiled quality criteria correspond to various methods, tools, and techniques. In a thorough sustainability visioning process these methods are not randomly but meaningfully combined. Obviously, there is not *one* single meaningful sequence. However, there are not an infinite number of *meaningful* sequences because some methods cannot be applied without others preceding (e.g. the sustainability assessment can not be conducted without the initial creation of vision material to be assessed); and some sequences make more sense than others (e.g. the consistency analysis is more meaningful after than before the system analysis; or, if the goal is to create a shared vision, it is advisable to employ participatory settings from the very beginning and not only towards the end of the visioning process). Most visioning methodologies therefore adopt the following general sequence: (i) Framing the visioning process [Framing]; (ii) Creating initial vision material (vision pool) [Initializing]; (iii) Decomposing and analyzing this material [Analyzing]; and finally, (iv) Revising and recomposing [Synthesizing and Finalizing] the vision (see review of exemplary visioning studies in the next section below).

Iterative Procedure. A thorough sustainability visioning process is *not* a simple and linear construction sequence. There is a need for continuous review, reflection, and revision, in short for an iterative procedure, in order to produce a high quality sustainability vision (Ravetz 2000; Nassauer and Corry 2004; Robinson and Tansey 2006; Trutnevyte et al. 2011). The general sequence outlined above accounts for this design guideline as it iteratively combines creation and revision of vision material. This guideline does not only comply with the general idea of research as a procedure of continuous refinement; it also embraces the process function of visioning as a collaborative learning process (Robinson 2003).

Creativity Techniques. The starting point of each visioning process, i.e. the initial creation of vision elements or full visions (vision pool) is – if not entirely based on previous results (document review) – a creative act. Furthermore, several vision quality criteria (e.g. sustainable, plausible, motivational) require a strong link between analytical and creative techniques (see quality criteria section above). In particular, using sustainability criteria and plausibility criteria for the creation of visions requires intuition, imagination, virtual transfer and other creative capacities (Wiek and Larson 2012). Research on enhancing creativity is in very early stages (Shneiderman et al. 2006) and even fewer recommendations have been evaluated. Several generic creativity techniques, including appreciative inquiry, associative processes, brainstorming, problem solving, gameplay, lateral thinking, prototyping, and story-telling have been developed in various fields (Vidal 2006; Burbiel 2009; Puccio et al. 2010). Creativity techniques have also been specifically developed for future-oriented and visioning research (Vidal 2004; Brabandere and Iny 2010; Varum and Melo 2010). The Future Workshop framework, for instances, specifies the use of creative activities, including fantasy trips, meditation, medial support, role playing, metaphors, picture stimulations, and storytelling (Eickhoff and Geffers 2007). A great deal of creative techniques have been developed for enhancing collective or collaborative creativity (Shneiderman et al. 2006; Vidal 2006; Cruickshank and Evans 2012), which refers to specific participatory settings (see design guideline below). Complementary to creativity techniques, creative professionals such as writers, directors, artists, designers, might be able to provide valuable support functions in visioning processes

Visualization Techniques. Visualization techniques embrace the original meaning of visions – they allow us *seeing* the desirable future state. Visualization techniques are critical for creating visions that are tangible and motivational (see quality criteria section above). There is a broad variety of visualization techniques, settings, and locations. Simple visualization techniques include vision maps (similar to conceptual/system maps), solution spaces, an other non-realistic visualizations (Wiek and Binder 2005; Iwaniec and Wiek in review). More sophisticated types are visualizations of landscape and city visions with a variety of formats, including 2D and 3D, GIS-based, dynamic and video visualizations (Kwartler and Bernard 2001; Batty et al. 2001; Couclelis 2004; Nicholson-Cole 2005; Pettit 2005; Shaw et al. 2009). Over the last years, several visualization tools have further been developed for visioning in participatory settings such as the visual preference survey (Elkins et al. 2009), the digital workshop (Salter et al. 2009), and others (Sheppard and Meitner 2005; Isenberg et al. 2011). Using visualization techniques and participatory settings, decision theaters have emerged as spaces in which participatory visioning process can be conducted (Wiek and Larson 2012).

Participatory Settings. The participatory setting corresponds to multiple quality criteria across the entire visioning process with particular applicability to the *shared* quality criteria. In order to create a *shared* vision, participatory settings are indispensible for visioning processes. The guiding questions for designing participatory settings are: *who participates with whom; in/on what; to what extent; and using which procedure* (Krütli et al. 2010). *Who participates with whom* – Various settings have been developed to support participation among different stakeholder groups; most often settings are differentiated on a first level into expert vs. laypeople settings. But the involved parties can be further determined with respect to age, sex, profession, socio-economic background, and other aspects. The selection of stakeholders for participatory settings is a challenging and contested task in particular in visioning processes (Hurley and Walker 2004; Uyesugi and Shipley 2005; Kallis et al. 2009; Oels 2009; Quist et al. 2011; Iwaniec and Wiek in review). *In/on what* – This is quite simple, namely: on all the relevant features of the vision, and therefore participation needs to happen in all critical stages of the visioning process. As pointed out above, participatory settings have been developed for all components of the visioning process. Yet, because of limited capacity, time, and other resources in most visioning processes, it has been argued that participation should rather be considered a dynamic process with different stages of higher and lower involvement of different stakeholder groups (Krütli et al. 2010). *To what extent* – There is broad agreement that for ambitious tasks, such as visioning, participatory settings need to move beyond consultative forms, climbing "the ladder of participation" (Arnstein 1969), to approaches that creatively engage participants, build capacity, and create robust results that are likely to become implemented (Fischer 1993; van Kerkhoff and Lebel 2006). This involves engaging surprise, disagreement, confusion, objections and other interactive processes during the engagement activities. There are a wide variety of examples that demonstrate how to successfully engage people in challenging visioning exercises, including systems thinking, tradeoff exploration, and discussions on sustainability (e.g. Robinson and Tansey 2006; van de Kerkhof 2006; Hamlett & Cobb 2006; Robinson et al. 2011; Talwar et al. 2011). *Using which procedure* – The dominant procedure of creating shared visions has been and still is the model of consensus building (Susskind et al. 1999). More recently, this assumption has been challenged based on the argument that mapping out diversity of positions and preferences yields important insights, increases mutual understanding, and enables more informed negotiations (van de Kerkhof 2006). Thus, collaborative planning and governance literature has put special emphasis on *negotiation* of different, or even conflicting perspectives and values (e.g. van de Hove 2006; Ansell and Gash 2008). Helping participants negotiate sustainability targets, trade-offs and so forth can easily overwhelm participants and deplete capacity of the group; thus, participatory settings are tasked to allow participants to effectively challenge and engage with each other (Kallis et al. 2009).

The following design guidelines correspond to one particular vision quality criterion:

Vision Review. Each vision element needs to comply with the formal definition of a vision as a *desirable* state in the *future*. The vision review also needs to check if elements of (aspirational) surprise, utopian thought, far-sightedness, and holistic perspective are inherent in the vision. In addition, compliance with further specifications as determined in the visioning process (e.g. specific temporal and spatial scope) need to be ensured (Iwaniec and Wiek in review).

Sustainability Assessment. The application of sustainability assessment methods ensures that the vision is constructed as a *sustainability* vision. Several sustainability assessment methods have been developed (Gibson 2006; Ness et al. 2007), including multi-criteria assessment methodology, and most of them are applicable in participatory settings. Sustainability criteria have been specified and operationalized for application in sustainability assessment methods (Wiek and Larson 2012). Few of these methods have been explicitly developed for application in visioning approaches, including the sustainability solution space approach (Wiek and Binder 2005) and the integrated sustainability assessment approach (Weaver and Rotmans 2006). The latter suggests also using sustainability criteria to *create* sustainability visions (as opposed to only using them for evaluating previously created sustainability visions), which requires integrating creative techniques into the assessment processes.

System Analysis. Applying system analysis methods allows exploring the systemic features of visions, including drivers, feedback loops, indirect impacts, etc. Modeling approaches, including system dynamics, are most suitable for this type of analysis and have also been developed for participatory visioning settings (Videira et al. 2010). Vester (1988) and Vervoort et al. (2010) have developed frameworks for reviewing and constructing simulation and serious gaming tools in future-oriented activities.

Consistency Analysis. Methods for consistency analysis allow for exploring and resolving potential conflicts and trade-offs within visions. Trade-off analysis is a standard approach for interactive nonlinear multi-objective optimization (Eskelinen and Miettinen 2011), which can be considered a technical visioning methodology. Based on consistency analysis (Tietje 2005), Wiek and Binder (2005) have developed the Sustainability Solution Space approach that integrates consistency analysis into sustainability visioning.

Plausibility Appraisal. Similar to sustainability assessment, plausibility appraisal can be used for both evaluation and design of visions. Several plausibility concepts and criteria have been proposed (see quality criteria section above), but the methodology of plausibility appraisal is still at a nascent state. Yet, plausibility appraisal is critical from the very beginning of a visioning process as it is a key criterion for the initial compilation of vision material in vision pools.

Target Specification. The field of target specification has been contested in academia because of its explicit normative character. Yet, it is a critical for visioning, which is recognized an explicitly normative research effort (Swart et al. 2004), as it makes visions tangible and implementable. There are few attempts to develop methods for target specification in visioning, specifically focusing on the key question "what is a sustainable level of indicator X" (Wiek and Binder 2005; Rauch and Newman 2008). Recently, a new effort has been undertaken to establish target specification as a critical endeavor in sustainability research (Rockström et al. 2009), which can be utilized for sustainability visioning processes.

Actor-oriented Analysis. Applying methods for actor-oriented analysis in visioning processes enhances the relevance of visions for stakeholder groups critical in the phase of implementation. Actor-oriented analysis has widely been developed in institutional theory (Ostrom 2009). Yet, the approaches remain largely confined to the current state and have only recently been further developed for the *construction* of governance arrangements (Wiek et al. 2007; Wiek and Larson 2012) and thus made usable in visioning processes.

Priorities Assessment. Methods for eliciting, analyzing, and representing priorities are used to capture the nuanced desirability structure of the vision (Trutnevyte et al. 2011). Eliciting priorities often adopts participatory settings and can be structured as consensus-oriented (Susskind et al. 1999), diversity-oriented (van Kerkhof and Lebel 2006), or both (i.e. mapping diversity first, then building consensus). Eliciting priorities can be conducted iteratively (Trutnevyte et al. 2011) as well as through direct ("stated preferences") or indirect ("revealed preferences") procedures (Robèrt 2005; Menzel and Wiek 2009). Priorities inform consistency analyses by providing indications for trade-off making. Priorities also fulfill a function in participatory settings as high priority goals are potentially important nodes to initiate consensus building and vision implementation.

Table 2 summarizes the developed design guidelines for visioning methodology and links them back to the vision quality criteria developed in the previous section.

Table 2 Vision quality criteria and corresponding methods and sources

Vision Quality Criteria	Visioning Methodology	Source
[General]	Meaningful sequence	Okubo 2000
[General]	Iterative procedure	Robinson and Tansey 2006
[General]	Participatory settings	Robinson and Tansey 2006; Weaver and Rotmans 2006; Loorbach 2010; Quist et al. 2011
Visionary	Vision review	Iwaniec and Wiek 2012
Sustainable	Sustainability assessment Creative techniques	Gibson 2006; Weaver and Rotmans 2006
Systemic	System analysis Visualization techniques	Vester 1988; Videira et al. 2010; Vervoort et al. 2010
Coherent	Consistency analysis Priority assessment	Wiek and Binder 2005; Eskelinen and Miettinen 2011
Plausible	Plausibility appraisal Creative techniques	Wright 2010; Wiek et al. 2012
Tangible	Targets/thresholds Visualization techniques	Rauch and Newman 2008; Rockström et al. 2009
Relevant	Actor-oriented analysis and construction	Ostrom 2009; Wangel 2011; Wiek and Larson 2012
Nuanced	Priority assessment	Robert 2005; McDowall and Eames 2007
Motivational	Creative techniques (story telling, games)	Vidal 2004; Shneiderman et al. 2006; Eickhoff and Geffers 2007; Varum et al. 2010
Shared	Participatory settings (mapping diversity, negotiation, building agreement)	Fischer 1993; van Kerkhoff and Lebel 2006; Kruetli et al. 2010; Lang et al. 2012

Review of exemplary visioning studies

Only few general visioning approaches include sufficiently detailed descriptions of all procedural steps, which would allow comprehending and replicating visioning activities. For example, while nearly all approaches call for broad stakeholder engagement, few approaches (e.g. Backcasting or Future Search Conference) detail how participant are included, or what level of participation ought to be engaged (and why). This lack of information makes it difficult to understand the rationale of several approaches mentioned above and to use them for the design of visioning projects. Thus, in the following, we briefly review and illustrate some of the compiled methods employed in exemplary visioning studies. With this, we intend to exemplarily demonstrate how specific visioning studies have attempted to adhere to some of the compiled quality criteria through specific methodologies and procedures (with no intention to suggest that these studies are the only ones, or the most prominent ones).

Nassauer and Corry (2004) propose a framework for developing landscape visions ("normative scenarios") and present results from an application to agricultural landscapes in Iowa, USA (reference year 2025). The core of the visioning study was structured into the development and evaluation of three distinct visions based on contrasting policy goals for agricultural production, water quality, and biodiversity. Participatory engagement was interdisciplinary and largely expert-based (i.e. agriculture, ecology, economics, geography, hydrology, architecture and planning, and policy) that included broader public involvement through an informal survey of local decision-makers and farmers. The visioning process embodied to differing degrees several of the quality criteria (i.e. systemic, relevant, motivational, and shared) with emphasis on the visions' plausibility and tangibility. The plausibility criterion was specifically defined as: "Plausibility depends upon what qualitative changes in public values, technology, and policy orientation or economic support for policy can be credibly asserted rather than what has happened to landscapes in the past." While still being grounded in empirical justification, emphasis is put on what policy options are being discussed rather than likelihood of landscape changes. Vision tangibility was achieved by applying advanced communicative and experiential techniques, including: exploratory narratives; GIS and hand drawn maps; site visits with interdisciplinary field exercises; and photo realistic digital images of ground level and aerial views of the future landscape. The criteria applied in the vision evaluations included performance measures for goal specificity (i.e. generality, realism, accuracy, precision, data availability, and scale) and plausibility (Santelmann, et al. 2004).

Uyesugi and Shipley (2005) and supporting documents (Vancouver 2005) describe visioning processes as part of the Vancouver CityPlan. The visioning process targeted the entire population of Vancouver in British Columbia, Canada with a special focus on minority groups. The city not only faces the challenges of large-scale and multicultural planning, but under rapidly changing population demographics in some communities. The Vancouver CityPlan featured exemplarily techniques and procedures in crafting motivational and shared visions at both the neighborhood and city-level. Creative Workshops and city-level Vision Fairs used interactive displays (maps, photos, fact sheets, and comment boards) and incorporated artists to sketch participants' ideas to engage residents about housing, economy, jobs, transportation, city services, environment, and public places. Uyesugi and Shipley (2005) reviewed planning documents and conducted interviews to examine diversity-emphasized visioning processes and participant perspectives in four Vancouver neighborhoods. This included not only ethic diversity, but also included targeted recruitment of seniors, youth, religious groups, community groups, and business associations. Throughout the visioning process, promotional material, workshops, presentations, surveys, summary documents, and interviews were conducted in multiple languages. Some of the challenges highlighted by Uyesugi and Shipley (2005) include language and cultural tensions, but the visioning process, especially multicultural involvement, was perceived by participants to have been well conducted. Implementation of the vision had yet to produce notable outcomes, which led to unsatisfied participant reactions.

The visioning study by Machler and Golub (2012) focuses on the topic of transport accessibility in the Sky Harbor neighborhood of central Phoenix, Arizona. The result of the study is a sustainability solution space of transport accessibility that defines the desirable and sustainable range for each accessibility indicator, in which action can be taken without pushing any other accessibility indicator (or other sustainability indicator of relevance) out of its desirable and sustainable range. Conducted as sustainability research employing participatory research settings, the study complies with several of the compiled quality criteria (e.g. sustainable and shared); yet, it puts emphasis on systems perspective and coherence. Key steps of the visioning process are therefore to determine the systemic inter-linkages among transportation accessibility indicators; and, building on these results, analyzing and reconciling potential conflicts between the indicator-specific targets. The guiding question for the systems perspective on the vision is: do changes in one indicator affect the performance of others? For example, the number of basic services located within a reasonable walking distance influences a household's spending on transportation (with a lower number of services requiring higher spending). The systemic analyzes provides the base for consistency analysis and reconciliation of target conflicts. For the above example, what is a desirable/sustainable number of services (range) that does not conflict with a desirable/sustainable range of spending on transportation? Conflicts can also emerge between accessibility and other sustainability targets; for instance, providing free transportation to all residents might be considered most desirable in terms of accessibility, but might be inconsistent with other neighborhood goals because an inacceptable amount of resources would have to be withdrawn from other community initiatives. The resulting transport accessibility vision is the result of iterative conflict reconciliations and is eventually composed of a coherent set of targets free of irreconcilable contradictions.

The three studies address different fields of application, i.e. landscape ecology, community development, and transportation planning. Each of the studies displays numerous quality features; yet, they focus on different vision quality criteria, and therefore, put different emphasis on specific methodological components. In conjunction, they illustrate the spectrum of methodological accomplishments in applied visioning methodology.

Discussion

Visioning processes in sustainability research and other fields are challenged by calls for applying more rigorous visioning methodology and high quality visions as outcomes. This review article compiled and structured a set of quality criteria for sustainability visions synthesized from the literature. By articulating the quality criteria to craft better sustainability visions, the article provides a reference set of guidelines to develop sustainability visions and evaluate visioning processes. The review process was primarily synthesis-oriented and constructive. A series of aspects need further attention and elaboration.

Shipley (2002) points out that visioning methodology is often rather based on experiences and initial reflections than evidence-based evaluations and tests. A critical first step to overcome this deficit is to adequately document and justify the methodological procedures applied. Without sufficient detail, it is difficult to appraise any given methodology against quality criteria. On this basis, some of the claims and promises in the (sustainability) visioning literature – for instance, the best use of participatory settings – have to get further substantiated. For instance, the criterion of plausibility and the method of plausibility appraisal rest on a fairly thin conceptual basis that just recently has received more attention in academia (Wright 2010; Wiek et al. 2012). Similarly, how analytical and creative approaches productively intersect and how (in detail) creative techniques ought to support visioning processes need further elaboration. The maturing of the visioning field will reveal in how far the compiled quality criteria and methodological components are complete or if additional criteria are necessary to enhance the quality of sustainability visions and visioning processes.

Considering the diversity of criteria, a challenge for visioning studies is to adhere to *all* vision quality criteria and design guidelines. During the still nascent stage of visioning activities, this might require to compromise (to some extent) on some of the proposed criteria, as appropriate methodologies are still under development. Also, while sustainability visions ideally display features from all ten quality criteria, the context and framing of the visioning process will drive some diversity (or even hierarchy) in the emphasis and sequence of the different criteria (e.g. emphasis on imaginative visioning to promote creative dialogue first vs. (or followed by) focus on coherent and plausible visioning to promote operationalization). Variations of the general sequence and deviations in details occur in all visioning studies; they ought to be transparently described and justified. An important factor for making progress in sustainability visioning will be the strengthening of the connection between visioning practice and research, as suggested for similar fields (Myers and Banerjee 2005). The quality criteria proposed here are intended to support and enable high-quality sustainability visioning, *not* constraining it. They should not be viewed as a corset, but guide researchers and practitioners through rich and thorough activities to achieve high-quality sustainability visions.

The pursuit of high-quality sustainability visions through rigorous visioning research in academia and professional practice requires the continuous capacity building of researchers and practitioners involved in visioning studies and the design of appropriate courses and curricula for students and professionals. This is best achieved through a close collaboration between academia and practice in (sustainability) visioning research.

Conclusions

There is a clear intent to create more quality-oriented sustainability visioning methodologies in various fields, spanning from urban planning to technology development. We draw three conclusions from the presented review to further enhance sustainability visioning research and practice: First, there is a need for more empirical evidence on the validity of the compiled quality criteria and design guidelines. Second, the field is urged to develop sustainability visioning methodologies that adhere not only to one or some of the quality criteria – but *all* of them. And finally, specific educational programs would be beneficial that teach sustainability researchers and professionals, but also other professionals (e.g. urban planners and engineers), how to rigorously craft (sustainability) visions.

CHAPTER 3

SPARC – A CRITERIA-BASED APPROACH TO VISIONING IN TRANSFORMATIONAL SUSTAINABILITY RESEARCH

Introduction

Governments, companies, non-profit organizations, and consumers around the world increasingly strive to plan and take decisions in pursuit of resource efficiency, health, and justice, in short, towards sustainable development (Sarewitz et al. 2012). Sustainability-oriented visions, i.e. sustainable future states and dynamics, have been recognized as important components of these endeavors. They leapfrog status quo challenges and trends by articulating desirable futures and outlining sustainable solutions. They serve as normative reference points for strategies and action plans (Wiek 2010). Visioning if conducted collaboratively can help building constructive imaginative capacity, empowering stakeholders to take ownership of their future, and creating accountability for implementation.

Recent research has synthesized a set of design guidelines for sustainability visioning, such as incorporating adequate methods and participatory processes for constructing and/or appraising a sufficient level of sustainability, systemic relations, consistency, and plausibility of visions (Wiek and Iwaniec 2013). Current visioning methodologies comply with some of these guidelines. For example, the visioning study conducted by Nassauer and Corry (2004) puts emphasis on plausibility appraisal and target specification in the construction of visions for agrarian landscapes in Iowa. Uyesugi and Shipley (2005) describe a visioning study with a special focus on participatory processes involving minority groups in the construction of urban visions for neighborhoods in

Vancouver, British Columbia. The vision study conducted by Machler et al. (2013) pays special attention to consistency analysis in the construction of a vision for neighborhood accessibility in Phoenix, Arizona. However, the current state of visioning research and practice leaves room for improvements. The field is urged to develop and test sustainability visioning methodologies that adheres not only to one or some of the design guidelines, but *all* of them.

This article presents a novel approach for criteria-based sustainability visioning. The methodology is called *SPARC*, an acronym composed of key methodological features: **S**ystemic, **P**articipatory, **A**ction-oriented, **R**elevant, **C**onsistent (= *SPARC*); it intends to connote with "sparking". The *SPARC* methodology has specifically been designed vis-à-vis the set of currently recognized design guidelines (Wiek and Iwaniec 2013). *SPARC* therefore considers systems relations, coherence, sustainability principles, relevance, and specificity; combines extractive and interactive public participation (capacity building); and links creative with formalized activities. Because of the fairly sophisticated methodological procedures incorporated, we refer to *SPARC* as a sustainability visioning *research* approach. Yet, the article adopts a broad notion of "research" as structured knowledge generation based on a set of design guidelines, corresponding to quality criteria for the aspired visions. The article intends to support both sustainability researchers *and* professionals, and, in fact, strives to bridge vision research and practice (Myers and Banerjee 2005; Minowitz and Wiek 2012; Iwaniec and Wiek in review).

We first present *SPARC* in theory and then provide examples of *SPARC* applications in sustainable urban development research from Phoenix, Arizona.

SPARC offers guidance on how to rigorously create and craft sustainability visions. While the methodology has a strong conceptual foundation in the design guidelines, actual *SPARC* applications have proven to be challenging in several respects. While providing a constructive framework, the article also offers researchers, professionals, and students a critical perspective on the challenges and pitfalls that are often connected with visioning practices. With this, we intend to contribute to a continuous improvement of visioning across various domains of research and application.

Design guidelines for sustainability visioning

Neither creative nor formalized skills *alone* can provide the substance that is needed for complex cognitive, intellectual, and emotional tasks such as developing sustainability visions (Wierzbicki 2007). The combination of creative *and* formalized skill sets is needed to create and craft sustainability visions. Yet, current visioning approaches often rely heavily on creative and unstructured processes, leading to results that might be inspirational but usually do not hold up to other criteria such as accuracy, coherence, or effectiveness (Shipley 2002). Similarly, advanced visioning requires balancing abstract reasoning, such as engaging sustainability principles, with specifications to make visions tangible, for examples, by means of visualizations (Shaw et al. 2009).

Wiek and Iwaniec (2013) have reviewed visioning literature scattered over different strands of literature to synthesize design guidelines for sustainability visioning methodologies (Tab. 1). The design guidelines are directly derived from a set of quality criteria for visions – based on the idea that sustainability visioning needs to adhere to certain standards in order to create and craft quality visions. The design guidelines are presented here because they guided the composition of the *SPARC* methodology, which is described in the next section.

Table 1 Design guidelines for visioning methodologies (based on Wiek and Iwaniec 2013)

Quality Criteria	Design Guideline	Visioning Method
Visionary	Methodology needs to be capable of generating future-oriented and normative elements (statements, visuals, etc.), as well as differentiating between transformational and incremental features of those elements.	Vision review
Sustainable	Methodology needs to be capable of generating a vision that complies with sustainability principles	Sustainability appraisal
Systemic	Methodology needs to be capable of representing the systemic interrelations within a vision	System analysis
Coherent	Methodology needs be capable of identifying and resolving conflicts and trade-offs within a vision	Consistency analysis
Plausible	Methodology needs to be capable of analyzing and enhancing the evidence base of a vision	Plausibility analysis
Tangible	Methodology needs to be capable of specifying a vision by means of indicators, targets, and vision pool elements	Operationalization
Relevant	Methodology needs to be capable of articulating the activities, roles, and responsibilities of people in a vision	Actor-oriented analysis
Nuanced	Methodology needs to be capable of prioritizing the elements within a vision and thereby providing guidance on what to focus attention and resources on	Priority assessment
Motivational	Methodology needs to be capable of creating a vision that is inspirational towards implementation and action	Creative techniques (e.g. story telling)
Shared	Methodology needs to be capable of a generating a critical degree of convergence, agreement, and support of a vision by relevant stakeholders	Participatory settings

SPARC methodology for sustainability visioning

SPARC offers a variety of options for designing visioning processes and is a domain-general procedure, in that can be realized in visioning processes for different types of organizational units (e.g. city administration, corporation, non-profit organization, etc.), topics (e.g. energy, water, transportation, food, health), spatial scales (from local to global), and temporal scales (1-100 years into the future). The concept of sustainability allows for a variety of valid visions (Swart et al. 2004; Wiek and Iwaniec 2013).

Furthermore, different stakeholder groups might have different ideas on what a desirable future might be – not all of them compatible or in alliance with sustainability principles (Minowitz and Wiek 2013). Key features of the *SPARC* methodology therefore respond to challenges of how to facilitate visioning activities across different stakeholder groups; how to map diverse visions and synthesize them; and how to navigate pluralistic visions while striving for compliance with sustainability principles. Thereby, *SPARC* moves beyond consultative forms of public engagement, climbing "the ladder of participation" (Arnstein 1969), to approaches that creatively engage and empower the community (Talwar et al. 2011; Lang et al. 2012; Shipley and Utz 2012). *SPARC* incorporates deliberation and negotiation techniques that explicitly address surprise, disagreement, confusion, objections, and other critical elements of rich visioning processes. *SPARC* builds capacity not only for creating and crafting sustainability visions that are inspirational for and shared among different stakeholder groups, but also increase capacity in systems thinking, future thinking, and value thinking required for sustainability problem solving (Wiek et al. 2011).

SPARC is structured in a sequence of five phases for conducting sustainability visioning processes in research and practice (Fig. 1). It starts with *framing* by way of defining the domain, scope, and scale of the vision (Phase 1); *eliciting* vision elements and composing them into a preliminary sustainability vision (Phase 2); continues with *analyzing* the elicited material (Phase 3); *revising and recomposing* the sustainability vision (Phase 4); and concludes with *disseminating* the vision products (Phase 5). The sequence of activities among the phases is designed such that creative and analytical procedures recursively inform one another. Phases 2 and 4 encourage and enable creative processes, while phases 3 and 4 incorporate a variety of analytical procedures. Phases 1 and 4 are conducted iteratively throughout the *SPARC* process to revisit and respond to emergent needs. All phases are performed in facilitated collaboration across all relevant stakeholder groups (see sections below).

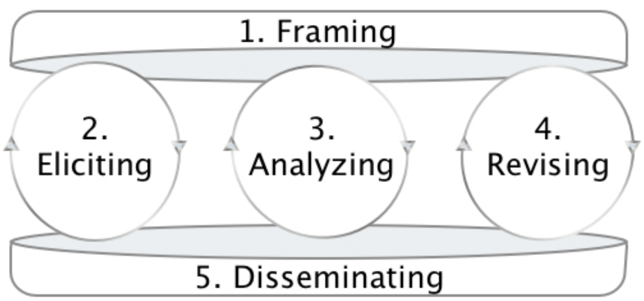


Fig. 1 *SPARC* phases

Five-phase visioning methodology from framing through eliciting vision elements and drafting an initial vision, analyzing and deconstructing it, revising and recomposing the sustainability vision, to iterative and final dissemination of visioning processes and products.

Phase 1 – Framing the visioning study

The first phase establishes 'what will be of concern' in the visioning process. This phase orients the visioning process with regard to aspects such as the sectors of interest, spatial or institutional boundaries, timeframes, intended specificity and detail, partnerships, and the participatory scope. Sustainability visions are holistic and systemic, however this acknowledges that not everything can be included and that the selection of domains, scope, and scale are done intentionally and thoughtfully.

Researchers and practitioners initializing this phase (since, visioning processes may not always be able to initialize with broad representativeness from the onset) must be aware of the pivotal role of early conditions. Backward planning of the visioning process and products will help anticipate initial needs and identify available resources. For instance, stakeholder-mapping approaches (i.e. systematically exploring who might be impacted, influential, under-represented, etc.) will be useful in identifying potential partnerships and the initial participatory scope of this phase and for subsequent phases. Initial framing of the visioning process should be comprehensive, but not inflexible or finalized. This balance can play out in different ways: more deductive approaches (e.g. starting from specific normative concepts or principles) need to get complemented by unforeseen vision elements brought up in the process; more inductive approaches (e.g. starting from bottom-up responses and narratives) need to engage with over-arching normative concepts and principles at a later stage. Either way, the framing phase will need to be revisited, and, to some extent, amended throughout the visioning process to review and incorporate emergent needs.

Phase 2 – Eliciting vision elements and drafting an initial sustainability vision

The goal of this phase is to create the first draft of the sustainability vision. As the start for the vision, non-legacy thinking and creativity are important in this phase. This early draft of the vision is produced by collecting descriptions of the desirable future, a so-called *pool of vision elements*. Outcomes from this phase may resemble those from traditional visioning approaches, but here this phase serves as an initial elicitation of stakeholder values and perspectives, as well as capacity building for crafting the vision in subsequent phases. Systems analysis, sustainability appraisal, and other analytical and evaluative procedures follow in the revision and re-composition phases 3 and 4.

Approaches to elicitation: '*tabula-rasa*' *and responsive procedures* – The first step of phase 2 encourages creativity about the aspired future state. We propose a procedure that combines 'tabula-rasa' and responsive approaches to elicit vision elements: participants are invited to suggest vision elements (‘tabula-rasa’ approach) as well as *comment on* these vision elements (responsive approach).

‘Tabula rasa’ approaches usually employ open questions such as “Imagine the best version of [vision subject] in [spatial specification] in [reference year]; what do you see/hear/smell/experience/etc.?” to elicit a pool of vision elements or full narratives. Different activities should be combined to encourage creativity and rich descriptions, make the visions tangible, and capture the diversity of the vision. Short video interviews or verbal storytelling can describe what participants imagine doing in the ideal world on a given day (“What do you imagine doing in this ideal world on Wednesday, March 12, 2050?”). Illustrations can be sketched to imagine a day in the life of a given person. Place-based activities such as walking audits, bus tours, and virtual tours (e.g. GIS mapping and rendered simulations) can further encourage creativity and spatial exploration of vision elements.

Responsive approaches elicit vision elements by prompting responses to previously compiled narratives, images, videos, and audio material, by asking participates to craft representative narratives and visualization from previously compiled vision elements, or by selecting elements and preferences from a pre-defined vision pool. For example, vignette-based and visual preference surveys, serve to make the imagined future tangible and to elicit preference and descriptive responses. Vision pools might include: photos, photo-realistic renderings, drawings, sketches, video clips, stories, recorded sounds, etc. Approaches may be combined sequentially (e.g. ‘tabula rasa’ first, then adding elicited vision elements to a pre-defined vision pool to select from) to expand the vision pool.

Both approaches can be conducted by each individual participant or as a group. Individual engagement settings (i.e. analog or web-based surveys, interviews, and interactive activities) can reach a larger audience, but at the potential cost of the level of engagement. Conducted as in group activities, the goal is to decide whether descriptions are adequate and that the illustrations match and represent the vision elements.

Prioritization – The next step is tasked with the initial prioritization and organization of the vision elements: priority (Which vision elements do you value most?), temporal priority (What is the sequence of the envisioned changes?), and spatial priority (Where should the changes take place?). Vision elements are prioritized to get an initial understanding of the ranking of the individual elements and the overall structure of the vision. Initial organization of the elicited vision elements into domains or using sustainability principles or pre-selected themes to elicit the vision elements can encourage comprehensiveness and enhance representativeness. This can be used in preparation for and allow for broader engagement in data analysis (Phase 3) by conducting participatory exploration of similar and conflicting vision elements and relationships within and across domains.

Structuring the elicitation and compiling the results – The overall procedure of eliciting, organizing, and compiling the vision elements can be structured as consensus-oriented (Susskind et al. 1999), diversity-oriented (van de Kerkhof and Lebel 2006) or both (i.e. mapping diversity first, then building consensus). The diversity-approach is especially useful for larger groups and institutions where multiple Phase 2 activities are conducted with different groups of participants. Diversity can be elicited on different levels (e.g. for corporations diversity can be elicited among individuals, teams, stakeholder groups, departments, or institution). Drafting the initial vision is accomplished by listing the vision elements (i.e. laundry list) or optionally combining them into the categories or domains. Whereas consensus-oriented elicitation will result in a single shared vision of prioritized vision elements, the diversity-oriented approach will result in several visions displaying the similarity and heterogeneity of the different stakeholder groups.

The activities in this phase should be as creative and interactive as possible. Use explicit techniques to enhance creativity and uncouple people from the current state and problems (van de Kerkhof and Wieczorek 2005). While, few recommendations on enhancing creativity have been rigorously evaluated (Shneiderman et al. 2006), a number of creativity techniques have been developed for use in future-oriented research (Vidal 2004; Brabandere and Iny 2010; Varum and Melo 2010) and specifically for visioning studies (see examples from Future Workshops (Jungk and Müller 1987), Imagination Studio (Eickhoff and Geffers 2007), Vision Fair (Uyesugi et al. 2005) and Walking Audits (Xiong et al. 2012)). To ensure the emphasis on creativity does not lead the participants off track, design guidelines (i.e. sustainability principles) can be incorporated (in the form of an ex-ante appraisal; per the methods in phase 3) into the creation of the vision pool to which people are asked to respond. The activities are facilitated primarily to balance inputs and give guidance (task compliance). In addition to other typical process-based support, the facilitators might also need to: ask 'why' questions, ask for clarifications (e.g. what might that look like or optionally help structure the individual narratives in categories such as economy, community, etc.), make sure that the narratives are vision narratives (i.e. normative and future-oriented), make sure they consider the vision's framing (per phase 1), record data, and work with other facilitators such as artists and other creative practitioners. Keeping this phase simple allows for increasing complexity in subsequent phases as capacity has increased.

Phase 3 – Analyzing and assessing the sustainability vision draft

The goal of this phase is to reveal the basic structure of the drafted vision and evaluate the vision for systemic coherence and sustainability. In this phase the vision narratives are deconstructed and coded (e.g. content analysis) into generalized vision elements with their associated specified preferences (qualifiers). Vision qualifiers provide context and specificity for normative, spatial, organizational, and temporal preferences associated with the vision elements. For example, the narrative "water is used in 2050 in a way that demonstrates appreciation and responsibility for this precious good" would be deconstructed to: "water consumption" being the element and "appreciative" and "responsible" as the associated normative qualifiers.

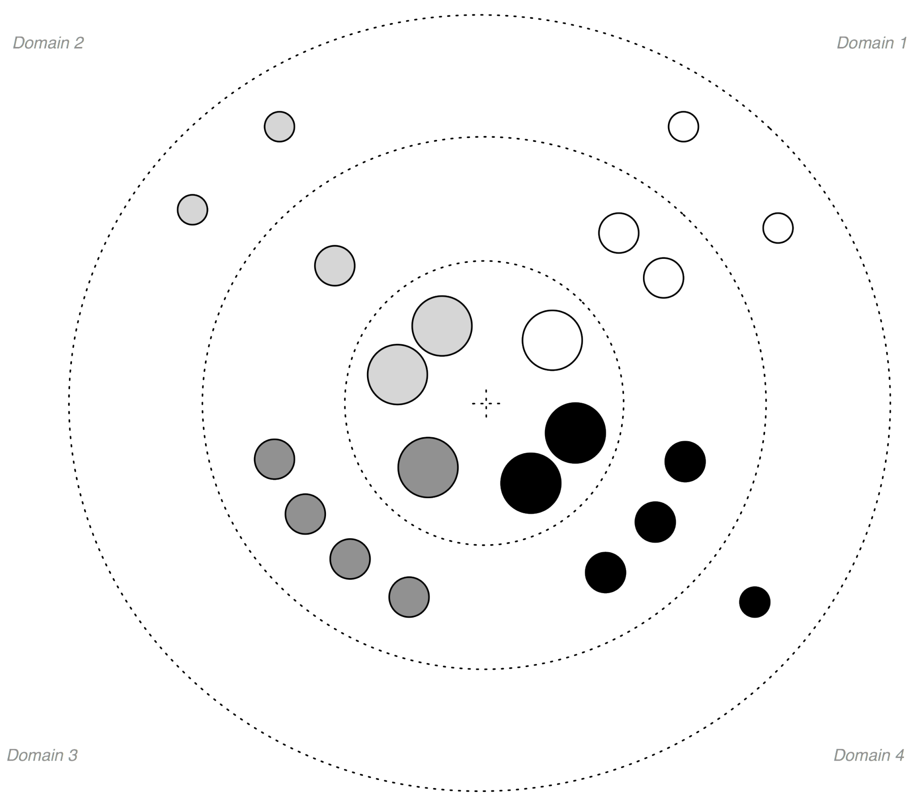
The vision elements are all analyzed to determine high priority vision elements, clustering of related elements and qualifiers, systemic relationships among elements, overall structure of the vision, potential trade-offs and synergies between different elements, conflicts among the same element with different preferences, underlying assumptions, and fulfillment of sustainability principles.

Vision review – The vision review procedure can occur before or during the coding process to assess and validate the normative quality of the vision. The end result is to ensure that the vision draft describes a desirable state in the future. Synthetic of the vision elements, the overall vision is checked for comprehensiveness and holistic perspective. Individual elements and the overall vision are assessed for qualities that are future-oriented (i.e. long-term, far-sighted, and anticipatory) and aspirational (i.e. utopian thought, motivational, ambitious surprise). Non-compliant narratives, such as statements that are negative (we do NOT want…), referential (better than…, less of…), or outside of framing scope (Phase 1), can be rearticulated by the respondent if done in a participatory setting. Otherwise, inferential guidelines need to be specified for non-compliant narratives during the coding process or identified as excluded from the data set.

Priority assessment – Visions are composed of various elements and not all of them are of equal desirability. Priority assessment, the statistical analysis of priority values, allows for nuanced representation of complex value-laden preferences (Robèrt 2005; McDowall and Eames 2007). Simple ranking of priority scores can be highly informative in identifying critical vision elements. More sophisticated statistical and visualization techniques (see vision maps in subsequent section) allow for nuanced exploration of patterns among diverse stakeholder groups. However, prescriptive universal approaches to statistical analysis are problematic in that the *SPARC* visioning process is flexible to varying contexts and conditions. Analysis and results should be explored and validated in participatory settings.

Visualizing preferences and representing diversity – In the consensus-oriented approach, the results are represented in a systems map of the vision (vision map) representing the generalized vision elements (Fig. 2). The vision map is used to visualize the vision and the priority of individual elements. Associated qualifiers can be overlaid on the vision map to provide richer understanding of vision elements. In figure 2a, the example vision map organizes the vision elements using ordinate position and color to visualize the elements clustered along thematic domains and priority rankings.

For the diversity-oriented approach, before the vision map can be created the vision elements may require initial clustering in order to reduce the number of elements (i.e. diversity analysis). The counts and priority scores for the vision elements may also be normalized to account for multiple Phase 2 activities with different groups or across the same participants through time. This results in a standard map of the aggregate vision (Fig. 2a). Mapping preferences around associated vision elements may highlight potential normative conflicts to be addressed in a subsequent step. Figure 2b, illustrates an individual vision map displayed in relation to the aggregate vision in order to identify similarities and differences among the different visions.



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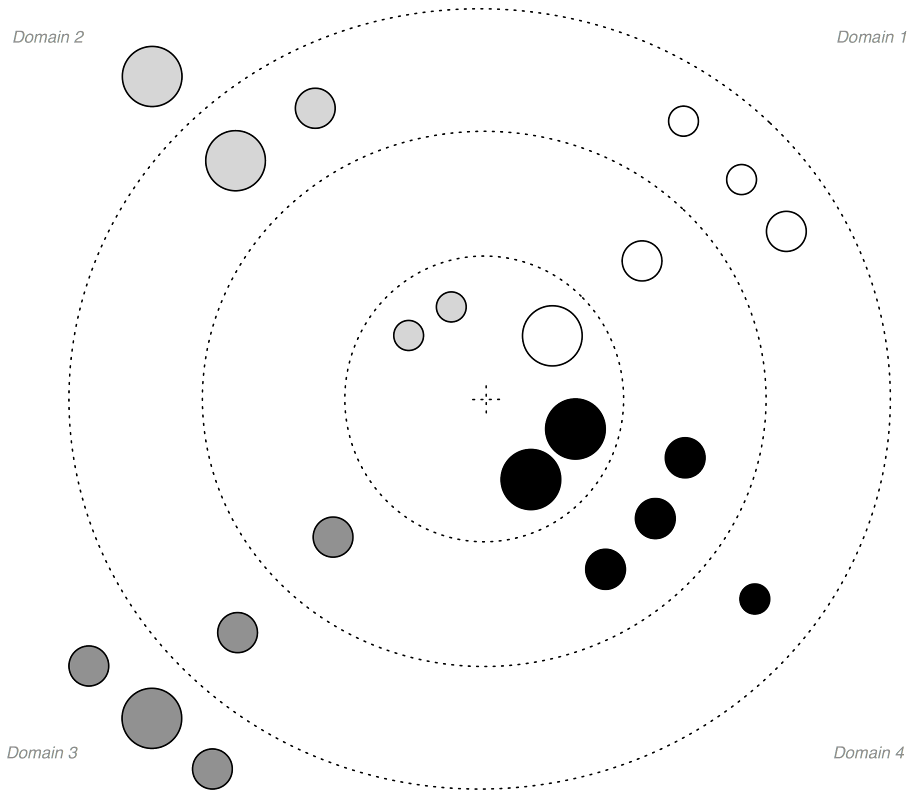

2b

Fig. 2 Vision maps for consensus and diversity-oriented approaches

2a. The example vision map organizes thematic domains (e.g. economic, environment, community, infrastructure) by quadrant position and/or color; and represents priority scores by size and/or centrality. The vision map indicates the key vision elements for each domain (highest priority scores; ca. 5 per domain) and for the overall system (e.g. city, company, etc.; ca. 20 total)

2b. The diversity-oriented approach may result in several different vision maps. This example illustrates similarity and difference between a single stakeholder group's vision and the overall "standard" vision or another stakeholder group. Where there is consensus with the "standard" vision, large vision elements are centrally located and smaller ones are located along the perimeter (or outside of the vision map if not identified as a high priority element). Differences among the visions have larger vision elements further away from the center or smaller ones centrally located.

System analysis and consistency analysis – Direct and indirect relationships among vision elements, directionality of relationships, and system-level connectivity of vision elements are identified in the system analysis (Vester 1988; Wiek et al. 2008; Videira et al. 2010). A weighted accounting of a vision element's priority score based on its systemic importance provides a system-level calculation for the priority scores. Potential conflicts and synergies are being identified through a consistency analysis (Tietje 2005; Wiek and Walter 2009). They can be illustrated on vision maps of the subsystems (Fig. 3). The aim is to ensure that the vision is composed of compatible goals and free of conflicts (Wiek and Binder 2005; Grunwald 2007; Potschin et al. 2010). The two predominant forms of potential conflicts are preference heterogeneity (zeroth-order normative conflicts among different stakeholder preferences associated with the same vision element) and system trade-offs (first-order systems conflicts among elements with direct relationships). Further analysis can be conducted for indirect system trade-offs at the system-level (e.g. conceptual models and causal-loop diagrams to identify positive and negative feedbacks and distal incoherence across subsystems). Conflicts among stakeholder preferences will have already been resolved in a previous phase, if consensus-oriented elicitation was conducted, otherwise should be identified in this step. Conflicts and synergies are indicated when the enhancement of one element (or subsystem) results in a correspondingly undesirable or desirable outcome of an interconnected element.

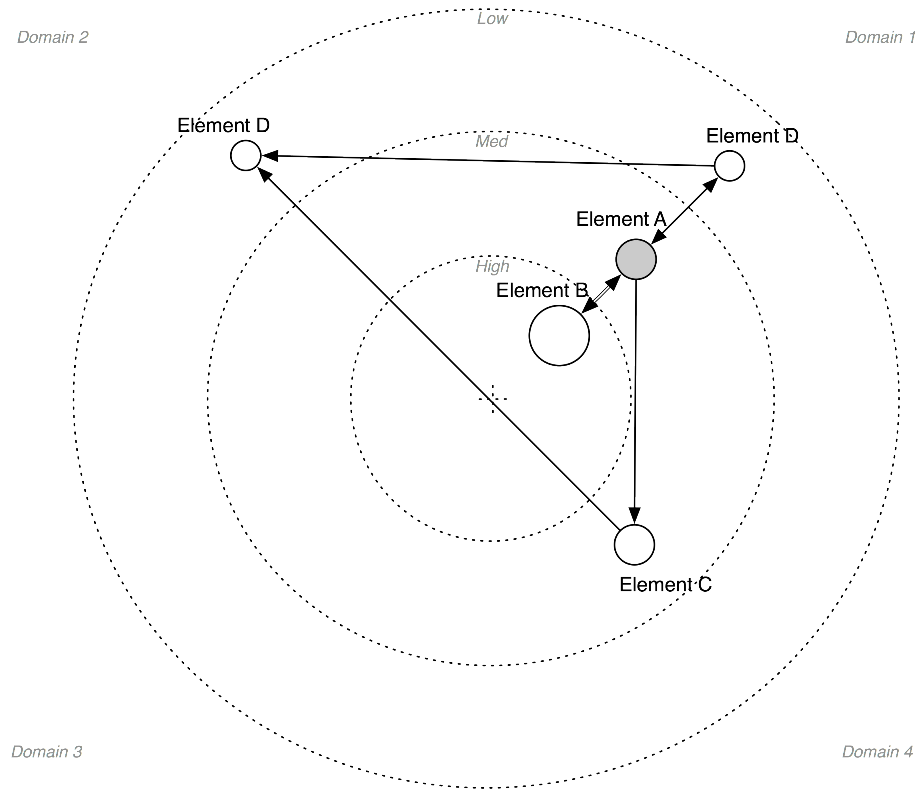

Fig. 3 Subsystem vision map
Linkages represent direct systems relationships among vision elements surrounding the subsystem for element A. Arrowheads on the linkages represent directionality of the relationships (cause-effect/influences). Double-stroke linkage represents potential conflicts between elements A and B.

Operationalization – This step is operationalizing the vision (linking it to specific targets and indicators). Some of the specified preferences may indicate clear detailed targets, while others might only contain vague descriptions. Vague descriptions need to be operationalized so that each of the vision elements have clear qualitative and/or quantitative measures. Target specification lies in between being excessively exacting and indistinct, that is, it provides sufficient detail to comprehend and operationalize the vision, while still leaving room for inspiration and flexibility. Targets and indicators should be informed by sustainability principles, evidence-based parameters, system relationships and thresholds, and provide a transparent and measurable endpoint for the future desirable state (Wiek and Binder 2005; Rockström et al. 2009). The integration of creative procedures, such as the incorporation of representative visuals, will enhance the selection and assessment of sustainability indicators and targets. Qualitative and quantitative targets include descriptions of critical features of the future desirable state (e.g. referential end-points, sustainable trajectories, and thresholds).

Sustainability appraisal – The following step checks the vision elements (and the overall vision) against a set of sustainability principles. At its core, the introduction of sustainability principles is designed to facilitate the dialogue of the basic qualities of a future desirable state. Several sustainability assessment approaches have been developed (Gibson 2006; Ness et al. 2007; Wiek and Larson 2012), and some applied to sustainability of a vision (Wiek and Binder 2005; Weaver and Rotmans 2006; Minowitz and Wiek 2013). While more prominent syntheses of sustainability principles from the literature will be useful in the formation of a set of principles useful for evaluating the vision, an important consideration in the selection process is stakeholder saliency.

Plausibility analysis – The tension between a vision being sufficiently evidence-based and relevant while also being aspirational and transformational is important to acknowledge; imbalance could result in status-quo or at the other extreme fanciful images of the future (Wright 2010; Wiek et al. in press). Evidence-based examples that have been implemented in the past, elsewhere in the world, or have been otherwise demonstrated realizable (e.g. concept proofs, empirical studies, pilot projects, and extend peer-reviews) can be used to substantiate an idea – for some statement can be substantiated more/less than others. Transformational qualities emphasize aspirational and innovative changes to structures and functions, trend-breaking trajectories, and processes that are catalytic to the larger system. Reviewing to what degree a vision is sustainable, transformative, and substantiated, allows for reflection on the type of vision being created and provides insight for designing subsequent participatory activities.

Actor-oriented analysis – This methodological procedure includes a detailed accounting of relevant actors (individual and organizational stakeholders) and their activities, interactions, needs, and roles specific to the vision (Meadows 1996; Wright 2010; Wiek and Larson 2012). This should describe what actors are doing, how actors interact, why they are doing it, how they are affected, and what are their responsibilities. Depending on the scope of the vision, we may even more profoundly envision, who we will be as society and human beings (what our skills, fears, dreams, and values will be).

Results from this phase are a prerequisite to designing the subsequent participatory activities (in Phase 4) by identifying where further revision needs to be targeted. All parts of the analysis will be discussed with the participants. This phase results in a vision profile (and vision maps) that indicate:

1. the generalized elements of the vision and priority ranking of the elements
2. specified preferences
3. systemic structure of the vision
4. underlying value structure
5. compliance or non-compliance with sustainability principles
6. potential conflicts, trade-offs, and synergies
7. transformative potential and plausibility of the vision
8. operationalized targets and indicators

Phase 4 – Revising and recomposing the sustainability visions

This phase of the visioning process pursues the goal to revise and recompose the analyzed vision. The process of revision and recomposition is initiated by reviewing the previous visioning steps, the vision profile from Phase 3, and highlighting where further revision needs to be targeted. This allows participants to become aware of the improvement potential in the vision draft as well as to gain inspiration from the vision.

Vision review for revising – The first step is the review and refinement of the vision elements (and associated qualifiers). Similar to the vision pool activity in Phase 2, crafting and selecting rich descriptions (in the form of images and narratives) allow participants to become familiar with the vision elements and serve to make the imagined future tangible. The underlying guiding questions for this step are: Do the vision elements adequately and comprehensively represent the future desired state? Are there missing elements? Are there elements we could remove? Are all elements adequately prioritized? Is the vision visionary? Is the vision plausible? Is the vision sustainable? Is the vision complete?

Next is to review and revise systemic linkages. The activity is to discuss the systemic relationships and to decide whether the important systemic links between the elements are adequately represented. The tasks for this step are to add, remove, and clarify relationships (including potential conflicts and synergies) on the vision maps. As they are potentially easier to miss, it is important to explicitly emphasize a review for future relationships that may not exist in the current state. These first two steps serve as a review and check of Phase 3 materials, but will also be iterative throughout the Phase 4 process as the vision is further revised (per the subsequent methodological steps).

Reprioritization – The second step focuses on the vision elements that require further revision (e.g. resolving potential conflicts among vision elements; differences among spatially explicit preferences, systemic trade-offs; non-compliant with sustainability principles; non-visionary; non-plausible; vague targets and indicators). This is a rich task that relies on negotiation and consensus building to explore and reconcile potential deficiencies in the vision product. Starting from the GIS maps and vision maps from the previous phase will facilitate exploring the focal elements while ensuring a holistic perspective of the vision.

The activity consists of exploring possible options by: adding or removing elements to change the system constellation; changing the priority of elements (i.e. size and position of the vision elements); or provide a description of the relationship, what it would look like, how it might interact with other elements, and where are the changes taking place. Whenever a change is made, the participants will evaluate their new system constellation. This activity is played out across the entire comprehensive vision map, with all vision elements, until all potential conflicts have been addressed.

The activity is also utilized to explore how the issue is or could be made sustainable (based on which parts do not comply and which parts are synergistic with the sustainability principles). This step can start with the sustainability principles identified from previous phases, but should be reviewed and revised into a set of salient sustainability principles. The newly revised system constellations are to be explored in a similar approach as above, but the activity here is to address vision elements (and subsystems) that potentially conflict or that are synergistic with the identified sustainability principles.

Recomposition – The final step is to compose, from the revised material, an overall sustainability vision. The GIS maps and revised vision maps serve to display (i) a spatial representation of the vision; (ii) the systemic attributes of the vision; (iii) synergistic relationships; (iv) the relationship of the vision to sustainability principles. Narratives and illustrations of the vision are crafted by interweaving the descriptions and targets of the GIS and vision maps (i.e. a description of preferences, what co-existing elements look like, how it might play out, where changes are occurring, what are specific people doing and how they will be affected). As much rich details as possible are included in the vision narrative and illustrations (i.e. descriptions of vision elements, relationships, operational targets, and important synergies) with an emphasis on specific people and places. As a final review, it might be useful for capacity building to compare the composed vision with the initial draft resulting from Phase 2.

This phase is highly interactive and facilitated. Creativity enhancing processes can be preformed iteratively or combined with the analytical steps. Activities such as game playing, illustrating, story-telling, and vision pools should be used to explicitly enhance stakeholder engagement and inspiration while staying relevant to the overall process and outcomes. Gameplay with the vision maps (cf. Iwaniec and Wiek in review) can be used in this phase to reprioritize the vision, achieve the best balance among trade-offs for desirable outcomes, and negotiate targets. Developing creative illustrations and narratives (e.g. a day in the life of…) used to specify and describe the recomposed vision will also contribute to its tangibility.

In addition to inviting participants from the previous phases, further participant recruitment might be beneficial if there were gaps in representativeness. Inviting experts and partners, related to the different domains and issues touched upon in the vision, will inform discussion about potential revisions. It is important that the role of experts is not based on decision-making, but they provide information, respond to questions, and stimulate reflections on coherence, sustainability issues, etc. Larger engagement settings may benefit from organizing workshop activities around small mixed-group work (e.g. focused on specific conflicts or divergent preferences) between introductory and wrap-up plenaries (e.g. for initial review of vision drafts and the process used to develop them and final reflection and discussion on the shared vision). As in the other phases, the role of facilitators is mainly balancing inputs, ensuring task compliance, documentation, and encouraging needed descriptive context. Strong facilitator training for managing negotiation cannot be over emphasized and will aid in resolving potential conflicts and power dynamics.

Phase 5 – Disseminating the visioning results (vision)

Disseminating the final version of the sustainability vision entails more than just meaningfully conveying the future state that is described in the vision. Dissemination is not just happening at the end, it is dispersed throughout the process (Fig. 1). This ongoing phase engages the broader community with the vision and visioning process to further elicit preferences, check representativeness, develop opportunities for further recruitment of participants, and support transparency. Documentation of the procedures and outcomes (including capacity building outcomes) will aid in transparency and support longitudinal comparisons across the phases within the visioning study and successive cross-study comparisons of the vision methodology.

Embedding the participants into the dissemination process using quotes, photos, and direct involvement will facilitate and maintain existing buy-in, accountability, and transparency. The final vision uses narratives and visuals that are explicitly motivational and action-oriented (accounting for actors, actions, structures, dynamics, and places) in order to spark activity toward realizing the vision. Creative practitioners will be important in preparing design, art, games, and performance-based approaches. Explicit targets, indicators, thresholds, their systemic linkages, and priorities should be highlighted to provide clear guidance for operationalizing the vision.

SPARC visions craft the targets and goals to intentionally guide the strategies and pathways for sustainable and desirable changes. However advanced the visioning process, needs and aspirations are dynamic and will require successive reviews and iterative visioning processes. Furthermore, however motivating the visions are, alone they are often not a sufficient driver for catalyzing transformational changes. Sustainability visions need to be incorporated into the designing, implementing, monitoring, and evaluating of policies and programs.

Table 2 Key methodological steps and outcomes of *SPARC*
Steps in the Framing and Disseminating phases are conducted iteratively throughout the *SPARC* process.

Phases	Steps	Outcomes
Phase 1: Framing	Frame setting & planning	Content, process & anticipated needs
	Stakeholder identification	Participatory design
	Stakeholder recruitment	List of participants
Phase 2: Eliciting	Elicitation & creative techniques	Vision pool
	Prioritization	
	Ex-ante appraisals	
		Compilation of indicators and targets
	Compilation	Vision draft
Phase 3: Analyzing & Assessing	Vision review	Analyzed vision draft
	Priority assessment	(data on all criteria)
	Diversity analysis	
	Systems analysis	
	Consistency analysis	
	Sustainability appraisal	
	Plausibility analysis	
	Actor-oriented analysis	
	Operationalization	
Phase 4: Revising & Recomposing	Review	Revised vision draft
	Reprioritization	
	Recomposition	
Phase 5: Dissemination	Documentation	Final vision
	Visualization	(after final iteration)

How *SPARC* follows the design guidelines

The *SPARC* approach was designed to comply to *all* quality criteria and design guidelines for sustainability visioning. Table 3 summaries methodological steps incorporated in *SPARC* in order to highlight how each design guideline is addressed. Creative and formalized techniques are combined to conduct the methodological steps and fulfill a variety of process functions, including developing sustainability indicators and tangible targets using visually-enhanced assessments and building capacity for systems perspective through the use of systems-based board games (in phase 4). In that all phases are participatory, methodological aspects of the participatory setting are ubiquitous throughout the *SPARC* methodology. Emphasis is given through procedures such as: participatory identification and recruitment in Phase 1 to check representativeness of participants; diversity and consensus-oriented approaches in the participatory setting of Phase 2 to capture the heterogeneity of values and preferences; group evaluation and negotiation in Phases 3 and 4 to support meaningful engagement to identify and resolve deficiencies and in recomposing of the final vision; and creative techniques for dissemination in Phase 5 to communicate, inspire, and motivate the broader community to engage in the visioning process or implementation of the vision.

Table 3 How *SPARC* follows the Design Guidelines
Detailed techniques and procedures for each step are provided in Section 3.

Quality Criteria	Design Guideline	Steps (and Phases)
Visionary	Methodology needs to be capable of generating future-oriented and normative elements (statements, visuals, etc.), as well as differentiating between transformational and incremental features of those elements.	Frame setting (1) Elicitation (2) Ex-ante appraisal (2) Vision review (3 & 4)
Sustainable	Methodology needs to be capable of generating a vision that complies with sustainability principles	Frame setting (1) Operationalization (3) Sustainability appraisal (3) Reprioritization (4)
Systemic	Methodology needs to be capable of representing the systemic interrelations within a vision	Systems analysis (3) Reprioritization (4)
Coherent	Methodology needs be capable of identifying and resolving conflicts and trade-offs within a vision	Consistency analysis (3) Reprioritization (4)
Plausible	Methodology needs to be capable of analyzing and enhancing the evidence base of a vision	Ex-ante appraisal (2) Plausibility analysis (3) Recomposition (4)
Tangible	Methodology needs to be capable of specifying a vision by means of indicators, targets, and vision pool elements	Ex-ante appraisal (2) Operationalization (3) Recomposition (4)
Relevant	Methodology needs to be capable of articulating the activities, roles, and responsibilities of people in a vision	Ex-ante appraisals (2) Actor-oriented analysis (3) Recomposition (4)
Nuanced	Methodology needs to be capable of prioritizing the elements within a vision and thereby providing guidance on what to focus attention and resources on	Prioritization (2) Priority assessment (3) Reprioritization (4)
Motivational	Methodology needs to be capable of creating a vision that is inspirational towards implementation and action	Creative techniques (2) Recomposition (4) Documentation (5) Visualization (5)
Shared	Methodology needs to be capable of a generating a critical degree of convergence, agreement, and support of a vision by relevant stakeholders	Participatory setting (all phases)

Empirical illustrations - sustainability visioning in Phoenix

In this section we summarize three urban development projects that applied *SPARC* in Phoenix, Arizona. We first describe the projects, then identify key differences (Tab. 4), and finally discuss some of the challenges in applying the *SPARC* methodology in real-world sustainability projects.

SPARC was first applied in the General Plan update in Phoenix, which is the city's long-range planning document to guide urban development in the future (up to 2050). Researchers from ASU's School of Sustainability, planners from the City's Planning Department, and different stakeholder groups engaged in analyzing the current state of Phoenix, crafting future visions and scenarios, and developing transformative sustainability strategies, which have been incorporated into the General Plan Hearing Draft in 2010 (Wiek et al. 2012). The project aided the City of Phoenix in conducting its first stakeholder engagement in 30 years (related to the General Plan), engaging more than one hundred citizens, businesses, non-profit organizations, and other stakeholder groups. Framing of the project focused on state mandated planning elements and "the three pillars of sustainability," namely *Environment*, *Community*, *Economy*; plus a forth domain, *Infrastructure*. Vision elements comprising the initial vision draft were elicited primarily from open-ended questions in multiple participatory forums across Phoenix. Analytical steps focused on the systemic structure of the bottom-up elicited vision elements and identifying potential conflicts and trade-off resulting from the diversity-oriented approach. Revising and recomposing of the vision took place in a single large-scale participatory event using game-based approaches that further emphasized inter-relationships (i.e. trade-offs and synergies) among vision elements and negotiating normative differences. Iwaniec and Wiek (in review) detail the General Plan visioning process up to the General Plan Hearing (2010) to the Phoenix City Council. The General Plan update is currently ongoing and scheduled to be ratified by public vote in 2015.

SPARC was then applied multiple times, while being further develop, in a multi-year transit-oriented urban development project in Phoenix, the "Reinvent Phoenix" grant, which was won by the City of Phoenix in collaboration with Arizona State University and other partners. The grant is funded through the U.S. Department for Housing and Urban Development's (HUD) Sustainable Communities program. Over a three-year period (2012-2014), the project aims at creating a new model for urban development in Phoenix – one that improves quality of life while maintaining desirability and attainability for the entire spectrum of incomes, ages, family sizes, and physical and developmental abilities along the light rail corridor. The Reinvent Phoenix program eliminates physical and institutional barriers to transit-oriented development and catalyzes livable, sustainable development through transformational research and planning, regulatory reform, innovative infrastructure designs, economic development incentives, capacity building, and affordable housing implementation activities. Participatory research design ensures that a variety of stakeholder groups are involved in identifying strategic improvements that enhance safe, convenient access to quality, affordable housing, well-paying jobs, education and training programs, and fresh food and healthcare services. Reinvent Phoenix focuses on six topical elements: land use, housing, economic development, mobility, green infrastructure, and health; in five transit districts including (from east to west and south to north) Gateway, Eastlake, Midtown, Uptown, and Solano [Planning for the Downtown District of the light rail corridor is excluded from Reinvent Phoenix because of completed previous planning efforts, partly using transit-oriented development ideas]; and is structured into planning, design, and implementation phases.

SPARC was applied in all five districts of the light rail corridor; we are focusing here on the first two visioning studies conducted for the Gateway District and the Eastlake-Garfield District. The objectives of the visioning studies were manifold:

i) To generate a vision of transit-oriented and sustainable community development, specific to the respective transit district for the year 2040. The vision was expected:

a. To comply with a set of widely recognized quality criteria, including compliance with sustainability criteria, consistency, and specificity (Wiek and Iwaniec 2013).

b. To spell out specific formations of the vision in transition areas within the respective transit district that are distinct and recognizable.

c. To be generated through a variety of public engagements in order to integrate local knowledge, values, and preferences, as well as create public buy-in for the visions created (willingness to contribute to the implementation).

d. To integrate several formats, including descriptions, visuals, narratives, and operationalized targets (for specific indicators) to resonate with different audiences and provide information that can be used for various subsequent activities.

e. To be applicable in the transformational planning effort of Reinvent Phoenix that integrates visioning, current state assessment, and strategy building (Johnson et al. 2011). This requires coordination with ongoing current state assessment activities (indicator selection).

ii) To create a network of key stakeholders and residents who are willing to stay involved in the subsequent Reinvent Phoenix activities and phases (design and implementation) in the respective transit district (Johnson et al. 2011).

The second Reinvent Phoenix visioning study (Eastlake-Garfield) was explicitly intended to improve the process and content template for visioning research in the Reinvent Phoenix project that had been developed and applied previously (Gateway District) to further guide the Reinvent Phoenix visioning activities (Wiek et al. 2013).

Table 4 Breakdown of the *SPARC* phases and methodological approach of the three empirical examples

SPARC Phases	*SPARC* Steps	General Plan Update Phoenix – Vision Study	Reinvent Phoenix, Gateway District – Vision Study	Reinvent Phoenix, Eastlake-Garfield District – Vision Study
Phase 1: Framing	Frame setting & planning	City & university partnership; Domain-based framing	City & university partnership; Planning elements framing	City & university partnership; Sustainability principle framing
	Stakeholder identification & recruitment	Village Planning Committees & Community members	Expert panel & District community members	Expert panel & District community members
Phase 2: Eliciting	Elicitation & creative techniques	Participatory forums; 'Tabula rasa'	Participatory forums & Web survey; Responsive	Participatory workshop; Responsive Actor-specific narratives
	Prioritization	yes: Voting activity	yes: Visual preference survey; Vignette preference survey	yes: Visual preference survey; GIS priority mapping
	Operationalization	no	no	yes: Indicators & targets
	Ex-ante appraisals	no	no	yes: Sustainability assess. / visually-enhanced assessment
	Compilation	Diversity-oriented	Consensus-oriented	Consensus-oriented
Phase 3: Analyzing & assessing	Vision review	yes: Content analysis; Review; Vision map	yes: Review; Vision map	yes: Review; Vision map
	Priority assessment	yes: Vision map	yes: Vision maps	yes: Vision maps
	Diversity analysis	yes: Cluster analysis; Vision maps	yes: Vision maps	yes: Vision maps
	Systems analysis	yes: Causal loop diagram; Network analysis	no	no
	Consistency analy.	yes: Influence matrix	no	no
	Sustainability appr.	no	yes: Sustainabil. assess.	yes: Sustainabil. assess.
	Plausibility appr.	no	yes: Expert panel	yes: Literature review; Expert panel
	Actor-oriented analysis	no	yes: Actor-specific narrative	yes: Actor-specific narrative
	Operationalization	yes: Only relative quantifications for targets, no indicators	no	yes [see previous phase]
Phase 4: Revising & Recomposing	Review & Reprioritization	Participatory workshop; Vision pool-based review; Game-based systemic and sustainability evaluation	Participatory workshop; Visual preference survey; GIS priority mapping;	no
	Recomposition	Actor-specific narratives	Actor-specific narratives	
Phase 5: Dissemination	Review of documentation & visualization	Stakeholder review; City Council Hearing review;	City planners review; DPZ review	City planners review; DPZ review
	Vision dissemination	Ongoing: until 2015		

Discussion and conclusions

Central to the development of *SPARC* is the conviction that sustainability visioning should be based on standards of quality criteria and design guidelines, if it is to result in superior crafted visions. We need to advance the research and practice of sustainability visioning if we expect visioning methodology to be a serious tool to guide and direct sustainable transformational change. Numerous exemplary visioning approaches have been presented in the literature. In order to establish sustainability visioning as a research practice, key focus needs to be on criteria-based methodology to support visioning studies and successive cross-study comparisons. The challenge has been designing a comprehensive process that is methodological rigorous, inspirational and engaging, and knowledge generating.

SPARC is constructed from a set of design guidelines — based on a synthetic review of quality criteria — structured as a sequence of creative and formal procedures. Creative techniques are incorporated to inspire motivational and visionary thinking and to aid engagement for complex analytical and evaluative processes. The methodological steps are designed to reflexively conduct and evaluate visioning activities. The emphasis on the collaboration between practice and research is intended to take advantage of co-productive dynamics among designing, conducting, evaluating, and learning as a mode of reflexivity in research and practice (Schön 1983; Myers and Banerjee 2005). The diverse activities integrated into the *SPARC* phases, presupposes transdisciplinary settings (i.e. in contrast to researchers having a consultation/observation role, practitioners having a design/operational role, and stakeholders having an engagement role). Extending evaluative and review procedures to all core phases allow each phase to progress from basic levels of engagement such as eliciting, to analyzing and revising. Additionally, reiterations of the framing and dissemination phases throughout the process allow for a degree of in-process reflexivity.

Complementing the need for advanced approaches and transdisciplinary settings are the researchers and professionals with competencies to push forward sustainability visioning research practice. Specific to sustainability education, *SPARC*'s incorporation of creative, analytical, and evaluative skills may be applied to overcome related shortcomings in current programs and curricula (Ihsen and Brandt 1998; de Haan 2006; Wiek et al. 2011).

SPARC offers guidance on how to rigorously create and craft sustainability visions. While the methodology seems to be conceptually strong, actual applications have proven to be challenging in several respects. While providing a constructive framework, the article also offers researchers, professionals, and students a critical perspective on the challenges that are often connected with visioning practices. With this, we intend to contribute to a continuous improvement of visioning across various domains of research and application.

CHAPTER 4

ADVANCING SUSTAINABILITY VISIONING PRACTICE IN PLANNING – THE GENERAL PLAN REVISION IN PHOENIX, ARIZONA

Introduction

Sustainability, in terms of long-term viability and integrity of local to global societies, has become an important reference for how governments, companies, non-profit organizations, and civil society at large think about and plan for the future. This increased awareness accompanies concerns that conventional approaches may be inadequate to bring about a desirable and sustainable future (Robinson 2003; Newman 2005; Brewer 2007; Wiek & Iwaniec 2013). Explicit value orientation, long-term considerations, broad stakeholder participation, and social learning have been described as important elements of a novel approach to envisioning desirable futures.

For more than 10 years, urban planners and scholars have experimented with both incorporating sustainability ideas (Berke & Conroy 2000; Portney 2003; Bulkeley 2006; Newman & Jennings 2008; Schmitt Olabisi et al. 2010) as well as integrating more structured visioning approaches into urban planning processes (Shipley & Newkirk 1998; Okubo 2000; van Asselt & Rijken-Klomp 2002; Shipley et al. 2004; Wiek et al. 2005; Shipley & Michela 2006; Phdungsilp 2011; Sheppard et al. 2011; Robinson et al. 2011). Both attempts are synergistic and put emphasis on ideas of what the future *should* look like rather than what it *could* look like. The majority of cities in the United States have adopted visioning processes for their plan updates, often incorporating sustainability ideas; prominent examples include Imagine Austin (Austin, TX), GoTo2040 (Chicago, IL); PlaNYC 2030 (New York City, NY); VisionPDX (Portland, OR), The Sustainability

Plan for the City of San Francisco (San Francisco, CA), and Toward a Sustainable Seattle (Seattle, WA). These processes are usually characterized by: engaging a larger population (>1,000 participants); conducting surveys and public meetings; creating visions through lists of goals and targets (sometimes confounded with actions); and applying no explicit or fairly simple sustainability concepts (e.g. triple bottom line) in the creation of the vision.

Deficits have been identified in the current practice of urban visioning, in particular the lack of: systemic considerations that account for the complexity of cities; incorporation of advanced concepts and principles of sustainability; application of creativity-enhancing approaches; interactive public participation that allows for civic capacity building; and monitoring and evaluation processes (Shipley et al. 1998; Shipley 2002; Berke et al. 2006; Shipley & Michela 2006; Newman & Jennings 2008; Wiek & Iwaniec 2013). Thus, progress is needed in the development of advanced visioning approaches; in other words, there is a need for visioning *research*.

Visioning research, informed by sustainability concepts, is still at a nascent stage (Wiek & Iwaniec 2013). Despite increased recognition and an increasing number of visioning studies, academic as well as professional, there has been little research conducted on the quality of sustainability visioning processes and the produced visions. Robert Shipley has pioneered visioning research in planning studies since the late 1990s and key insights from his studies demonstrate the need for theoretical and evaluative research on visioning (Shipley & Newkirk 1998; Shipley & Newkirk 1999; Shipley 2000; Shipley 2002; Shipley et al. 2004; Uyesugi & Shipley 2005; Shipley & Michela 2006). A small number of evaluative studies provide insight on some visioning challenges. Helling (1998) developed and applied an evaluative framework to improve the initial framing and scope. Critical evaluation on participatory processes conducted by McCann (2001), Hurley & Walker (2004), Uyesugi & Shipley (2005), and Oels (2009) have highlighted the complexity of collaborative engagement in visioning projects. Berke & Conroy (2000) and Jepson & Edwards (2010) evaluated the incorporation, understanding, and balance of sustainability principles in urban planning, including visioning. A recent review of the academic literature on visioning synthesizes a set of quality criteria and design guidelines specifically for sustainability visioning (Wiek & Iwaniec 2013).

The current state of the art converges on a visioning practice that accounts for complex urban dynamics, embraces coherence, and adopts advanced sustainability concepts, while allowing all relevant stakeholders to provide inputs. Incorporating such visioning practice into regular planning processes allows city administrations to avoid conflicting and sub-optimal development; unintended consequences of development with adverse impacts; and stakeholder resistance due to lack of ownership and accountability (Wiek & Binder 2005; Wiek & Walter 2009; Talwar et al. 2011; Smith & Wiek 2012). Bridging the gap between visioning practice and research calls for stronger collaboration between planners and researchers *during* the planning practice (Myers & Banerjee 2005), as a mode of reflexive practice (Schön 1983).

In this article, we present the process and results of such a collaboration, which was part of a research project in support of the General Plan update in Phoenix (Wiek et al. 2010; Wiek et al. 2012). The city's General Plan is the single most important official document that provides long-range guidance for the city's future development. On invitation of the City Planning Manager, a team of sustainability researchers together with a team of city planners conducted a sustainability visioning study, among other activities, with the intent to incorporate the results into the updated General Plan. The study offers insights on practices and challenges to planners and researchers in their pursuits of more rigorous visioning procedures in urban planning.

Case study Phoenix – sustainability visioning research for the General Plan update

Urban planning in Phoenix is largely conducted at the city and urban village scale. The village model was created to make the planning process more flexible and account for local heterogeneity in character and identity (City of Phoenix 1986). Phoenix' urban villages are: Ahwatukee Foothills (AF), Alhambra (AL), Camelback East (CE), Central City (CC), Deer Valley (DSTV), Desert View (DV), Encanto (EN), Estrella (ES), Laveen (LV), Maryvale (MW), North Gateway (NG), North Mountain (NM), Paradise Valley (PV), South Mountain (SM), Rio Vista (RV). Village Planning Committees (VPC) are composed of Mayoral and City Council appointed residents and stakeholders representing local business, professionals, and education. Monthly meetings are public and held with the goal of strengthening community input, in particular for the updates of the General Plan.

The first comprehensive and long-range plan for the city of Phoenix was the General Plan adopted in 1972. Throughout the 1970s, there were citizen committees engaged in urban planning processes. Notable public involvement includes the creation of the urban village model and its adoption in the *Phoenix Concept Plan 2000* (City of Phoenix 1979). Since these 1970s activities, public engagement in long-range urban planning has been limited in Phoenix. In 1985, an interim plan was adopted based on village recommendations and compiled in the *Goals Formation Report* (City of Phoenix 1984). *Arizona Revised Statutes* (ARS) and *Growing Smarter Legislation* (State of Arizona 1998; State of Arizona 2000) required cities and towns to adopt General Plans as policy documents for guiding long term planning and development. ARS also required that General Plans be updated, replaced, or re-adopted every 10-15 years through a public process that allows for citizen and public agency comments to be considered and incorporated into the Plan.

The last General Plan update in Phoenix was adopted by City Council Resolution in 2001; the public vote was held in March 2002. There was no General Plan update between 1985 and 2002. In preparation of the 2002 General Plan, the first biennial Phoenix Community Attitude Survey (2002) was conducted of over 2,000 residents equally distributed in each Council district. The survey was design to measure public satisfaction and identify opinions on proposed changes on desirability, quality of life, neighborhood-specific problems, city services, performance, and infrastructure. The most recent General Plan update for Phoenix was scheduled for completion in 2012 and has been rescheduled to be completed in 2015 (extension granted by state legislature).

In 2009, in preparation of the General Plan update, the City Planning Manager at that time recognized deficits in the city's planning processes. In addition, significant budget cuts had further limited the capacity of the planning department. The City Planning Manager approached faculty at Arizona State University (ASU) with expertise in anticipatory governance and sustainability research. The initial series of meetings identified the following objectives for a collaboration on the General Plan update: (a) adopting *interactive* public engagement procedures (as opposed to previous *extractive* engagements (survey), or participation limited to the VPCs); (b) developing capacity for *long-range* planning; and (c) addressing major urban *sustainability* challenges. This set of objectives led to the adoption of a new procedural framework for the General Plan update, following the concepts of anticipatory governance (Guston 2008; Quay 2010) and transformational planning for sustainable cities (Wiek 2010). In support of this process, the project leaders from ASU designed a graduate research studio as well as subsequent team thesis research, which is described in detail elsewhere (Wiek et al. 2010; Wiek et al. 2012). The project team was composed of the City Planning Manager and a team of 12 city planners, as well as two faculty, six senior graduate students conducting their thesis research within the project, and an additional 16 graduate students from different academic programs at ASU participating in the studio. The project was designed at the interface between research, education, and professional planning practice, with all parties involved in continuous learning processes.

Part of this larger project was the sustainability visioning research study we present in this article. Prior to this initiative, visioning had been a marginal activity of previous General Plan updates with insignificant public participation. An exemplary outcome, a one-page 'laundry list' vision, can be reviewed in the General Plan from 2002 (City of Phoenix 2002). The goal of the visioning study was to create a robust and comprehensive sustainability vision for Phoenix in 2050, to be incorporated into the General Plan update. The project leaders were also asked to design the study in a way that it would build professional and civic capacity in structured visioning. The study pursued the following three objectives:

1. Identify emergent themes, relationships, and heterogeneity of vision statements across the different Phoenix villages through broad public engagement.

2. Develop a comprehensive vision for the City of Phoenix that is based on these initial inputs but further crafted through interactive public engagement with respect to systemic relations, coherence, sustainability principles, relevance, and specificity.
3. Organize and demonstrate capacity building in structured visioning, including public engagement and sustainability-oriented reasoning.

These objectives intend to make progress towards a more rigorous visioning practice (Shipley 2002; Shipley et al. 2004; Wiek & Iwaniec 2013).

Although unique in several aspects, including historical, cultural, and political particularities of planning and visioning in Phoenix, the outlined planning and visioning challenges are being faced by many cities in the United States and elsewhere (Berke & Conroy 2000; Shipley et al. 2004; Truffer et al. 2010; Svara 2011; Smith & Wiek 2012). Thus, a case study on Phoenix can provide valuable insights into the opportunities and limits of integrating advanced visioning practice into urban planning. In fact, it has been argued that the challenges in Phoenix are so drastic, and the conditions for societal progress in general, and sustainability efforts in particular, are so adverse[2] that learning from Phoenix might be of particular value: “If Phoenix could become sustainable, then it could be done anywhere.” (Ross 2011, p. 14)

[2] A recent example of these conditions is Arizona Senate Bill (SB) 1507 (“PROHIBITING THE STATE AND ITS POLITICAL SUBDIVISIONS FROM ADOPTING OR IMPLEMENTING THE UNITED NATIONS RIO DECLARATION ON ENVIRONMENT AND DEVELOPMENT.”), which passed the AZ Senate in March 2012, before it failed in the House in May 2012.

Study design

The visioning study largely follows the *SPARC* visioning research methodology that is based on a synthesis of best practices in sustainability visioning (Wiek et al. 2013); it adopts and modifies various visioning methods currently used in urban planning (Minowitz & Wiek 2012). The acronym "*SPARC*" represents the first letters of key methodological features: *S*ystemic, *P*articipatory, *A*ction-oriented, *R*elevant, *C*onsistent (= *SPARC*); it obviously intends to connote with "sparking". *SPARC* visioning considers systems relations, coherence, sustainability principles, relevance, and specificity; combines extractive and interactive public participation (capacity building); and links creative with analytical activities. Deviations from the *SPARC* methodology occurred throughout the process due to a series of process constraints, which are indicated and discussed below.

The visioning process was structured into six phases: (1) framing the visioning process; (2) eliciting vision statements and priorities; (3) analyzing the vision drafts; (4) reviewing and revising the analyzed vision drafts; (5) finalizing the vision; (6) final review and dissemination (Fig. 1). In the following, we outline the key features (activities, actors, products) of the five project phases. For details on the general functions of the phases and on the methods employed, see Wiek et al. (2013).

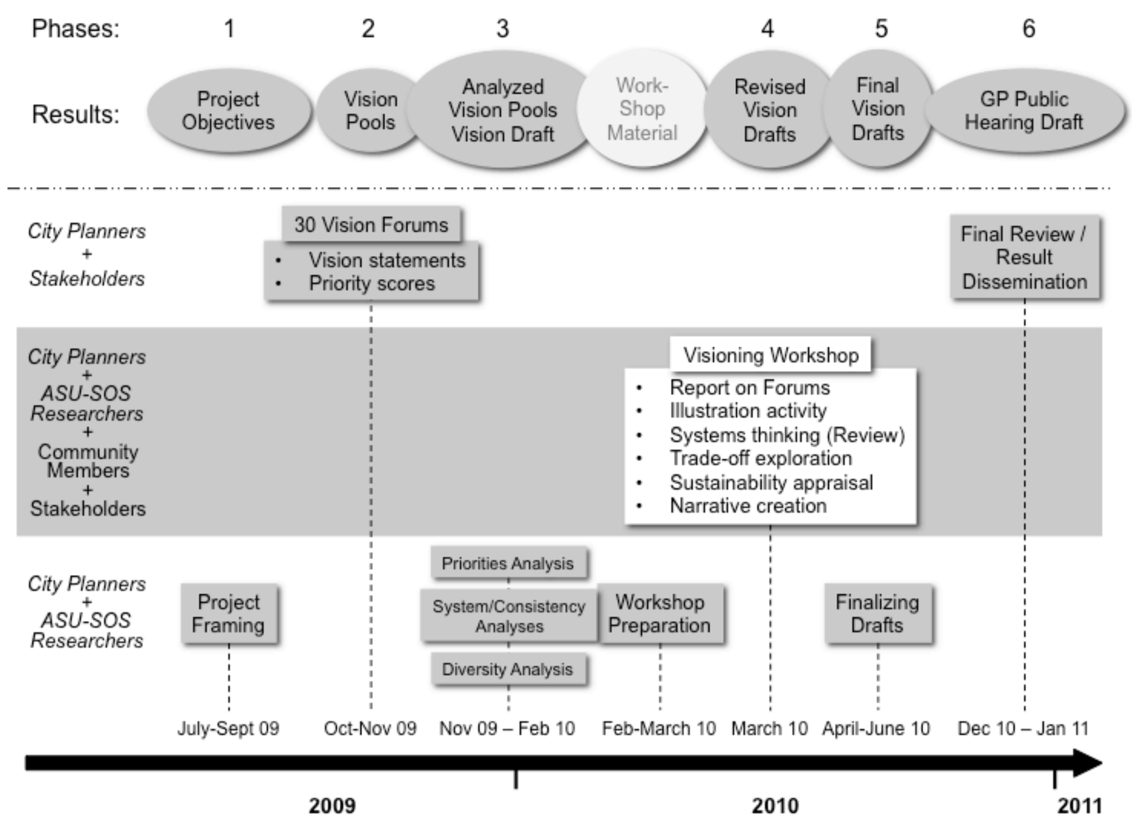

Fig. 1 Storyboard of the Phoenix sustainability visioning research project, following the six-phase model of the *SPARC* visioning research methodology

Phase 1 – Framing the visioning process

The first phase orientated, structured, bounded, in short, *framed* the visioning process. Framing aspects included: process function, domains of interest, temporal scope, spatial boundaries, visioning methodology, and participatory design. The main framing occurred at the beginning, but some framing aspects were reconsidered and revised at later stages. The framing was initially determined by legislative planning requirements, including the mandated update of the General Plan. The City of Phoenix Planning Department initially defined 2050 as the reference year for the vision and domains of interest around "the three pillars of sustainability," namely *Environment*, *Community*, *Economy*; plus a forth domain, *Infrastructure*, emphasizing the built environment as critical urban domain. The city planning manager sought to establish the General Plan Update, and the visioning process in particular, as new paradigms of city planning that is long-term oriented, open, and informed by ideas of sustainability (Wiek et al. 2012). Thus, city planners agreed on the need for public engagement in all city villages during the visioning process. Because of flaws in time allocation and general unfamiliarity with public participation in city planning, however, there was no public participation in the initial framing (as suggested in the *SPARC* methodology).

Phase 2 – Eliciting vision statements and priorities (Vision Forums)

Thirty small-scale participatory meetings (Vision Forums) were conducted among the 15 city villages to elicit and organize vision statements from community members. Two Forums were held in each village during consecutive VPC monthly meetings. Over 750 (non-unique) individuals participated in the 30 Forums (13-40 participants/Forum). They were public events; yet, because of the reliance on the existing VPC structure, most Forum participants were VPC members.

The Forums were designed to introduce the visioning process, and elicit vision statements as well as priority scores from the participants. After an initial discussion (based on the guiding question "What do you value most about Phoenix and why?"), the core visioning activity centered on the question: "Imagine Phoenix as the best it can be in 2050 – What do you see?" The participants were encouraged to provide *future-oriented, value-based* statements (not just future-oriented OR value statements). The vision statements were then prioritized in a voting activity. Because of time constraints, participants were not asked to provide overall narratives based on their individual vision statements (as suggested in the *SPARC* methodology).

The products were 15 lists (pools) of prioritized vision statements (organized by domain), one for each city village.

Phase 3 – Analyzing the vision pools and drafting a vision

In the third phase, the elicited vision statements were deconstructed and standardized. For example, the vision statement "abundance of drought tolerant trees for shade" was assigned the standardized elements: Vegetation, Xeric, Trees, Landscaping, Water Management, Shade. Standardized value propositions or ‘normative qualifiers’ (e.g. abundant, affordable, diverse, responsible, strong, superior) were assigned to each element. A vision element is therefore composed of a standardized element a standardized value proposition. Descriptive codes were utilized to specify actors’ role, impact, location and spatial scale.

The initial analysis of the village visions included:

1. Eliminating false vision statements (not complying with the vision statement definition)
2. Compile the coded statements for each village vision (content analysis)
3. Calculating aggregated priority scores for compiled statements

Additional data analysis and processing included:

4. Qualitative system analysis of the relationships among the underlying elements for each village vision

5. Consistency analysis for each village vision, identifying potentially conflicting relationships between vision elements (e.g. more highways vs. fewer cars; or, abundant mesic vegetation vs. strong water conservation)
6. Diversity analysis of all village visions (cluster analysis)
7. Qualitative system analysis (including the calculation of weighted priority scores accounting for network relationships) and consistency analysis of the overall city vision
8. Creating the initial narrative for the city vision (based on the results from 1-7).

Results were visualized and formulated with the public engagement of the subsequent phase in mind. Because of time constraints, a sustainability appraisal of the visions was not performed in this phase (as suggested in the *SPARC* methodology). The vision drafts were initially clustered and interpreted by the team of city planners and then coded and analyzed by the team of ASU researchers. Data sharing and iterative feedback between both teams were frequent throughout this phase.

The products were priority maps, system maps, and trade-off maps of the visions for each of the 15 villages, as well as for the overall city vision. In addition, an initial narrative for the city vision was produced.

Phase 4 – Reviewing and revising the vision draft (Visioning Workshop)

A half-day Visioning Workshop was held at Phoenix City Hall to report back the results from the Village Vision Forums; collectively revise the vision drafts as refined inputs for the finalization of the vision; and build capacity for collectively crafting sustainability visions in the future. All participants of the Forums were invited to the Workshop. Additional recruitment was done through the City's webpage, emails, newsletters, and social media. Community leaders were contacted in order to encourage participation among the Hispanic population and youth.

Prior to the workshop, guidebooks were created that compiled instructions on all activities of the workshop. Posters, visuals, and other materials presented the analytical results in accessible ways. All facilitators participated in two training sessions, were provided instruction on facilitation and workshop content, and practiced in dry runs that included community members.

The project leaders kicked-off the workshop in a plenary session by reporting back the outcomes from the Vision Forums. The preliminary city vision was presented as priority maps, visuals, and a narrative, read by a professional narrator.

Participants were then divided into groups with 9-10 participants and 2 facilitators/note-takers (1 planner, 1 researcher). The small-group activities focused on one out of six urban subsystems to allow for in-depth discussions. The subsystems were: Abundant Vegetation, Comprehensive Mass Transit, Dense City Cores, Enhanced Roads/Highways, Lots of Open Space, and Responsible Water Use. It is important to note that the subsystems were not selected just focusing on priority scores, but were selected based on potential conflicts, system-level priority scores, and betweenness centrality. Each subsystem was assigned to two groups for reliability testing.

Each subsystem was visualized as a game board with movable cards representing vision elements, and replaceable arrows representing synergistic or conflicting systems relations. The five small-group activities were:

1. The group generated illustrations of all vision elements and got familiarized with each other's perspectives. Each group created a collage of their assigned subsystem from supplied visuals (photos, art, symbols, etc.), and composed a brief narrative. The subsequent group activities utilized the visualized subsystems as game boards. The activities were designed for receiving refined input on vision preferences, but also for collective capacity building in systems thinking, trade-off making, and sustainability appraisal.
2. The group reviewed the representation of the subsystem on the game boards (elements and systemic relations). Adjustments were made such as removing/adding elements or arrows.
3. Each group member reviewed the prioritization and, if necessary, re-prioritize elements in order to, first, adequately represent their vision preferences, and second, to reconcile the identified conflicts or trade-offs. The subsequent group discussion allowed for further modification before the participants were polled on the desirability of the revised subsystem vision.
4. The groups appraised the sustainability of the subsystem vision and to do a final re-prioritization, if necessary, in order to align desirability and sustainability of the vision. Guiding questions were: "How does the vision address – (a) the future our children and grandchildren will inherit; (b) the availability of resources; (c) the environment as a whole; (d) inclusiveness, equality, and justice; (e) our impact on the broader region, country, and planet?"
5. Each group produced a short narrative for the agreed upon subsystem vision ("A day in the life of a Phoenician in 2050").

Fig. 2 During the Visioning Workshop at Phoenix City Hall, stakeholders, city planners, and sustainability researchers engaged in revising the vision draft using systems game boards

The workshop concluded with a plenary that included brief presentations of the narratives and a final discussion. Feedback forms were collected from the participants. Within a week of the workshop, the project leaders debriefed the facilitators individually and as a group for additional post-workshop feedback.

The products were illustrated, narrated, refined, and revised vision subsystems, represented in different formats: illustrative collages, various photo-documented game board configurations and descriptions, and the final narrations of the visions.

Phase 5 – Finalizing the vision

The revised vision subsystems were re-integrated into new system and priority maps of the city vision. From the revised outcomes, the research team inferred the relative priority of the remaining vision elements; analyzed the maps for changes in system configuration and priority scores; extended the narratives ("A day in the life of a Phoenician in 2050"); refined the collages; created data-driven profiles for the six vision subsystems; and presented all results in a project report (Wiek et al. 2010). A sustainability appraisal of the recomposed vision was not performed in this phase (as suggested in the *SPARC* methodology). Participant feedback forms and facilitator debriefings were used to further explore the perceived quality of the visioning outcomes and process.

The final product was a report that presented the vision for Phoenix in 2050 as a systemic, coherent, tangible, and sustainable city vision. The main results were also presented in the updated General Plan (Public Hearing Draft) (City of Phoenix 2010).

Phase 6 – Final review and dissemination

The city planners presented the Public Hearing Draft of the updated General Plan to the Village Planning Committees in all 15 villages and the Planning Commission. After final review and approval, it was expected to bring the plan to the voters for ratification. The final product of this phase was planned to be a public voting result (approval/rejection).

However, a minority of the VPCs provided substantial critique, including the need for more public involvement and concerns with the further updating process. Based on this feedback, the city planners were concerned about the public vote. In retrospect, there were good reasons for this concern as, for instance, in the neighboring city of Scottsdale voters rejected the update of the General Plan in March 2012, despite public engagement.

The Planning Commission and the City Council, in consultation with the city planners, decided to restart the Phoenix General Plan Update. Although state legislation requires decadal updates and voter ratification to the city's General Plan, the Arizona Legislature passed House Bill 2145 in 2010, which extends the timeframe for cities to readopt an existing, or adopt a new General Plan by July 1, 2015 the latest. After several changes in the political and administrative personnel structures (Mayor, City Council, City Planning Manager) in 2011, since April 2012 there is a new attempt underway to update the Phoenix General Plan, including the city vision. Restarting the process from Phase 1, a new team of city planners is collaborating with ASU researchers, building off the results of the previous visioning research (2009-2011) documented here. This iteration, while requiring additional efforts and resources, is in line with recommendations about reflexivity, flexibility, and adaptation in the *SPARC* methodology.

Capacity building

In addition to generating a vision for Phoenix, the described study had the function of building collective capacity for visioning as an important professional competency (planners) as well as a civic and societal capability (general public). This required pursuing explicit capacity building opportunities. The planners were trained and coached throughout the project in team meetings and workshops. For the capacity building with the general public, the research team developed a progressive model from mapping diversity of preferences (Van de Kerkhof 2006) in early stages (vision drafting) to negotiation and consensus building (Susskind et al. 1999) at later stages (revisions of drafts). The model structured the participatory activities with increasing degrees of difficulty (Fig. 3). Aligned with this was an increase in levels of participation from information and consultation to collaboration (Arnstein 1969). This was reflected in the different designs of the two main public engagement events (Phases 2 and 4). Unlike the Vision Forums, the Visioning Workshop centered less on *extractive* and more on *interactive* small-group activities, in which participants were confronted with increasingly complex tasks and facilitators played a much more active role, also providing input and challenging participants' opinions and preferences.

Increasing Degrees of Difficulty

Activity / Task	Event	Level of Participation
Background information	Forums (Plenary)	Information T1
Eliciting value statements (Present)	Forums (Q1)	Consultation T1
Eliciting vision statements (Future)	Forums (Q2)	Consultation T1
Eliciting priority scores	Forums	Consultation T2
Report on Forums	Workshop (Plenary)	Information T2
Illustration activity	Workshop (SGA1)	Consultation T2
Systems thinking (Review)	Workshop (SGA2)	Consultation T2
Trade-off exploration	Workshop (SGA3)	Collaboration
Sustainability appraisal	Workshop (SGA4)	Collaboration
Narrative creation	Workshop (SGA5)	Consultation T2

Increasing Levels of Participation

Fig. 3 Progressive capacity-building model employed in the Phoenix visioning study
The levels of participation include different types (T) of information (T1 = primary; T2 = secondary/report back) and of consultation (T1 = only instructions, no stimuli; T2 = instructions with stimuli). Other abbreviations: Q = Question; SGA = Small Group Activity.

Finally, the visioning study strove to combine creative and analytical activities in order to ensure visioning quality in different dimensions (inspirational and compelling/sound), and to account for different skills of the participants. This was reflected in the overall design of the visioning process, and in the public engagement events. Creative activities were non-verbal (illustrative) as well as verbal (narratives). The activities also balanced instructions without and with stimuli (e.g. visual vision pool) in order to support and guide some of the consultative activities.

Results

Vision statements from the Vision Forums and initial vision draft

The analysis of the Vision Forums data identified key vision elements for Phoenix's future. The number of vision statements (1905 total and 759 unique vision statements) varied significantly among the 15 city villages (minimum: 11; maximum: 97). The content analysis resulted in 92 unique vision elements (1717 total vision elements) that were further processed.

Vision elements and subsystems – The highest priority *vision* elements (elements *with* normative qualifiers) were: Smart Government, More Employment Opportunities, Enhanced Roads and Highways, Green Development, Superior Education, and Responsible Water Use (Fig. 4). The frequency distribution of the priority scores followed a logarithmic pattern tapering off quickly after 40% of cumulative priority score (12 of the 92 unique vision elements accounted for nearly 40% of the cumulative priority score).

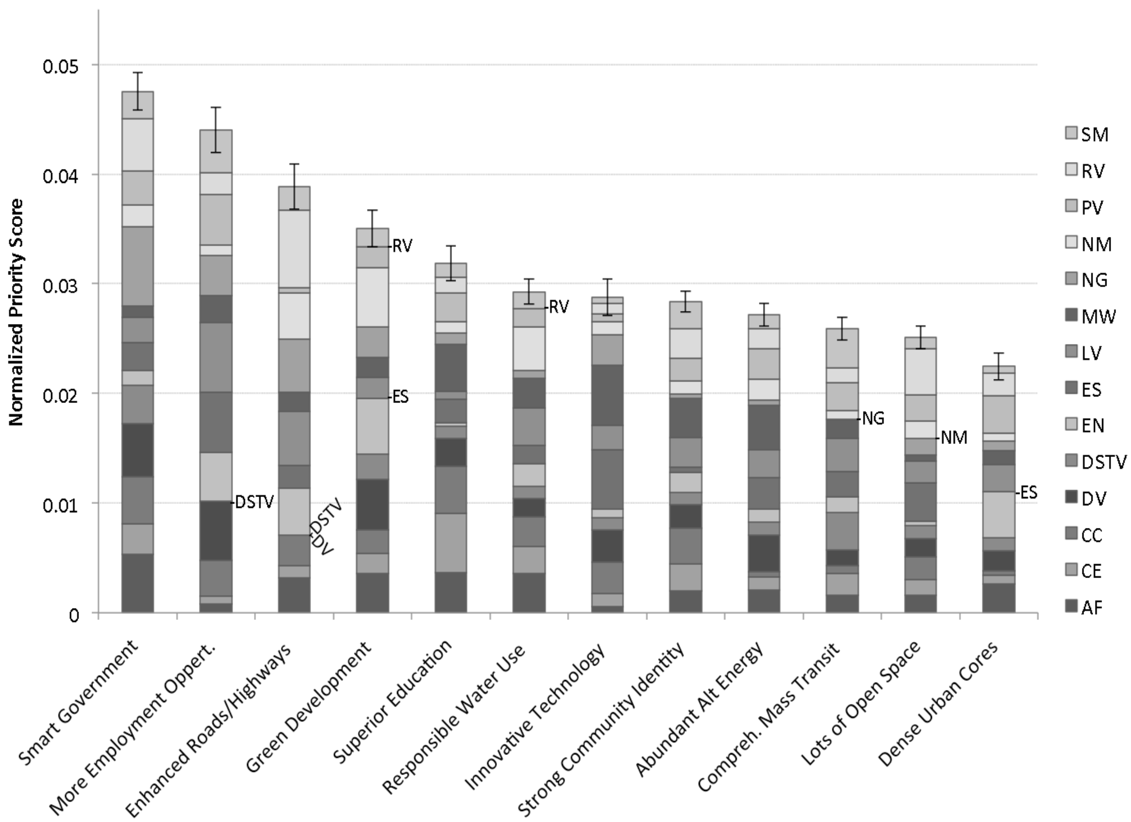

Fig. 4 Top vision elements by priority score from the Vision Forums
Error bars display one standard deviation from the mean across all villages for each vision element. The key indicates the order that the village counts are organized with village labels located immediately left of each stacked bar graphics corresponding to a normalized priority score = 0.

While the initial analysis focused on priority scores only, the subsequent analyses considered multiple features of the vision elements. Based on relevant potential conflicts, priority scores, and betweenness centrality, seven vision subsystems were identified that required more nuanced prioritization of vision elements and system relationships. These vision subsystems are: *Smart Government*, *Enhanced Roads/Highways*, *Responsible Water Use*, *Comprehensive Mass Transit*, *Lots of Open Space*, *Dense Urban Cores*, *Abundant Vegetation*. The difference between this selection and the initial ranking based on priority scores (Fig. 4) is justified for each of the six vision subsystems. For example, the vision element "Abundant Vegetation" (rank 25 of 92) was not among the vision elements with the highest priority scores (Fig. 4); yet, it was selected because of a potential systems tradeoff with “Responsible Water Use”, conflicts between mesic and xeric vegetation, plausibility contestation regarding xeric vegetation’s ability to “Reduce Urban Heat”, as well as high systems-level priority (i.e. weighted sum of the priority scores for “Abundant Vegetation” and interconnected vision elements), and its ability to bridge connectivity among other subsystems (i.e. the “Responsible Water Use” and “Dense Urban Cores” subsystems).

Table 1 compiles the vision elements entailed in each of the six subsystems that were discussed in the visioning workshop (*Smart Government* was removed, as indicated above).

Table 1 Vision elements in the six vision subsystems
The selection criteria for vision elements included in the subsystems was 1) potential conflicts and trade-offs, 2) system-level priority score, and 3) betweenness centrality of the network. All subsystems shared at least one vision element to facilitate re-integration into the final vision.

Enhanced Roads/Highways	Responsible Water Use	Comprehensive Mass Transit	Lots of Open Space	Dense Urban Cores	Abundant Vegetation
Comprehensive Mass Transit	Abundant Vegetation	Enhanced Roads/Highways	Diverse Entertainment	Abundant Shade	Abundant Shade
Improved Regional Connectivity	Attract People to Live/Work	Enhanced Walkability	Many Parks	Abundant Vegetation	Enhanced Walkability
More Employment Opportunities	Dense Urban Cores	Improved Regional Connectivity	Revitalized Canals/Rivers	Comprehensive Mass Transit	Reduced Urban Heat
Superior Air Quality	Promote Urban Agriculture	More Employment Opportunities	Vacant Lots Filled In	Enhanced Walkability	Responsible Water Use
		Superior Air Quality		More Mixed Use	

Figure 5 illustrates the relative priority of the vision elements included in the six vision subsystems, distributed among the four domains: Environment, Community, Economy, and Infrastructure.

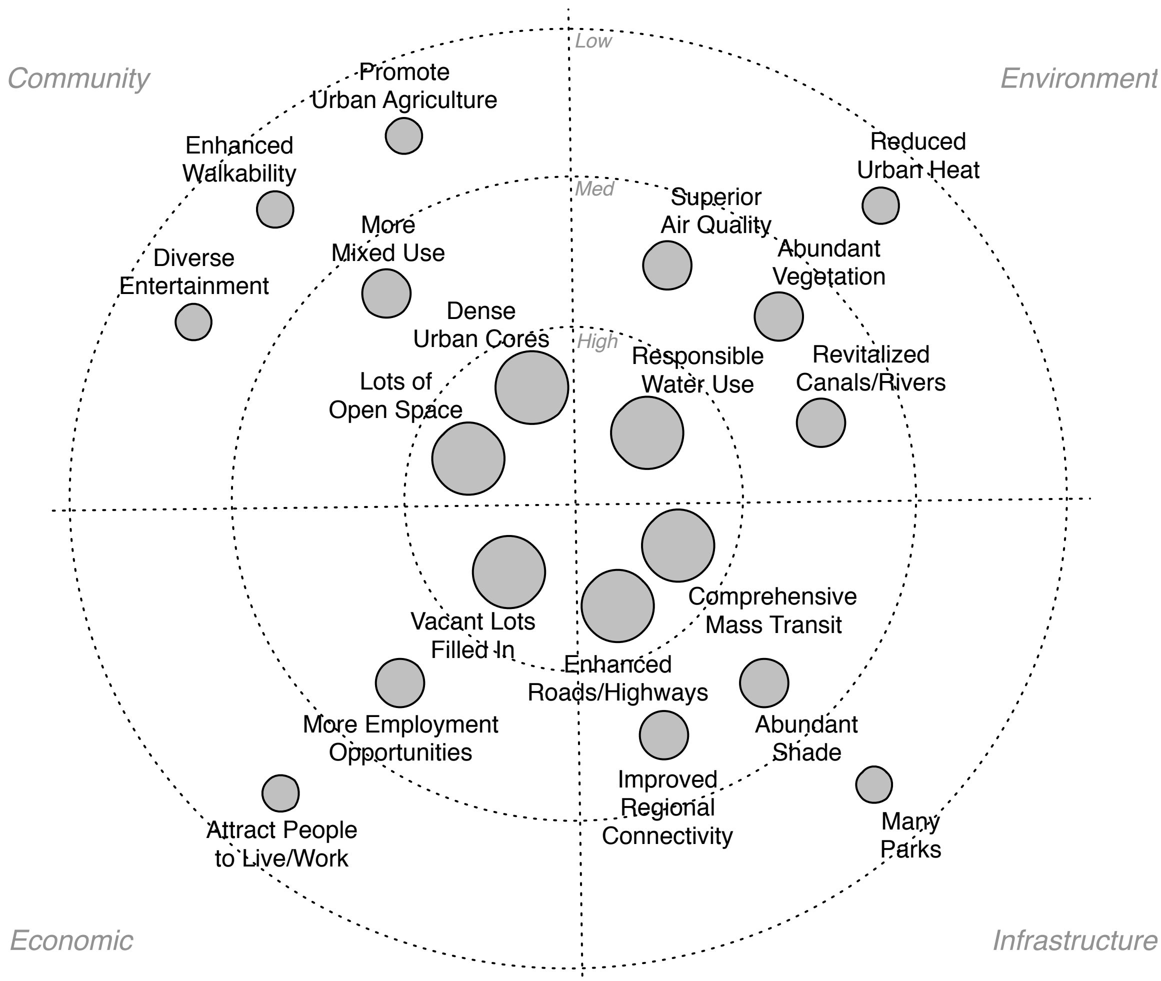

Fig. 5 Bulls-eye chart of city-level vision elements for the six vision subsystems
Vision elements are arranged within four quadrats, corresponding to four domains: Environment, Community, Economy, and Infrastructure. Vision elements located in the center of the chart and with the largest node size represents the highest (network-weighted) priority scores, for the overall city. Vision elements decrease in priority as they radiate outwards from the center and decrease in size. Differences to the initial ranking based on priority scores (Fig. 4) are due to analyses of network-weighted priority for the selection of subsystem vision elements.. For example, the vision element "More Employment Opportunities" was ranked second highest in the initial ranking; yet, it did not make the central circle of highest-priority vision elements in this representation based on the weighted summation of its priority score and the priority scores of its interconnected vision elements.

Heterogeneity among visions – The 15 villages clustered into three groups. The first group of villages AF, DSTV, CC, and CE clustered due to the high prioritization given to Governance, Education, and Development (village ES clustered into a possible separate group due to the absence of the Development vision element). Villages DV, LV, PV, SM, and NG built a second cluster due to shared values on vision elements surrounding issues of Urban Heat, Walkability, and Neighborhoods. The third group of villages EN, NM, MW, and RV clustered around issues of Roads/Highways, Civic Responsibility, and Safety. The three clusters indicate preferences for different urban development pathways within the city. Interestingly, the city-level vision did not cluster within any of the village groupings. Figure 6 illustrates an exemplary deviation between the city vision and the vision for village AF.

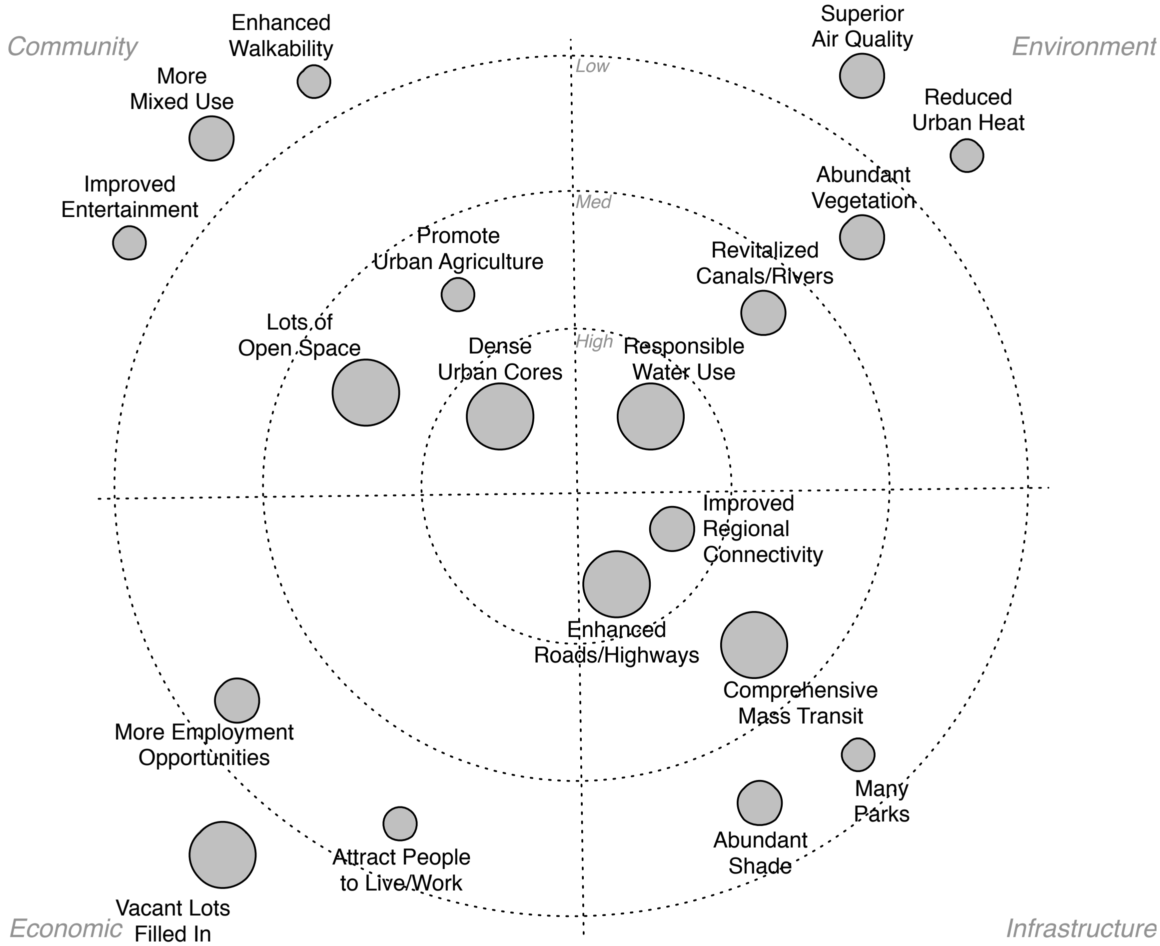

Fig. 6 Bulls-eye chart of village-level vision elements (Village AF) and city-level comparison for the subsystems

Vision elements radiate outward with decreasing village-level priority. Vision elements not included in the village AF vision are located on the periphery of the chart. Node size indicates city-level priority. Larger nodes at the periphery (or smaller nodes in the center) indicate divergence between city and village priorities.

However, different clusters do not necessarily represent a conflict, as different village-level visions may co-exist within the overall city's vision.

Coherence – Potentially conflicting goals were identified among the vision elements and exemplified challenges of coherence (consistency matrix). For example, the vision subsystem Abundant Vegetation encompassed potentially conflicting preferences for vegetation, mesic (e.g. "shade trees" and "protect our lawns") vs. xeric ("desert trees" and "hillsides covered in saguaros"), as well as system-level conflicts between abundant mesic vegetation vs. strong water conservation, or desert vegetation vs. shade for walkability.

Potential conflicts often emerge from a lack of considering the complex nature of a city (not all options can co-exist). However, they can also result from a lack of making the vision spatially explicit. For example, the vision subsystem Enhanced Roads/Highways included the conflict "more highways" vs. "fewer cars" (and improved air quality). The key question here is: *where?* Similarly, from the vision statements and prioritizations, it was apparent that increasing the density of the city was an important aspect of the vision. However, insufficient specification made it difficult to determine the form and function of the high-density future (e.g. just downtown, multiple urban cores, or the city overall?).

Initial vision draft (narrative) – Based on the results presented above, an initial draft of the vision was generated through narratives for each of the four urban domains: Community, Economy, Environment, and Infrastructure (Fig. 7). The narratives were based entirely on the high-priority vision statements elicited through the Vision Forums (Wiek et al. 2010).

Phoenix' *Community* is described as offering "high quality of life for all residents" and is characterized by unique community identity, celebrated cultural diversity, revitalized and dense neighborhoods, vibrant and accessible arts, open and inclusive collective governance, and an emphasis on lifelong education. Phoenix' *Economy* is described as "robust, diverse, and stable" through diverse employment opportunities, businesses embedded in the community, green social and technological innovations (especially in energy and water), and supportive flexible and integrative governance. Due to sustainable land-use planning, the “healthy, place-aware, and broadly appreciated” *Environment* of Phoenix has high air, water, and ecosystem quality with an overall low carbon footprint, abundant vegetation for shade. It is celebrated for its unique desert city landscapes, mountain preserves, and abundance of sunshine. Phoenix’ *Infrastructure* is of “high quality and efficient,” offers various transportation options, complies with high green standards. It includes renowned parks, trails, and canals, and provides easy access to services such as libraries, community centers, police, fire departments, and wireless communication technologies.

Vision – Phoenix in 2050

The following vision is based in its entirety on vision statements and inputs elicited from citizens of the City of Phoenix.

Imagine the best version of Phoenix in 2050 – the city of our children and grandchildren: *How do they live in our city?*

Our urban ***Community*** enables a high quality of life for all residents in 2050.

All Phoenix neighborhoods have a unique sense of place created by memorable locations and community events. Yet, careful adaptation and innovation accounts for new values and preferences emerging in the communities. Phoenix's neighborhoods demonstrate respect for the character of the communities by preserving ***and*** innovating in thoughtful ways. Strong community identity does not only tolerate but celebrates diversity of history, culture, ethnicity, social background, and lifestyle. Revitalized historic neighborhoods, in concert with other vibrant neighborhoods, provide diverse and rich opportunities to experience arts and culture for all segments of the population, Including art galleries, public art, museums, exhibitions, theaters, and concerts.

Many neighborhoods are dense and compact, in particular in Downtown and the village cores. This allows efficient use of public resources to create attractive public transportation options, shading infrastructure, and high walkability. All neighborhoods are mixed-use communities with housing, small businesses, and easy access to community services like schools, other educational opportunities, parks and medical care, minimizing commute times.

Collective governance efforts enhance local programs and policies to create a true community of choice. Phoenix is also recognized as being a strong partner, rather than a competitor, in regional initiatives and jurisdictional affairs. Open and inclusive governance provides equal

Quotes from the original vision statements (full list included in Appendix A):

Vibrant communities…

[M]ix of new and old historic residential and commercial buildings

[E]mbraces its multi-cultural and multi-ethnic identity

Arts is part of the culture for all segments of the population

High density in central Phoenix…

Village cores are focus for density

High-density housing mixed with commercial uses

Phoenix is the leader in open governance

Regional collaboration instead

Fig. 7 Initial vision narratives
"Phoenix in 2050" and collages were crafted for the four domains: *Community* (excerpt depicted here), *Economy*, *Environment*, and *Infrastructure*. Direct quotes from associated vision statements (elicited in Phase 2) were included with the narratives.

Revised vision draft from the visioning workshop

Participants reviewed and revised the initial vision drafts focusing on the six vision subsystem: Abundant Vegetation, Comprehensive Mass Transit, Dense Urban Cores, Enhanced Roads/Highways, Lots of Open Space, Responsible Water Use. The Open Governance subsystem was not included on request of the city planners to avoid overtly politicized conflicts (size and role of city government). Game-boards for each vision subsystem were utilized as an entry point to address coherence, desirability, and sustainability (Fig. 8).

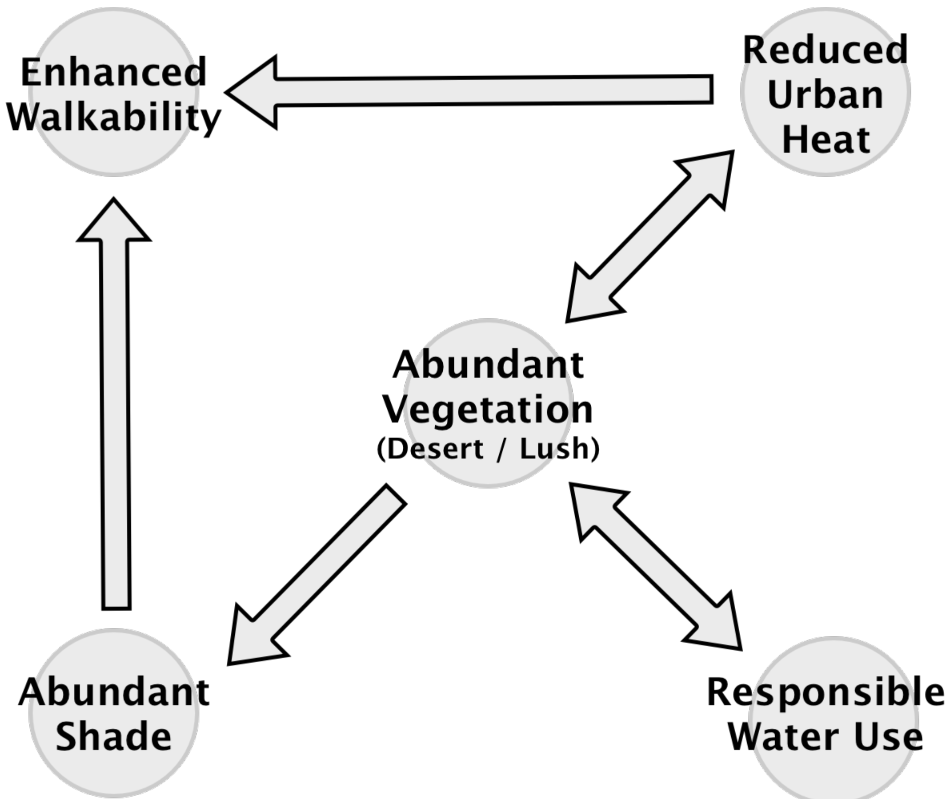

Fig. 8 Illustration of the game board used in Visioning Workshop for the vegetation subsystem Arrows indicate a systems relationship between two vision elements. Arrowheads indicate the directionality of the relationship's influence. Not depicted here: Colored arrow game-pieces were used to indicate relationships with potential conflicts or trade-offs. Differently sized circle game-pieces were used to indicate different priority options for each of the vision elements. On the back of each circle game-pieces were example vision statements from the Vision Forums.

Revised priorities and narrative descriptions – Abundant Vegetation final priorities did not vary greatly from the initial priority rankings and incorporated the original heterogeneity of stakeholder preferences. One of the groups focusing on Abundant Vegetation detailed differences in the type and density of vegetation in urban, suburban, and agriculture landscapes throughout the city, the second table focused on public trees in parks, preserves, and 'green' corridors for walkability, shade and biodiversity. Participants resolved potential conflicts by including in their vision a comparative description of the appropriate use of vegetation in different parts of the city. The revised vision described an abundance of mesic vegetation for cooling and shading the urban cores. Suburban neighborhoods were described as having an abundance of xeric vegetation, especially desert trees in parks and along streets.

Similarly, for *Lots of Open Space* both tables expressed a high desirability for preserving and enhancing open space, but addressed different types and spatial arrangements of open space. One vision addressed urban parks and vacant lots within the city for a "mix of uses" including more recreational parks in "areas that are underserved", commercial parks along waterscapes, and "community gardens". The second vision focused on protecting large desert parks, mountain preserves, and riparian areas for education, economic benefits, ecosystem functioning, and recreation.

The *Comprehensive Mass Transit* and *Enhanced Roads/Highways* visions had congruent results that converged into a shared transit vision. Envisioned outcomes among the tables differed only in the relative magnitude participants decided to demote road and highway infrastructure (e.g. remove or remodel lanes) and promote walkability. The revised vision emphasized diversifying alternative transportation options with a focus on accessibility and regional connectivity. Roads were enhanced to include safe walking and biking options for local employment and education, and served to support inter-city and regional connectivity through mass transit.

Among the *Dense Urban Cores* tables, there was a strong focus on the synergistic relationships of vision elements such as mass transit, mixed-use, and walkability to support increased urban densities. While the density of the city was described as increasing overall, this increase was focused at multiple urban cores within the city and especially downtown. Participants also incorporated many additional vision elements, such as community gardens, downtown housing, shopping, and cultural amenities to describe the envisioned urban cores.

Responsible Water Use visioning outcomes described the water system as a high priority and the need for it "to adapt/continually evolving" and to be "dynamic enough to handle future needs." While both tables agreed that due to water's relationships with other important vision elements, conflicting relationships required "a balance between all elements", but they emphasized different trade-offs as being most important. This distinction was especially evident in the narrative statements. One of the tables identified population growth as the largest barrier to responsible water use and envisioned strong regulations on water use, employing "smart use and reuse" strategies. The second table focused on trade-offs with vegetation, including agriculture, and envisioned a shift to more small-scale farming and “desert vegetation farming” to complement decreased water intensive “mass agriculture”.

Overall, the reprioritization of the vision elements and articulated qualitative descriptions resulted in revised visions that differed markedly from the earlier Phase 2 results (as detailed above). Reprioritization changes and narrative additions made during the visioning workshop activities—preliminary review of vision preferences, reconciling conflicts and trade-offs, and conducting the sustainability appraisal—are not reported separately due to insufficient documentation of the iterative gameplay. With the exception of Abundant Vegetation and Lots of Open Space, the resulting visions were consistent among replicate groups. The outcomes from Abundant Vegetation and Lots of Open Space were not incompatible; instead, the groups described different aspects and spatial extents of their subsystem. Overall and especially for Abundant Vegetation and Lots of Open Space, supporting narrative descriptions were critical for understanding the stakeholders' vision and decision-making process.

Re-incorporating revised subsystems into the vision – The narrative statements, accompanying the gameplay, were particularly crucial in re-incorporating the substantial revisions resulting from the workshop activities by providing rich descriptions of system relationships along with detailed qualifiers and specific strategies. For example, the conflict between two normative qualifiers (low and high) for housing density were partly decoupled; the prioritization of the High Density vision element did not directly conflict with the prioritization of Low Density with examination of the narrative statements. Together they reflect the desirability of increased density citywide, while maintaining distinct identities — some with lower densities — among specific communities. This exemplified the process of composing a shared vision while valuing rich heterogeneity and diversity in vision goals.

Extended narratives and refined collages ("A day in the life of a Phoenician in 2050") – Detailed stories, in the form of "A day in the life in…" narratives and illustrations, were crafted from the resulting re-prioritizations and descriptions of the vision and included direct quotes from participants. Narratives were told from the perspectives of different individuals in Phoenix 2050 – main actors include an elementary student, small business owner, and a retired couple. These personal narratives describe people's experience and how they interact with their community and environment through stories about alternative and mass transit, local arts, food, governance, school, and work (Fig. 9).

Fig. 9 Extended vision narratives
"A day in the life of a Phoenician in 2050" are stories for various actors and include images and highlighted descriptions for various vision subsystems. (The highlight for mass transit subsystem is depicted here.) Direct quotes from participants (Phase 4) are represented as underlined text.

The General Plan update

An important outcome of the study was the contribution to the Public Hearing Draft of the updated General Plan (City of Phoenix 2010). The Hearing Draft was a departure from previous General Plans in that it provides a sustainability transition plan for the city and incorporates the crafted sustainability vision, along with current state description, alternative future scenarios, and a set of transition strategies. The Hearing Draft included a revised vision narrative based on the results from the Vision Forums, the analyses, the Visioning Workshop, and subsequent revisions.

Evidence of built capacity

Participant feedback forms (Visioning Workshop) indicated increases to self-assessed civic capacity (n= 68 responses, out of 112 workshop participants): 84.3% of the workshop participants responded that the workshop "improved understanding of how priorities and potential conflicts between priorities have to be resolved in order to develop a robust vision for Phoenix in 2050"; 92.9% responded that the workshop helped to "create a vision for Phoenix in 2050 that is coherent and sustainable"; 95.7% responded that they "made a contribution to the creation of the vision for Phoenix in 2050"; 91.4% responded that they identify with the vision for Phoenix in 2050 they helped create; 95.7% responded that they would be willing participate in an event like this again.

Direct observation of subsequent planning practice in the City of Phoenix' Planning Department suggests an increase in discourse on meaningful public engagement, holistic and systems approaches, and the need to address coherence and sustainability conflicts through structured visioning activities. These changes manifest in ongoing visioning activities as part of larger urban planning projects in Phoenix (Wiek et al. 2013).

Discussion

New urban planning requirements have widely been recognized since the early 2000s. They include, among others, the call for theory-supported visioning processes that account for complex systems behavior, coherence, sustainability principles, and are expected to being conducted through interactive public participation (Shipley 2002; Wiek & Iwaniec 2013). One way to make progress on bridging the gap between these new requirements and current planning practice are collaborative arrangements between planning researchers and practitioners *during* the actual planning practice (Myers & Banerjee 2005). This seems even more important as the traditional government-led planning practice is being challenged by collaborative planning and governance approaches (Innes & Booher 2003). This article reports on a visioning research study conducted in Phoenix that attempted to act upon these insights in the context of a General Plan update. The collaborative project integrated visioning research, planning practice, and capacity building. We discuss key challenges experienced in this study and draw general conclusions for visioning processes in urban planning.

Applying the SPARC visioning methodology

Following the *SPARC* methodology with its "Drafting and Crafting" pattern offered methodological guidance and allowed for continuous enhancement of the vision through analytical and creative techniques. Despite the team's efforts to closely follow the *SPARC* methodology for quality purposes, there were deviations and deficits in the visioning process. Some research activities, including actor-oriented analysis, sustainability appraisal, and formal assessment of capacity building were not as rigorously prepared or conducted as desired. Advanced methodologies would have been available (Wiek & Binder 2005; Gibson 2006; Wiek & Larson 2012; Brown & Wei Chin 2013), but were not or not sufficiently applied. Also, while analytical results were presented in the Visioning Workshop (Phase 4), there was only limited time to fully engage with the data during the workshop. Similarly, the framing of the study (Phase 1) was done without broader stakeholder input. In all cases, additional time resources, for instance, for coaching members of the research team, and for more extensive stakeholder engagements would have been required but were not available. Finally, there is much potential for further refining the final vision. Unrevised portions of the vision map, while not incompatible with the overall visioning outcomes, would benefit from additional participatory trade-off exploration and sustainability appraisal. Also, robustness could have increased through sensitivity-oriented explorations with finer and coarser system resolutions (below and above village/city-level) and temporal variations (before and beyond 2050). Finally, the further refinement of the visual and narrative components of the vision lacked sophistication because of insufficient team expertise or collaborative efforts (with designers, artists, journalists, novelists, etc.). Some of these lessons learned have informed recent visioning studies in Phoenix (Wiek et al. 2013).

Linking visioning research and professional planning practice

A favorable constellation of an upcoming obligation (General Plan Update), need for support (budget cuts), administrative leadership (City Planning Manager), willingness to improve planning practice (junior city planners), and alignment with the university's commitment to collaborative partnerships in the region (ASU) enabled this unlikely collaborative study. The collaboration added value in terms of a quality General Planning Public Hearing Draft and enhanced capacity and buy-in for more advanced visioning methodology in urban planning. Willingness to further collaborate has manifested in joint presentations at professional and academic conferences; joint project acquisition and collaboration (Johnson et al. 2011); and the renewed collaboration on the new General Plan update process (as indicated above). The collaboration between planning research and practice brought to bear many of the aspired positive outcomes described in the literature (Myers & Banerjee 2005). However, there were several factors that posed in part serious obstacles to the collaboration. Some of these factors were: no official project budget and very limited project resources, which required a great deal of in-kind services and limitations to certain activities (e.g. stakeholder engagement); not enough time for reflection, structured capacity building, monitoring, and evaluation, which hindered deeper understanding and competence development as well as missed the opportunity to leave a stronger mark in terms of shifting institutional planning culture even further; resistance from senior city planners to revisit and change established planning practices, which created tensions within the team of planners as well as between the team of planners and researchers; sustainability researchers being inexperienced with professional planning practice, which led to misunderstandings and a general lack of appreciation with respect to the pressures and challenges city planning is exposed to in Phoenix. None of these factors became a ‘deal breaker’ but a key lesson is to recognize them in advance and take appropriate precautionary measures to secure a high-quality collaborative process.

Public engagement

While the planning literature often highlights the role of stakeholders and the general public in the visioning process (Shipley et al. 2004), there is a range of interpretations of who should be involved and what are most conducive conditions for broad participation (e.g. time and location; communication and retention). Even with a diversity-oriented approach that involved conducting Vision Forums throughout the city and explicitly targeting less represented groups for the Visioning Workshop, some degree of failure needs to be recognized. There was clear under-representation of English-speaking Hispanic and Black residents and complete absence of non-English speaking community members at the Visioning Workshop. This occurred even though the project team was able to solicit these community groups and recruit bilingual facilitators. A major barrier to broader representation at that time was AZ Senate Bill 1070 ("Support Our Law Enforcement and Safe Neighborhoods Act"), which encourages racial profiling and has been blocked in its major parts in federal courts. Another barrier was the centralized city government venue (City Hall), which did not encourage some parts of the population to participate. These barriers are critical as issues of "representativeness" are recognized as more important for the quality of the process than total number of participants (Hodge 1998).

The Phoenix visioning study incorporated different measures to enable continuous and accessible stakeholder communication. All stakeholder events (Forums, Workshop, Hearings) included a description of the overall visioning process as part of the General Plan Update, reporting back of outcomes from previous events, and opportunity to comment on these outcomes or provide additional input. The city's information technology implementations (e.g. website, RSS feeds, social media) provided calls for participation and input, advertised events, and disseminated information. Posted on the city's website and supporting infrastructure were process descriptions, presentation material, raw data, synthesized outcomes and other information on the visioning process. The city's visioning platform is currently being revised for a new upload without expiration. The openness to continuous stakeholder communication is a shift by the city administration away from the ten-year update model for the General Plan to an iterative process with frequent revisions.

Capacity building and social learning

An important requirement for advanced planning processes are explicit capacity building or social learning processes for the general public (Friedmann 1987; Innes & Booher 2003). In the Phoenix visioning study such capacity building was less intensive than the one for the city planners. A key mechanism was the iterative *SPARC* process of "Drafting and Crafting," which allowed the participants to revisit and internalize insights. The level of public involvement often varies over the course of a planning project (Krütli et al. 2010). Thereby, a large number of low-level engagement opportunities are unlikely to replace high-level involvement in terms of impact and outcomes. In the Phoenix visioning study, participants were confronted with increasingly challenging tasks, while offered increasingly more time and interaction to complete them (Fig. 2). There are some empirical indications of capacity enhancement (participant feedback and observation), but no testing method was applied that could substantiate these impressions. Potential success factors for capacity building include the use of visuals (collages and game boards), which potentially lowered resistance to engaging in more challenging group work and supported creative engagement. Stakeholders were even eager to find ways to "play" outside of the structured activities. Groups went beyond redefining, adding, and removing vision elements and relationships, and took advantage of opportunities to richly describe heterogeneity within the vision. Another critical condition for public engagement as capacity building is sound facilitation. Therefore, emphasis was placed on facilitator training, including coaching of the project team by a professional facilitator trainer. In addition, the 28 workshop facilitators contributed to and studied detailed guidebooks and played the role of both facilitator and participant in practice sessions. Other parts of the facilitator training was content related and required exchange and mutual learning between the city planners and the sustainability researchers on topics such as urban development in Phoenix, city visions from across the U.S., as well as sustainability concepts and issues. Finally, capacity building in the Phoenix visioning study extended to exploring diversity before building agreement (as opposed to direct consensus building). The diversity-oriented Phase 2 ensured that the visioning process benefited from diverse perspectives and was representative of the variety of stakeholders and community members (Qadeer 2000; van Asselt Marjolein & Rijkens-Klomp 2002; Uyesugi & Shipley 2005). Interactive negotiation of conflicts in Phase 4, and not simple suboptimal compromising, was crucial to arriving at a diversity-rich, yet shared vision, rather than a homogeneous vision.

Conclusions

The study adopted a sustainability visioning methodology (*SPARC*) in support of the City of Phoenix' General Plan update. The study design emphasizes coherence, sustainability, relevance, and specificity to craft a diversity-rich shared vision in a continuous learning process among various stakeholder groups. The study offered capacity building opportunities through progressive involvement and complexity of participatory tasks as well as the interplay of creative and analytical activities. Through the iterative visioning process prevalence, attributes, heterogeneity, and convergence of envisioned goals, as well as potential conflicts were addressed, with the primary goal of enhancing the coherence of the vision. Other critical features (including compliance with sustainability principles) remained underdeveloped due to time and capacity constraints. While the *SPARC* methodology provides robust guidelines for planning practice, it cannot compensate for insufficient project management, financial resources, expertise, or stakeholder recruitment. Frequent iterations of the visioning process can potentially ensure that General Plan updates result in the capacity for communities to develop meaningful dialogue on desirable and sustainable futures. To improve the quality of this dialogue, planners and researchers need strong collaborative arrangements, time for reflection, adequate resources, and evidence-based approaches to visioning.

CHAPTER 5

MODELING DESIRABLE, RESILIENT, AND SUSTAINABLE VISIONS

Introduction

Visions are crafted to put forward transformational goals, measure progress, and build capacity and shared purpose. Rather than concentrating on current and persistent dilemmas, the focus of the visioning process is to clearly articulate a future desirable state. Beyond just a comprehensive list of long-range goals, visions describe the end result of how those goals interact and play out into the future (Wiek and Iwaniec 2013).

This suggests that we must be asking a lot from visioning processes. However, the lack of theoretical and methodological development within the fields of visioning research and practice limits tangible outcomes and our expectations of the process (Helling 1998; Shipley 2002; van der Helm 2009). To begin addressing this gap, a recent review of visioning literature synthesized a criteria-based conceptual framework for developing sustainability visions (Wiek and Iwaniec 2013). Quality criteria for developing robust visioning approaches identified that visions need to be constructed such that they are: visionary, sustainable, systemic, coherent, plausible, tangible, relevant, nuanced, motivational, and shared. Within the reviewed literature some of these quality criteria were better represented than others; few visioning studies focused on formal procedures for crafting systemic and coherent visions. In this paper we address how to enhance systems perspective and methodological capacity for sustainability visioning.

We describe how systems modeling may be used to support visioning in emerging sustainability plans, programs, and education. We demonstrate the role of modeling visions, in participatory and group modeling settings to engage stakeholders in the process and create ownership. A tiered approach to modeling visions is presented, but as an enhancement of, not as a reinvention of, the visioning process. We work from solid foundations in visioning to make the process more rigorous and robust. While focused on the systemic criterion, we also examine how other specific quality criteria are fulfilled and may be supported. Finally, examples are provided from two recent projects where we have applied modeling to sustainability visioning. Through these examples we describe how the process of vision modeling was applied in urban long-range planning and in sustainability education. These examples illustrate the efficacy and power of applying systems modeling to visioning projects in order to better support both sustainability goals and the education of future sustainability researchers and practitioners.

Modeling, sustainability modeling, and current practice

We broadly define sustainability as a process (Childers et al. in review) and sustainability science as a research endeavor to understand this process while also applying this knowledge to real world challenges and solutions (Clark and Dickson 2003; Sarewitz et al. 2012; Wiek et al. 2012). The process of model development is conducted to better understand systems complexity and how our decisions affect system behavior through abstractions and simplifications of the real world. Modeling can support sustainability science by structuring the process of representing and exploring of real world challenges and solutions (cf. Wiek et al. 2012b). The value of modeling is evident in:

1. the process of model framing and construction, where decisions must be made about system boundaries, what to include in the model, and how to couple model components;

2. the formal articulation of assumptions and uncertainties about the system in question;

3. the visualization of the underlying structure and connectivity of the system, and;

4. the exposure, through visualization of model behavior, of system characteristics such as unexpected outcomes and response thresholds.

Sustainability models of the current state have some characteristics of models in general, including limitations and constraints posed by the resources on which the represented system depends on. There are some characteristics of sustainability models, though, that set them apart from other systems models. We posit that, based on a foundation of sustainability principles (Cherp et al. 2004; Gibson 2006; Jordan 2008), sustainability models should be: a) explicitly normative and participatory, with a focus on values and desirability; b) holistic rather than domain-specific; c) structured and evaluated based on sustainability principles; d) actor-oriented (i.e. focused on people, their actions, roles, values, and needs) in structure and interpretation, and; e) problem-based and solutions-oriented. It goes without saying that in the realm of all possible models, many of them will have some, perhaps many, of these five characteristics. We argue, though, that *sustainability models* should include all of them. This makes them distinct from models that might be used to support sustainability projects, but that do not meet the above characteristics.

Sustainability models are thus more likely to be heuristic, rather than predictive, because of their reliance on normative interpretations of the system. Because sustainability models are not necessarily anchored in our current quantitative understanding of a system, they are likely to be more open to creativity and thus to be more nimble, flexible, and potentially transformational than more traditional deterministic models. Real-world applications of sustainability models are increasing and are demonstrating growing sophistication. This is particularly true in fields such as natural resource management for local communities, where there are strong needs to integrate normative perspectives to better assess sustainability outcomes and represent complex social-technological-ecological dynamics (Astier et al. 2012; Wiek 2012).

Typically, modeling procedures produce either static snapshots of the current system state or dynamic representations of future scenarios that are anchored in present conditions. Normative-based approaches, even those that do include a visioning process—such as backcast modeling (Robinson 2003; Quist 2007), future mapping (Mason 2003), horizon mission methodology (Hojer and Mattsson 1999), impact of future technologies scenarios (Strong 2006), and sociovisioning (De Vries 2001)—do not explicitly model the future desirable state. Instead, sets of goals, moving targets, or indicators representing the vision are generally used to direct and assess scenario pathways. Additionally, most of the formal backcasting methodologies we list above (except for horizon mission and impact of future technologies approaches) all develop pathways that begin with the present system state and run *forward* in time with the vision goals serving as a beachhead.

Vision modeling

We define vision modeling as the process of constructing sustainability models such that the structure and function of the future desirable state is explicitly articulated as a systems model. Vision modeling puts emphasis on rigorously describing and clarifying the future state. It allows participants to see that future state from a systems perspective that includes complexity and the interrelated nature of the components.

We argue that, in many situations, modeling will enhance the process and outcomes of visioning, particularly when model development follows sustainability visioning criteria such as those put forth in Wiek & Iwaniec (2013). For example, model development as part of the visioning process includes steps that:

1. ensure that the vision is composed of compatible goals, free of conflicts and trade-offs

2. reinforce and serve as checks on the plausibility of the visioning goals, because model components must be based on realistic constraints;

3. make sure the visioning outcomes are tangible, largely through simulation runs of model and viewing the targets graphically, and;

4. help to categorize how various system components are prioritized and nuanced, through both qualitative and quantitative parameterization of the model that determines which outcomes are sensitive to which assumptions and by how much.

A real power of incorporating modeling into the visioning process is that the models may be used to explore systems-level structural features among the vision components and emergent dynamics among goals, targets, and indicators. In this way, modeling enhances systems thinking while also contributing to the coherence, plausibility, tangibility, and specificity of the vision. In summary, models have a long track record of being used to identify and understand problems and explore potential futures. We propose that using models to also help articulate sustainable visions takes them into the realm of identifying opportunities and scrutinizing solutions.

Tiered approach to modeling sustainability visions

We describe three broad approaches—conceptual, dynamic, and pathway—for modeling future system states (Fig. 1). These tiered approaches may be used iteratively as part of a sustainability visioning process. The extent of systems thinking, in representing the systems features (i.e. structure, dynamics, and emergent outcomes) of the vision, is used to distinguish among the set of approaches. Choosing the appropriate approach to use will depend on the context of the sustainability endeavor, the project goals, and the availability of resources (e.g. time, funding, and expertise).

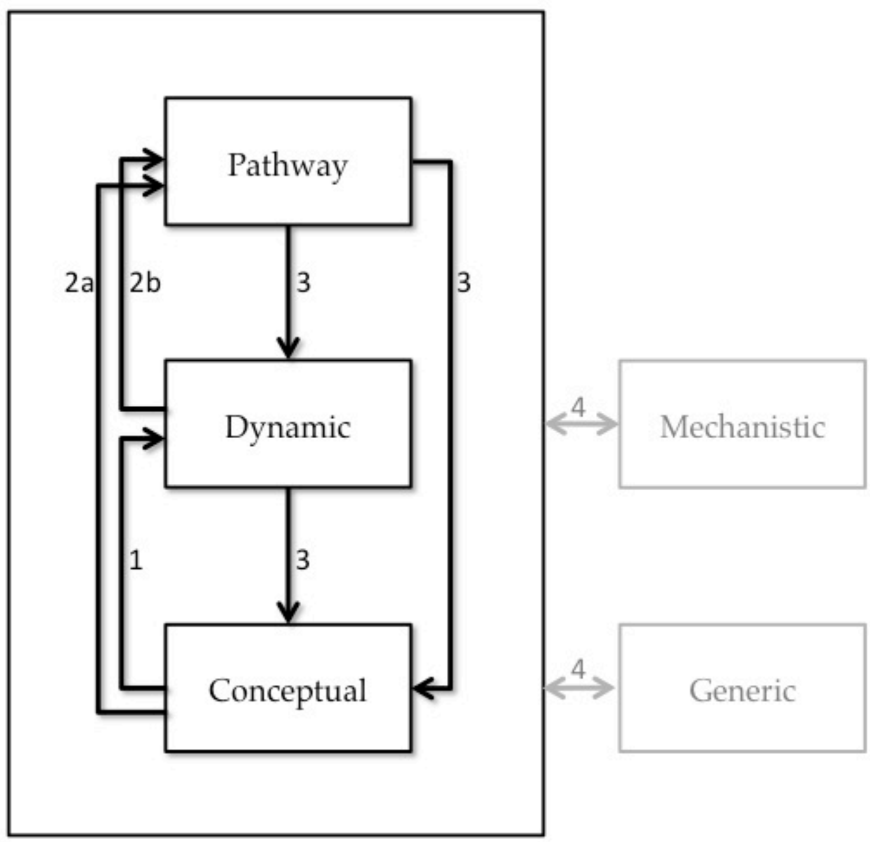

Fig. 1 Modeling sustainability visions
Boxes represent the different systems approaches to modeling sustainability visions connected by potential workflows 1) parameterizing functional models, 2a) qualitative or 2b) quantitative simulations of vision pathways, and 3) iterative model development based on undesirable outcomes or pathway heuristics. The use of 4) generic and mechanistic sustainability vision models while not discussed in this paper may have additional utility for visioning research and education.

Conceptual and rapid prototype vision models – Models are, by definition, abstractions of reality. Conceptual models (per Fig. 1) are non-quantitative diagrammatic representations that highlight connections among the various model components. Conceptual models of future desirable states provide structural representations of vision components and system relationships. This can be helpful to structure and organize components of the vision and to check for missing components and inconsistencies (i.e. conflicts and trade-offs) among components.

Easiest to construct, conceptual models are the most commonly utilized approach for incorporating systems thinking into participatory settings. Techniques such as influence matrices and trade-off assessments explore interrelations among vision components to identify potential conflicts, trade-offs, and synergies (Iwaniec and Wiek in review). Causal loop diagrams are used to visualize systemic characteristics; in visioning, this allows for better identification of potential intervention points associated with highly influential systemic features such as feedback loops, downstream factors, and network structure (Meadows 2008; Vester 2007). Actor-oriented and sustainability constellation approaches incorporate specific actors, rules, norms, needs, wants, resources, technologies, and actions in assessing beneficial and adverse effects (Meadows 2008; Ostrom 2009; Wiek and Larson 2012; Wiek et al. 2012). Conceptual approaches are typically qualitative representations of system structure, but relative quantifications can be used to make more nuanced inferences on conflicts, trade-offs, and interventions (Vennix 1996).

Dynamic vision models (functional, with input-output correspondence) – Building on the above approach (conceptual modeling), dynamic models (per Fig. 1) are parameterized such that the "running" models represent the dynamics of complex interactions among the system components. This increased specificity allows participants to better anticipate non-intuitive outcomes, such as 'hidden' conflicts due to thresholds or non-linearities, that are emergent from the inter-relationship of system components.

Parameters for the model are selected from evidence-based and empirical work, allowing the vision components and interactions to be more relevant to the real world (i.e. grounding the vision to reality), thus encouraging greater coherence and plausibility of simulated outcomes. Techniques such as sensitivity analysis and cross-impact analysis (Bishop et al. 2007) inform the selection of indicators, targets, and interventions based on how sensitive they are to change and the implications of emergent interactions. By simulating potential trajectories of the vision models, participants can explore the viability of various envisioned future states. Undesirable or unrealistic trajectories may require reviewing selected parameters and underlying assumptions, or returning to the conceptualization of the vision (arrow 3 in Fig. 1). Dynamic vision models are constructed to further improve the specificity and coherence of the conceptual vision models and allow participants to examine the viability and plausibility of the vision.

Pathways of vision models – Characterization of the sustainability gap between the vision model and initial conditions are needed for more cogent assessments of plausibility (Gaziulusoy et al. 2012). Pathways of vision models may be qualitatively crafted directly from conceptual models or quantitatively simulated from dynamic vision models (Fig. 1). These pathways are distinct from the potential future trajectories simulated by dynamic vision models — forward-running trajectories of the vision. Vision model pathways are simulated backwards (i.e. from the vision to the present conditions) through a heuristic process of identifying the proceeding components and conditions (actions, policies, technologies, institutions, etc.) that need to be in place in order to achieve the vision. Using this procedure, not all pathways directed backward from the vision may intersect with current state conditions, and the difference between the two is what we call the reality gap (Fig. 2). The models thus become a critical tool in also identifying how disparate (and in what way) future ambitions are from what may be plausibly realized (i.e. the sustainability gap in Fig. 2).

This approach is also distinct from, but potentially complementary to, backcast modeling where pathways starting from the current state intersect with pre-determined envisioned future goals (arrow 3 in Fig. 2). Conducting both scenario pathway approaches (backcast modeling and vision modeling) may increase the number of potential interventions and options available for consideration. A comparative approach that contrasts vision pathways with those developed from other scenario approaches may also allow for a better understanding of how the balance of deterministic and normative perspectives can shape scenario outcomes, such as a better understanding of how starting from current state conditions affects the resulting visions. The emphasis of this approach, however, is not merely to better understand methodological distinctions among scenario approaches, but also to enhance the process of visioning through a procedure of rigorously describing and scrutinizing the visions (i.e. through systems modeling). The purpose of the approach is to increase the relevance of the vision by exploring and articulating what is needed to achieve a desirable, resilient, and sustainable future.

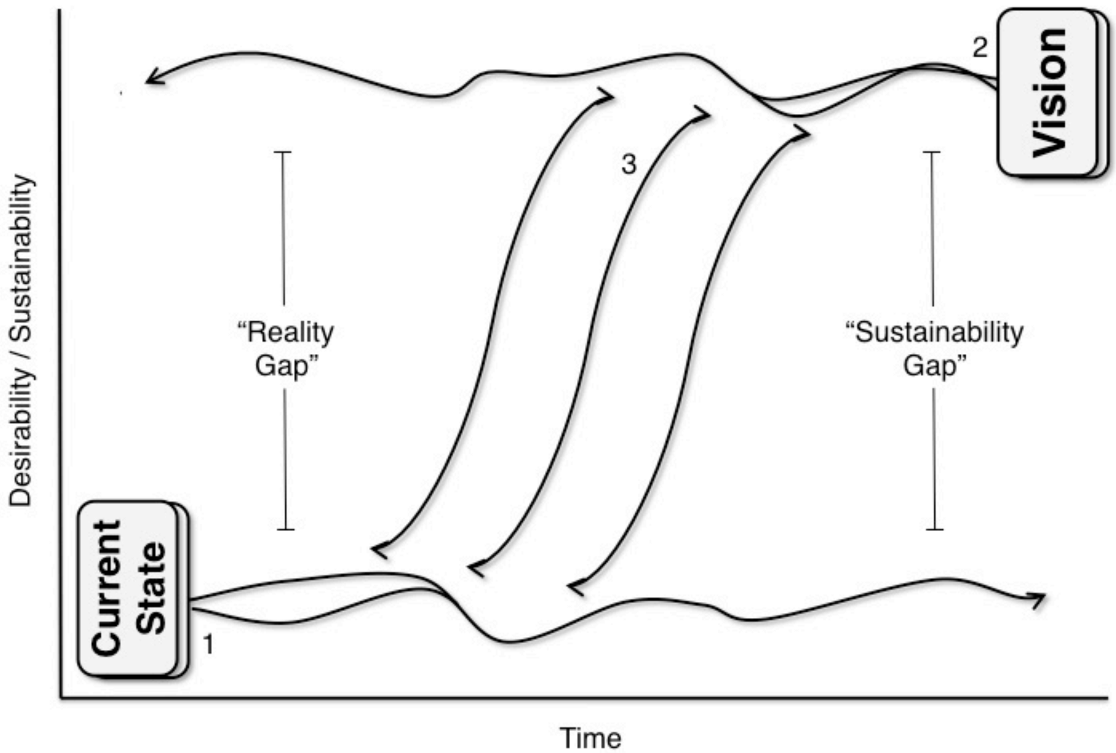

Fig. 2 Modeled pathway to and from the vision
1) models of the current state simulate deterministic pathways into the future; 2) models of the vision simulate pathways backwards from the envisioned future state; 3) pathways simulated to interconnect the vision and the current state. The reality and sustainability gaps represent the potential lack of correspondence between pathways originating from the different time horizons and are needed better understand how to craft 3) interconnecting pathways.

Engaging participants in sustainability vision modeling

Regardless of the approaches selected, we argue that all vision modeling activities should be conducted in participatory settings (Wiek and Iwaniec 2013). Many different interpretations of participatory modeling are found in the literature, with greatly varying levels of participatory involvement and a variety of approaches to modeling (Videira et al. 2010). In this paper, we stress the importance of participatory settings where stakeholders are highly engaged in the co-production of the models, and not just involved as data sources. Stakeholders should actively participate in all stages of the construction, calibration, and validation of the models. This will enhance their understanding of modeling limitations, their confidence in the model itself, and should encourage end-user implementation.

A primary challenge of participatory modeling include ensuring that analytical procedures are understood and negotiating among different knowledge systems, norms, and values (Vennix 1999; Hovmand et al. 2011). Truly incorporating stakeholders into analytical processes requires a strong investment in capacity development in order to maximize model construction success and facilitation, to negotiate consensus, and achieve buy-in. Early research on enhancing creativity in participatory modeling suggests that gameplay and art-based activities may help prepare participants to engage in more challenging formalized tasks (Shneiderman et al. 2006; Vidal 2006). Analytical and creative procedures are potentially complementary without necessarily being modular, sequential, or linear. Since vision modeling approaches are meant to be applicable in variety of fields, prescriptive approaches on how to integrate creative and formal activities are not feasible. While our focus is on developing and engaging formal procedures for visions modeling, the subsequent section does demonstrate integrating formal and creative procedures.

Real-world examples of modeling sustainability visions

The two examples in this section summarize the application of vision modeling in urban planning and sustainability education. We describe each projects' setting, goals, approach, and methods and highlight key differences in the ways visioning modeling was used (Tab. 1). A discussion of this summary and outcomes is provided in the subsequent section to demonstrate how vision modeling can be applied to develop perspectives and methodological capacity in systems thinking in real-world sustainability projects.

Table 1 Two examples of vision modeling projects

Project:	**Phoenix General Plan visioning study**	**ASU Sustainable Ecosystems undergraduate course**
Project setting:	Urban planning research	Sustainability Education
Project goal:	Develop rigorous visioning process & product	Teach sustainability competencies
Goal criteria:	Sustainability visioning quality criteria (Wiek and Iwaniec 2013)	Sustainability education competencies (Wiek et al. 2011)
Explicit role of vision modeling:	Addressing systemic criterion	Teaching systems thinking competency
Engagement setting:	Participatory modeling (visioning workshop)	Group modeling (in-class)
Vision modeling approach (scope: scale):	a. Conceptual (whole system: city & villages); b. Dynamic (subsystems: city)	a. Conceptual (subsystems: city); b. Dynamic (subsystems & integrated subsystems); c. Pathway: (integrated subsystems)
Modeling methods:	a. Causal loop diagram, influence matrix, network analysis b. Objective-oriented & game-based systems map	a. Objective-oriented & tutor system b. Objective-oriented & tutor system c. Objective-oriented & tutor system; trade-off and sensitivity analyses
Outcomes:	Systems conflict & trade-off revisions to the vision; participants (self-assessment survey) & practitioners (debriefing) reported enhanced systems perspective	Pre- & post-assessments demonstrated enhanced capacity for systems thinking & anticipatory competency building

Urban planning research: Phoenix General Plan

The Phoenix General Plan project is a state mandated long-range planning process with the practical objective to develop a comprehensive vision for the City of Phoenix (AZ, US) in order to guide future decision-making in all city departments (State of Arizona 1998; State of Arizona 2000). A key research assumption was that an emphasis on systems-based approaches would be an effective way to apply sustainability visioning quality criteria. Our research objectives were to design, conduct, and test a rigorous visioning process informed by sustainability visioning quality criteria. The process, results, and appraisal of this project are detailed in Iwaniec and Wiek (in review) and we summarize them in the context of vision modeling below.

In preparation for the city's decadal update to its General Plan, the City of Phoenix Planning Director approached faculty from Arizona State University (ASU) with expertise in sustainability research to collaborate on innovating the city's planning practice for the General Plan 2050. Through this partnership we incorporated modeling into the visioning process and the City of Phoenix conducted its first planning-directed stakeholder engagement activities, related in the General Plan, since the 1970s. Several participatory models of the future desirable state(s) were developed based on stakeholder elicitation, analysis, and evaluation of future-oriented values and preferences, in support of the sustainability visioning process.

Conceptual models of the visions were created for each of the fifteen villages that make up the City of Phoenix and an aggregate model for the entire city. Elicited vision narratives were deconstructed into key vision elements (e.g. "abundant vegetation", "enhanced walkability", "reduced heat", "abundant shade", and "responsible water use") with associated stakeholder values and preference. Conceptual systems models were constructed from the vision elements and systems relationships that connected the elements. We performed several analytical activities to explore and evaluate the vision models, including:

1. Causal loop diagrams and network analysis were used to analyze the overall system structure and relationships among the vision elements.

2. Consistency analysis was preformed to identify trade-offs and synergies among vision elements.

3. Diversity appraisal was used to identify similarities and differences among the vision models from different stakeholder groups (e.g. heterogeneity among the fifteen villages' visions).

Several dynamic models were created by parameterizing subsystems models selected from the overall conceptual model of the city's vision (see urban vegetation subsystem Fig. 3). Subsystem models were constructed to further engage participants with portions of the vision that had potential trade-offs and conflicts, both systemic and normative. The selection criteria for vision elements to include in the subsystems was a) potential conflicts and trade-offs, b) priority score, and c) betweenness centrality of the network. To parameterize vision elements in the subsystem models, the stakeholders negotiated the prioritization (priority score) of each vision elements. For example, high, medium, and low priorities represented stated preferences for the vision element "abundant vegetation" corresponding to 33%, 23%, and 13% tree canopy cover. In this urban desert ecosystem, the vision element "abundant vegetation" had direct (parameterized) impacts on the vision element "responsible water use". Additionally, in this case where both the “abundant vegetation” and “responsible water use” vision elements were prioritized as high, there were clear systems trade-offs that needed to be explored (Fig. 3). Game-based systems maps representing the models (Fig. 4a) were constructed to allow participants to:

1. familiarize themselves with their group’s subsystem by providing visualization and narratives of the vision elements, relationships, and overall subsystem.

2. explore potential implications of different changes to the vision, and negotiate trade-offs and conflicts (per the example in Fig. 3 and activity in Fig. 4).

3. appraise the sustainability of the final negotiated vision by responding to open-ended questions based on sustainability principles (informal appraisal).

Revisions to the models were the result of changes in the stakeholder priorities for vision elements (which represented changes to the model parameters), adding/removing vision elements and relationships (which represented changes to the structure of the model). Finally, the participant provided detailed actor-oriented narratives in order to add specificity and further describe the vision and simulated outcomes.

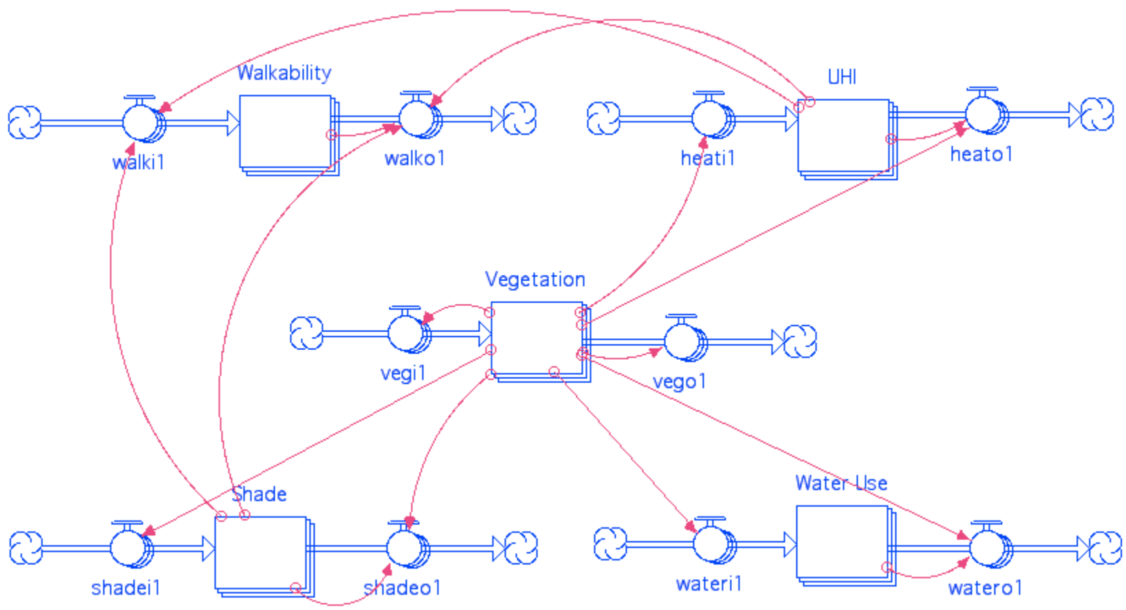

Fig. 3 Simplified representation of urban vegetation vision model from Phoenix General Plan Update
Vision elements included in this subsystem represented stakeholder preferences for "abundant vegetation", "enhanced walkability", "reduced heat" (UHI), "abundant shade", and "responsible water use". Relationships have been redrawn excluding convertors and drivers that are internal and external to the illustrative subsystem.

Fig. 4 Vision modeling activities
a) Phoenix General Plan Update workshop game board and b) ASU Sustainability Ecosystems Course.

Education example: Sustainable Ecosystems course

In the SOS 326 Sustainable Ecosystems upper-division course, taught in the School of Sustainability at ASU (Tempe, AZ, US), undergraduates collaborated in small group settings to construct, explore, and peer-tutor models of the Phoenix urban ecosystem (Fig. 4b). The overarching goal was to use object-oriented modeling & tutorial software to teach sustainability science competencies (Wiek et al. 2011) with a particular [and obvious] emphasis on the systems thinking competency. A key assumption was that the construction, documentation, and use of ill-defined models would be a more effective way to experience, and thus to learn, systems thinking when compared with simply exploring an existing model or not using models at all. Ill-defined model construction is when students must locate, digest, and filter considerable information to determine how to approach model development, how to conceptualize their system, and how to quantify relationships in their model. Status quo (SQ) plausibility-based scenario models were constructed from student identified sustainability challenges and information on the likelihood of current trends. Future desirable state (FDS), vision models were constructed from student developed sustainability visions, instructor defined 'real-world' constraints (e.g. hotter and drier climate that steadily reduced water availability), and aspirational and evidence-based interventions. Students began modeling exercises only after lectures had introduced critical background information, particularly on systems dynamics.

Our in-class modeling activities (conceptual, dynamic, and pathway models) focused on urban ecosystems in general and the City of Phoenix in particular. Students were initially divided into small groups of 3 - 5, and each group was charged with developing a systems model of one of three closely coupled subsystems of the urban ecosystem: 1) water; 2) green infrastructure, and; 3) transportation. The three subsystems corresponded to city department role-playing activities associated with the model development: 1) Phoenix Water Services; 2) Parks and Recreation, and; 3) Street Transportation and Public Transit. For each of the subsystems, SQ and FDS models were constructed and tutor systems developed. The Learning by Authoring an Intelligent Tutoring System (LAITS) and Dragoon modeling software, developed at ASU, was used to create these subsystem models and craft tutor systems for models (VanLehn et al. in review). This object-oriented software also allowed students to document how they developed their model, list assumptions, describe the decision-making process, and peer-tutor other students. The peer-tutoring took the form of students having to re-create each others models, provide constructive feedback on the models, and potentially revise the models. The progression from learning the software to using a fully integrated systems model of the Phoenix urban ecosystem included:

Step 1: Instruction was provided on how to navigate and use the modeling software, largely through simple but steadily more complex modeling exercises.

Step 2: Small groups of students were assigned to collaboratively model one of the three subsystems (i.e. water, urban vegetation, transportation) from either a SQ or FDS perspective. In the subsystem modeling narrative we provided students with a few suggestions about where to begin their search for critical information and how to decide on state variables, model structure, and parameterization of variables (e.g. city and departmental visioning documents).

Step 3: The student groups who were modeling the same subsystem then used the LAITS tutor system to critique and learn from each other's models. Using this forum, these groups hybridized their subsystem models into “consensus models” that included key components of their individual group models. For example, this resulted in one SQ consensus model for urban vegetation and one FDS consensus model for urban vegetation.

Step 4: We then reorganized the students into new groups, ensuring that each new group had “expertise” representing all three subsystems. These new groups were tasked with collaboratively coupling and integrating the three subsystem models into a ‘whole-city’ model. For example, in many cases the students coupled the water and urban vegetation subsystems through water use for irrigation, and coupled these to the transportation subsystem via urban heat island dynamics, and air pollution—noting that irrigated vegetation mitigates both while transportation exacerbates both.

Final Step: These new groups developed tutor systems for their SQ and FDS models and explored each other’s models. They used techniques such trade-off and sensitivity analyses to explore potential ‘best’ intervention points and where the systems might be too inflexible. Each group presented their final systems models, visualizations, and narratives to the entire class, then led a class discussion on their findings (e.g. reality and sustainability gaps, creativity and feasibility of the models, and recommended transition strategies).

Discussion

Our two examples illustrate the application and potential role of vision modeling in urban planning and sustainability education. While the main goals of the two examples were different (i.e. developing a robust urban vision and teaching sustainability competencies to students), both approaches demonstrate how vision modeling can be applied to develop perspectives and methodological capacity in systems thinking (Tab. 1).

In our urban planning study, modeling activities contributed to several of the sustainability vision quality criteria we presented above (Iwaniec and Wiek in review). While the primary goal is to describe how systemic methodological enhanced the visioning process, we also found that modeling contributed to the coherence and plausibility of envisioned goals. Potential trade-offs and conflicts were resolved by analyzing for not only obvious direct relationships, but also among indirectly connected goals. Modeling also served as a plausibility 'filter' on interventions and targets (e.g. by exposing biophysical constraints such as the maximum amount of transpirative cooling possible by desert verses mesic vegetation). The co-production of the vision model reinforced stakeholder buy-in and developed a shared proficiency in resolving normative conflicts as well as direct and indirect systems trade-offs. Further re-enforcing these findings, we found that capacities for systems thinking among the stakeholders (based on self-assessment surveys) and practitioners (based on facilitator debriefing) were enhanced.

In the education settings, sustainability competencies (Wiek et al. 2011) were used to define specific learning objectives, which we used to design these Sustainable Ecosystems in-class modeling activities. We found that vision modeling did enhance sustainability education competencies in our students, specifically their systems thinking and anticipatory competencies. Our preliminary analysis of formal pre- and post-assessments demonstrated enhanced capacity in systems thinking capacities and anticipatory competency building. Normative and strategic competency building was not explicitly assessed, but was included in peer-tutoring assessment guidelines and in rubrics used to grade the modeling process and final models. Peer evaluations assessed at regular intervals through the modeling process also showed that the group modeling activities contributed to interpersonal competency building and enhanced student collaboration skills. We posit that many of the ‘real world’ issues that our student will face after graduation will lie at the intersection of these competencies (i.e. the process of modeling alone can be used to develop systems competencies and visioning to develop normative competencies), and that through the integration of these approaches their ability to identify and scrutinize solutions will be enhanced.

The usefulness of modeling for heuristics, representation, learning, and discovery has been well documented (Oreskes et al. 1994). Systems modeling approaches described here (Fig. 1) do not represent the only form of system modeling (e.g. decontextualized-generic or specific-mechanistic modeling) or other broad categories of complexity modeling (e.g. agent-based, spatially-explicit, and process modeling) that may be useful in other sustainability visioning settings (VanLehn 2013). While not common place, there are examples of spatially-explicit models being used to support visioning processes (Marshall and Grady 2005; Lemp et al. 2008; Sheppard et al. 2011). These models are incorporated as either expert-based data or late in the participatory process for visualization and stakeholder review rather than being integrated throughout the visioning process. There are specific examples of scenario approaches, such as the QUEST backcasting technique (Robinson 2003), that do use systems models throughout the scenarios process. But as described earlier, this is distinct from vision modeling, in that instead of explicitly modeling the vision, the modeling activities start at present conditions and run forward through time using normative decision points.

The use (and hybridity) of different modeling approaches may emphasize different visioning quality criteria (e.g. systems modeling for developing *systemic* and *coherent* visions; agent-based modeling for actor-oriented *relevance*; spatially-explicit models for spatial *tangibility*; and process models for operational *nuance* and specificity). Recent work in linking agent-based and systems modeling approaches has been used in natural resource planning (Bousquet and Trébuil 2005) and may have interesting application to specifying actor-oriented visions to better articulate: who is implementing changes, how are rules and norms driving action, and who is affected by these action.

Various typologies of techniques suitable for future-oriented approaches exist in the literature. These include syntheses organized by research objectives (Chermack and Lynham 2001; Börjeson et al. 2006), by methodologies (Bradfield et al. 2005; Bishop et al. 2007), or by applications they can support (Schlüter et al. 2012; Varum and Melo 2010). What we still need are performance-based comparisons for approaches used in not just vision modeling, but also traditional visioning (Shipley 1997; Shipley and Michela 2006), scenario development (Varum and Melo 2010), and participatory modeling (Reed 2008; Voinov and Bousquet 2010) including the supportive use of state-of-the-art technology. It is important to re-emphasize that vision modeling is a process, and as such evaluative comparisons will need greater attention to be placed on stakeholder representativeness (who and how participants are involved) and capacity-building (quality of the dialogue and experiences, reflection, and learning).

Conclusions

Pursuing sustainability visions deserves a deep understanding of the interactions, feasibility, and outcomes of our normative choices and goals. By no means does the literature lack for repeated calls of rigorous systems thinking in sustainability practice and research. Yet, we still readily encounter critiques of hastily conducted endeavors without thorough analysis of trade-offs, interconnected indicators and goals, and emergent complex dynamics. Deleterious and persistent sustainability challenges foster tensions in sustainability between the urgency of needs and timely implementation while maintaining the necessity for comprehensive and long-term perspective. The modeling methodology employed when crafting sustainability visions ought to appropriately reflect this tension: the need for desirable results under realistic conditions and the need for robust long-term sustainable solutions.

Crafting, representing, and evaluating future desirable states through systems modeling in participatory settings is intended to support compliance of sustainability visioning quality criteria in order to develop desirable, resilient, and sustainable visions. Linking modeling processes with visioning processes will allow practitioners and researchers to better identify and scrutinize solutions and will depend on effective co-production and capacity development.

CHAPTER 6

SUMMATIVE FINDINGS AND CONCLUSIONS

Calls are repeatedly made for visions that can guide us toward sustainable futures. However, visioning is already prominent in planning, all of the fifty largest US cities have conducted long-range visioning, and scattered across the literature is an abundance of visioning studies from a broad range of fields. Based on the few evaluative studies that have been conducted on visioning there are apparent deficits that curtail our expectations and prospects of realizing process-based and product-derived outcomes (Helling 1998; Shipley et al. 2004; Shipley and Michela 2006). This suggests that these calls should instead focus on developing applied and theoretical understanding for crafting better sustainability visions. This dissertation addresses this through conceptual, methodological, and empirical research with the three overarching goals in mind:

1) Articulate and advance a research agenda for the applied and theoretical understanding of crafting sustainability visions;

2) Develop a research practice framing for conducting collaborative visioning studies; and

3) Enhance the rigor and robustness of visioning methodology.

Starting with this first goal, this research reviewed how visioning approaches are being designed, applied, and evaluated (Chapter 2). Subsequently, it developed a conceptual framework for visioning research practice by synthesizing criteria-based principles and design guidelines. In over 20 years of contemporary visioning there has been little critical research on approaches to support the development of sustainability visions. The research in Chapter 2 was distinctive in two main ways. The few evaluative studies that currently exist focus on urban planning settings. *This* research conducted a comprehensive review and identified prominent and exemplary visioning studies from research and practice across a variety of diverse fields (i.e. business, non-government organization, land-use management, natural resource management, sustainability science, urban and regional planning). Secondly, instead of focusing on deficiencies, this research focused on articulating what sustainability visioning is and on the constructive synthesis of a conceptual framework for criteria-based design and evaluation of sustainability visioning studies. Ten quality criteria of sustainability visions were synthesized and organized along three axes: desirability of the vision (visionary and sustainable), construction of the vision (systemic, coherent, plausible, and tangible), and transformational features of the vision (relevant, nuanced, motivational, and shared). Quality criteria were also found to be closely linked and synergistic, hence implementation and evaluation of the quality criteria should be integrated synergistically in support of each other. In correspondence to each of the quality criterion, design guidelines were compiled from the various methods, tools, and techniques used to construct and assess sustainability visions.

Together these quality criteria and design guidelines provide a concise reference framework to inform practitioners and researchers on how to design, implement, and evaluate sustainability visioning processes.

The use of advanced visioning procedures was identified in many contemporary visioning studies and illustrates the clear intent to create high quality sustainability visioning processes. However, among the reviewed studies there was not a single approach that adhered to all criteria. This research identified the need for approaches to integrate across all criteria-based design guidelines and for the development of empirical evidence on the validity and comprehensiveness of the compiled quality criteria and design guidelines.

The field is urged to develop sustainability visioning frameworks to develop and test (and ultimately compare) theoretical models and evidence-based methodologies that adhere not only to one or some of the quality criteria – but all of them.

To present a pragmatic way forward, this dissertation describes a novel sustainability visioning methodology designed with the intent of filling this gap and integrating across the set of quality criteria (Chapter 3). This methodological framework employed sustainability visioning design guidelines to craft visions that are Systemic, Participatory, Action-oriented, Relevant, Consistent (i.e. *SPARC* visioning methodology) integrating design guidelines across all ten quality criteria.

The overall methodology also provided a tiered capacity-building framework and built-in reflexive processes. The first phases of the visioning process are composed of relatively simpler engagement processes (e.g. informative and extractive) that successively increase in the level of engagement and task complexity (e.g. systems analysis and negotiation). Each new phase begins with a review and reflection process of previous activities and outcomes. Key to this multi-phase approach was the intentional sequencing of activities such that creative (Phase 2 and 4) and formalized (Phase 3 and 4) design procedures recursively inform one another. The role of facilitation also detailed the importance of training and preparation needed to successfully support collaborative activities. As a mode of reflexive research, close collaborative arrangements between researchers and practitioners are emphasized throughout the visioning process.

The SPARC visioning methodology was designed as knowledge generating framework, including extensive review and evaluative procedures. This allows for longitudinal comparisons of outcomes across the multiple phases within a visioning study. The structured sequence of methodological steps and robust criteria-based design guidelines support the development of further visioning studies for cross-study research among diversity-rich but comparable visioning processes. Both are needed in order to advance the development of evidence-based approaches.

Empirical studies were conducted to test and apply the conceptual and methodological frameworks. An in-depth description of a collaborative visioning study between the City of Phoenix Planning Department and sustainability researchers demonstrated tangible outcomes for implementing the sustainability visioning framework (Chapter 4). Key outcomes included development of: a vision for Phoenix in 2050; integrated visioning research, planning practice, and capacity building; and perspective and methodological capacity for long-range sustainability planning.

However, rigorous methodology and robust guidelines cannot fully ensure the success of visioning outcomes. Visioning process are embedded in the ‘messy’ complexities of the real world where preferences and aspirations change through time, power dynamics are asymmetrical, institutional and cultural inertias resist radical change, and project management and resources are often insufficient (Oels 2009; Lang et al. 2012; Shipley and Utz 2012; Brandt et al. 2013). For example, the Phoenix General Plan visioning took place in a climate where immediate concerns of economic decline may have overemphasized fiscal stability while deemphasizing visionary changes. Reflexivity of underlying values and social learning during the visioning process (Eames and Egmose 2011), frequent iterations of the visioning process (Iwaniec and Wiek in review), and review and revision of envisioned targets for adaptability and flexibility (Wiek and Binder 2005) aid in ensuring that visions are responsive to potential changes in goals through time. Aspirations, solutions, and underlying value systems need to be shared and understood, but understanding these differences may not be sufficient to negotiate across power imbalances. Highly skilled facilitators as well as collaborative training for stakeholders are important to address in-process power issues, but are unlikely to resolve external barriers to final implementation. Beneficiaries of the status quo are unlikely to allow major disturbances to their access to power. This highlights the need to have diverse stakeholders, including relevant decision-makers, to be embedded and have ownership of the visioning process and then champion the envisioned goals (Helling et al. 2001; Oels 2009). Strong collaborative arrangements require trust, training, and especially time (Shipley and Utz 2012). Although time (needed for in-depth reflexivity, social learning, and trust) is regularly cited as a limiting resource for participatory studies and may compete with stakeholder attendance and diversity. Adequate time is not the only common constraint in vision studies. Deficiencies in funding, expertise, political will, and stakeholder interest are commonly cited (Helling et al. 2001; Shipley et al. 2004; Uyesugi and Shipley 2005; Oels 2009). Data limitations will also undermine the quality of visioning studies, such as *SPARC*, that include evidence-based analysis and evaluation steps (c.f. Nassauer et al. 2002). These resource limitations may provide creative opportunities, but unlikely without associated trade-offs. The Phoenix General Plan update continued through its first two years without a dedicated operating budget. This funding constraint was important in that it initiated the partnership and likely contributed to the strong ongoing partnership between city planners and university researchers. However, a lack of funding limited the framing of the participatory agenda and resulted in concessions such as holding participatory activities during existing planning meetings (i.e. Village Council meetings). This is thought to have restricted greater representativeness among the community. In order for a visioning process to contribute to transformational change it must provide lasting impacts. However, post-visioning outcomes are rarely evaluated (Quist et al. 2011). Uyesugi and Shipley's (2005) work was highlighted for exemplary implementation of procedures to motivate and engage stakeholders (in Chapter 2), but follow up studies found rapidly declining satisfaction after participants did not see tangible outcomes being implemented. Follow up studies, in the form of iterative visioning and long-term studies of post-visioning social learning outcomes and solution implementation, are needed to further develop conceptual and methodological understanding.

To ensure that visioning processes have the capacity to develop meaningful dialogue on long-range futures, robust guidelines and rigorous methodological are needed, but *planners and researchers will need to iteratively anticipate and compensate for institutional, cultural, and project management challenges. This 'reality check' is provided to highlight critical challenges in visioning studies to inspire the design of studies that follow up on visioning outcomes and that continue to incorporate cutting-edge approaches to overcoming transdisciplinary barriers.*

The third goal, to enhance the rigor and robustness of visioning methodology, was a central theme throughout the research endeavors. The practice of visioning is still dominated by informal approaches to extract vision statements and organize lists and narratives of 'independent' goals without formal evaluation. For example, in planning settings where broad stakeholder involvement was elicited, the heterogeneity of perspectives and values were typically recorded without proceeding to earnest negotiation and consensus-building. Even among the most prominent approaches, few studies applied formal methodological procedures capable of fulfilling more than a few of the quality criteria and design guidelines; fewer still incorporated any rigorous analytical procedures into the participatory process. Review of the visioning literature demonstrated that rigorous methods do exist for a large number of quality criteria, but many remain in an early stage of development or rarely applied in visioning studies. A classification of this may be organized as: a) methods for which meeting quality criteria and associated design guidelines are developed and commonly applied; b) methods for which they are developed but rarely applied, and c) methods that lack sufficient evidence-based methodological validation. Of these, special emphasis need to be placed on methodological approaches that have been developed but not applied and where evidence-based approaches are still needed. For example, well-developed approaches for the sustainability, systemic, coherent, and relevant criteria exist but are frequently absent in visioning practice (c.f. Wiek and Binder 2005; Weaver and Rotmans 2006; McDowall and Eames 2007; Wagnel 2011; Wiek and Larson 2012; Minowitz and Wiek 2013). In some cases there is a deficiency of rigorous methodology, but the criteria are still commonly applied in practice. For instance, many of the incorporated motivational techniques incorporated in participatory settings are not evidence-based (Shneiderman et al. 2006). In other cases there is a lack of sufficient evidence or methods are in nascent stages, but infrequently employed. For example, methods for appraising the plausibility of envisioned goals are in an early stage of development (Wiek et al. in press). In order to advance visioning methodology, there needs to be a commitment to their development and to further evaluate currently utilized approaches in knowledge generating (i.e. reflexive and comparable) visioning studies.

Common to all applied visioning approaches reviewed was the lack of sufficient systemic appraisal of the crafted visions. At best, visioning approaches included the exploration of simple causal chains but typically did not comprehensively explore trade-offs. Enhancing systems perspective and methodological capacity was highly emphasized in this research. This was largely addressed by integrating formalized procedures throughout the visioning process, specifically the integration of systems methods in framing, analyzing, revising, and evaluating the vision. Incorporated into the City of Phoenix empirical study were collaborative procedures for identifying systems relationships among envisioned goals and thereby developing conceptual systems representations of the crafted visions. This allowed for the analysis of the structure of vision in order to 1) identify conflicts among envisioned goals, 2) identify where greater specificity was needed to define interrelationships, 3) explore and negotiate iterative revisions of the vision, and 4) evaluate the coherence of the visions. An additional key finding was the important role of creativity enhancing design guidelines, such as the use of illustrations (e.g. vision pools), interactive games (e.g. board games based on systems models of the vision), and narratives (e.g. 2050, a day in the life of…), in preparing participants for and engaging them in formalized processes. In fact, none of the final visioning outcomes were based solely on analytical or creative results, but emerged from the interplay of both.

To further enhance systems perspective and methodological capacity, systems modeling approaches were also explored to support visioning activities and for use in educational settings to teach future sustainability researchers and professional. Vision modeling was developed as a module to incorporate into visioning processes. This research (in Chapter 5) demonstrated that: 1) conceptual modeling was the easiest to incorporate to ensure that future desirable states were adequately described and free of vague and conflicting goals; 2) dynamic modeling required a higher degree of capacity-building and available expertise, but provided a means to explore (potentially unanticipated) outcomes and the long-range viability of dynamics resulting from the complex interaction among envisioned goals, and; 3) pathway modeling required a high degree of systems capacity-building and procedural time, but could be constructed from either conceptual or dynamic models to develop solutions-oriented pathways. The tiered design of the approach—conceptual modeling, dynamic modeling, and pathway modeling — was designed to allow practitioners and researchers to determine the extent of systems modeling appropriate for their vision study.

Vision modeling builds upon the above methodological framework to further advance systemic perspectives and methodological capacity for crafting and assessing sustainability visions. As a module in the *SPARC* methodology it enhances the construction of the vision (i.e. the quality criteria axis which includes: systemic, coherent, plausible, and tangible), with an emphasis on contributing enhanced design guidelines supporting systemic and coherent quality criteria. Many of these enhanced design guidelines also map directly to or support sustainability education competencies (Wiek et al. 2011), namely, system thinking and anticipatory discovery and learning.

A significant insight is the realization that achieving meaningful compliance (not simply checking off the list) of quality criteria and corresponding design guidelines requires a commitment to developing evidence-based methods and professional and civic capacity for visioning research practice.

REFERENCES

Chapter 1

Dreborg K (1996) Essence of backcasting. Futures 28:813–828

Han J, Fontanos P, Fukushi K, Herath S, Heeren N, Naso V, Cecchi C, Edwards P, Takeuchi K (2012) Innovation for sustainability: toward a sustainable urban future in industrialized cities. Sustainability Science 7:91–100

Höjer M (2000) Determinism and backcasting in future studies. Futures 32:613–634

Lindblom CE (1959) The science of "muddling through". Public Administration Review 19:79

Lindblom CE (1979) Still muddling, not yet through. Public Administration Review 39:517

Raskin P, Banuri T, Gallopin G, Gutman P, Hammond A, Kates R, Swart R (2002) Great transition: The promise and lure of the times ahead. Stockholm Environment Institute, Boston

Shipley R, Michela J (2006) Can vision motivate planning action? Planning Practice and Research 21:223–244

Wiek A, Farioli F, Fukushi K, et al. (2012) Sustainability science: bridging the gap between science and society. Sustainability Science 1–4

Chapter 2

Ames SC (1993) A guide to community visioning: Oregon Chapter of the American Planning Association. Planners Press, Chicago

Ansell C, Gash A (2007) Collaborative governance in theory and practice. Journal of Public Administration Research and Theory 18:543–571

Arnstein SR (1969) A ladder of citizen participation. Journal of the American Planning Association 35:216–224

Aurigi A (2005) Competing urban visions and the shaping of the digital city. Knowledge, Technology & Policy 18:12–26

Bagley E, Shaffer DW (2009) When people get in the way. International Journal of Gaming and Computer-Mediated Simulations 1:36–52

Batty M, Chapman D, Evans S, Haklay M, Kueppers S, Shiode N, Hudson-Smith A, Torrens PM (2001) Visualizing the city: communicating urban design to planners and decision-makers. In: Brail RK, Klosterman RE (eds) Planning support systems: Integrating geographic information systems, models, and visualization tools. ESRI Press, Redlands, California:405–419

Berke P, Backhurst M, Day M, Ericksen N, Laurian L, Crawford J, Dixon J (2006) What makes plan implementation successful? An evaluation of local plans and implementation practices in New Zealand. Environment and Planning B: Planning and Design 33: 581–600

Bossel H (1998) Earth at a crossroads: paths to a sustainable future. Cambridge University Press, Cambridge

Brandt D, Ihsen S (1998) Creativity: How to educate and train innovative engineers, or robots riding bicycles. European Journal of Engineering Education 23:131–132

Brewer GD (2007) Inventing the future: scenarios, imagination, mastery and control. Sustainability Science 2:159–177

Brown H, Vergragt P, Green K, Berchicci L (2003) Learning for sustainability transition through bounded socio-technical experiments in personal mobility. Technology Analysis & Strategic Management 15: 291–315

Burbiel J (2009) Creativity in research and development environments: A practical review. International Journal of Business Science & Applied Management 4:35–51

Carpenter SR, Folke C (2006) Ecology for transformation. Trends in Ecology & Evolution 21:309–315

Cash DW, Clark WC, Alcock F, Dickson NM, Eckley N, Guston DH, Jager J, Mitchell RB (2003) Knowledge systems for sustainable development. Proc. Natl. Acad. Sci. 100:8086–8091

Cherp A, George C, Kirkpatrick C (2004) A methodology for assessing national sustainable development strategies. Environment and Planning C: Government and Policy 22:913–926

Connelly S (2007) Mapping sustainable development as a contested concept. Local Environment 12:259–278

Constanza R (2000) Visions of alternative (unpredictable) futures and their use in policy analysis. Conservation Ecology 4:5–22

Couclelis H (2004) The construction of the digital city. Environment and Planning B 31:5–20

Cruickshank L, Evans M (2012) Designing creative frameworks: design thinking as an engine for new facilitation approaches. International Journal of Arts and Technology 5:73–85

de Brabandere L, Iny A (2010) Scenarios and creativity: Thinking in new boxes. Technological Forecasting and Social Change 77:1506–1512

de Saint-Exupéry A (1948) Citadelle. Paris: Editions Gallimard

Dreborg K (1996) Essence of backcasting. Futures 28:813–828

Eames M, Egmose J (2011) Community foresight for urban sustainability: Insights from the Citizens Science for Sustainability (SuScit) project. Technological Forecasting and Social Change 78: 769–784

Eickhoff P, Geffer SG (2009) Power of Imagination Studio: A Further Development of the Future Workshop Concept. In: Holman P, Devane T, Cady S (eds) The change handbook - The definitive resource on today's best methods for engaging whole systems. Trade Paperback, Berrett-Koehler Publishers, San Francisco:27–35

Elkington J (1998) Partnerships from cannibals with forks: The triple bottom line of 21st-century business. Environmental Quality Management 8:37–51

Elkins LA, Bivins D, Holbrook L (2009) Community visioning process: A Tool for successful planning. Journal of Higher Education Outreach and Engagement 13:75–84

Eskelinen P, Miettinen K (2011) Trade-off analysis approach for interactive nonlinear multiobjective optimization. OR Spectrum 1:5–36

Fischer F (1993) Citizen participation and the democratization of policy expertise: From theoretical inquiry to practical cases. Policy Sciences 26:165–187

Gaber J (2007) Simulating planning: SimCity as a pedagogical tool. Journal of Planning Education and Research 27:113–121

Gibson RB (2006) Sustainability assessment: basic components of a practical approach. Impact Assessment and Project Appraisal 24:170–182

Grunwald A (2007) Converging technologies: Visions, increased contingencies of the conditio humana, and search for orientation. Futures 39:380–392

Guy S, Marvin S (2000) Models and pathways: the diversity of sustainable urban futures. In: Williams K, Burton E, Jenks M (eds) Achieving sustainable urban form. E & FN Spoon, London:9–18

Hamlett PW, Cobb MD (2006) Potential solutions to public deliberation problems: Structured deliberations and polarization cascades. Policy Studies 34:629–648

Han J, Fontanos P, Fukushi K, Herath S, Heeren N, Naso V, Cecchi C, Edwards P, Takeuchi K (2012) Innovation for sustainability: toward a sustainable urban future in industrialized cities. Sustainability Science 7:91–100

Helling A (1998) Collaborative visioning: Proceed with caution!: Results from evaluating Atlanta's Vision 2020 project. Journal of the American Planning Association 64:335–349

Hjerpe M, Linnér B (2009) Utopian and dystopian thought in climate change science and policy. Futures 41:234–245

Holmberg J (1998) Backcasting: A Natural Step in operationalising sustainable development. Greener Management International: 30–52

Holmberg J, Robèrt KH (2000) Backcasting from non-overlapping sustainability principles–a framework for strategic planning. International Journal of Sustainable Development & World Ecology 7:291–308

Hopwood B, Mellor M, O'Brien G (2005) Sustainable development: mapping different approaches. Sustainable Development 13:38–52

Höjer M (2000) Determinism and backcasting in future studies. Futures 32:613–634

Hurley PT, Walker PA (2004) Whose vision? Conspiracy theory and land-use planning in Nevada County, California. Environment and Planning A 36:1529–1547

Isenberg P, Elmqvist N, Scholtz J, Cernea D, Kwan-Liu Ma, Hagen H (2011) Collaborative visualization: Definition, challenges, and research agenda. Information Visualization 10:310–326

Iwaniec D, Wiek A (in review) Sustainability visioning research in planning – The General Plan revision in Phoenix, Arizona.

James S, Lahti T (2004) The Natural Step for Communities: How Cities and Towns can Change to Sustainable Practices. New Society Publishers, Gabriola Island, BC

Jordan A (2008) The governance of sustainable development: taking stock and looking forwards. Environment and Planning C: Government and Policy 26:17–33

Jungk R, Müllert N (1987) Future workshops: How to create desirable futures. Institute for Social Inventions, London

Kallis G, Hatzilacou D, Mexa A, Coccossis H, Svoronou E (2009) Beyond the manual: Practicing deliberative visioning in a Greek island. Ecological Economics 68:979–989

Kates RW, Clark WC, Corell R, Hall JM, Jaeger CC, Lowe I, Mccarthy JJ, Schellnhuber HJ, Bolin B, Dickson NM, Faucheux S, Gallopin GC, Grubler A, Huntley B, J a ger J, Jodha NS, Kasperson RE, Mabogunje A, Matson P, Mooney H, Moore III B, O'Riordan T, Svedlin U (2001) Sustainability Science. Science 292:641–642

Kemp R, Martens P (2007) Sustainable development: how to manage something that is subjective and never can be achieved? Sustainability: Science, Practice, & Policy 3:5–14

Kim J, Oki T (2011) Visioneering: An essential framework in sustainability science. Sustain Science 6:247–251

Komiyama H, Takeuchi K (2006) Sustainability science: building a new discipline. Sustainability Science 1:1–6

Krütli P, Stauffacher M, Flüeler T, Scholz RW (2010) Functional-dynamic public participation in technological decision-making: site selection processes of nuclear waste repositories. Journal of Risk Research 13:861–875

Kwartler M, Bernard R (2001) CommunityViz: an integrated planning support system. In: Brail RK, Klosterman RE (eds) Planning support systems: Integrating geographic information systems, models, and visualization tools. ESRI Press, Redlands, California:285–308

Loorbach D (2010) Transition management for sustainable development: A prescriptive, complexity-based governance framework. Governance an International Journal of Policy, Administration, and Institutions 23:161–183

Machler L, Golub A (2012) Using a "Sustainable Solution Space" approach to develop a vision of sustainable accessibility in a low-income community in Phoenix, Arizona. International Journal of Sustainable Transportation 6:298–319

McDowall W, Eames M (2007) Towards a sustainable hydrogen economy: A multi-criteria sustainability appraisal of competing hydrogen futures. International Journal of Hydrogen Energy 32: 4611–4626

Meadows D (1996) Envisioning a sustainable world. In: Costanza R, Segura O, Martinez-Alier J (eds) Getting down to Earth: Practical Applications of Ecological Economics. Island Press, Washington DC, p. 8

Menzel S, Wiek A (2009) Valuation in morally charged situations: The role of deontological stances and intuition for trade-off making. Ecological Economics 68:2198–2206

Morioka T, Saito O, Yabar H (2006) The pathway to a sustainable industrial society–initiative of the Research Institute for Sustainability Science (RISS) at Osaka University. Sustainability Science 1:65–82

Myers D, Banerjee T (2005) Toward greater heights for planning: Reconciling the differences between profession, practice, and academic field. Journal of the American Planning Association 71:121–129

Nassauer JI, Corry RC (2004) Using normative scenarios in landscape ecology. Landscape Ecology 19:343–356

Nelessen A (1994) Visions for a new american dream. American Planning Association, Chicago

Ness B, Urbel-Piirsalu E, Anderberg S, Olsson L (2007) Categorising tools for sustainability assessment. Ecological Economics 60:498–508

Newman P (2005) Pipe dreams and ideologues: values and planning. People and Place 13:41–53

Newman P, Jennings I (2008) Cities as sustainable ecosystems: principles and practices. Island Press, Washington, DC

Nicholson-Cole SA (2005) Representing climate change futures: a critique on the use of images for visual communication. Computers, Environment and Urban Systems 29:255–273

Nilsson EM (2010) Simulated "real" worlds: Actions mediated through computer game play in science education. Doctoral Thesis, Malmö University, Malmö, Sweden

Oels A (2009) The power of visioning: The contribution of Future Search Conferences to decision-making in Local Agenda 21 processes. In: Coenen FHJM (ed) Public participation and better environmental decisions. Springer Science, New York:73–88

Okubo D (2000) The community visioning and strategic planning handbook. National Civic League Press, Denver, CO

Olson RL (1995) Sustainability as a social vision. Journal of Social Issues 51:15–35

Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. Science 325:419–422

Pettit CJ (2005) Use of a collaborative GIS-based planning-support system to assist in formulating a sustainable-development scenario for Hervey Bay, Australia. Environment and Planning B 32:523–545

Potschin MB, Haines-Young RH (2008) Sustainability impact assessments: limits, thresholds and the sustainability choice space. In: Helming K, Tabbush P, Perez-Soba M (eds) Sustainability impact assessment of land use policies. Springer, Berlin:425–450

Potschin MB, Klug H, Haines-Young RH (2010) From vision to action: Framing the Leitbild concept in the context of landscape planning. Futures 42:656–667

Puccio GJ, Cabra JF, Fox JM, Cahen H (2010) Creativity on demand: Historical approaches and future trends. Artificial Intelligence for Engineering Design, Analysis and Manufacturing 24:153–159

Quist, J, Thissen W, Vergragt P (2011) The impact and spin-off of participatory backcasting: From vision to niche. Technological Forecasting and Social Change 78: 883–897

Raskin P, Banuri T, Gallopin G, Gutman P, Hammond A, Kates R, Swart R (2002) Great transition: The promise and lure of the times ahead. Stockholm Environment Institute, Boston

Rauch JN, Newman J (2008) Research and solutions: Zeroing in on sustainability. Sustainability: The Journal of Record 1:387–390

Ravetz J (2000) Integrated assessment for sustainability appraisal in cities and regions. Environmental Impact Assessment Review 20:31–64

Robèrt M (2005) Backcasting and econometrics for sustainable planning. Journal of Cleaner Production 13:841–851

Robinson JB (1982) Energy backcasting A proposed method of policy analysis. Energy Policy 10:337–344

Robinson JB (2003) Future subjunctive: backcasting as social learning. Futures 35:839–856

Robinson J, Tansey J (2006) Co-production, emergent properties and strong interactive social research: the Georgia Basin Futures Project. Science and Public Policy 33:151–160

Robinson J, Burch S, Talwar S, O'Shea M, Walsh M (2011) Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. Technological Forecasting and Social Change 78:756–768

Rockström J, Steffen W, Noone K, Persson Å, Chapin FS, et al. (2009) A safe operating space for humanity. Nature 461:472–475

Salter JD, Campbell C, Journeay M, Sheppard SRJ (2009) The digital workshop: Exploring the use of interactive and immersive visualisation tools in participatory planning. Journal of Environmental Management 90:2090–2101

Santelmann MV, White D, Freemark K, Nassauer JI, Eilers JM, Vache KB, Danielson BJ, Corry RC, Clark ME, Polasky S, Cruse RM, Sifneos J, Rustigian H, Coiner C, Wu J, Debinski D (2004) Assessing alternative futures for agriculture in Iowa, USA. Landscape Ecology 19:357–374

Scott AJ, Shorten J, Owen R, Owen I (2011) What kind of countryside do the public want: community visions from Wales UK? GeoJournal 76:417–436

Senge P (1993) The Fifth Discipline: The art and practice of the learning organization. Doubleday, New York

Shaw A, Sheppard S, Burch S, Flanders D, Wiek A, Carmichael J, Robinson J, Cohen S (2009) Making local futures tangible—Synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building. Global Environmental Change 19:447–463

Sheate WR, Partidário MR (2010) Strategic approaches and assessment techniques—Potential for knowledge brokerage towards sustainability. Environmental Impact Assessment Review 30:278–288

Sheppard SRJ (2001) Guidance for crystal ball gazers: developing a code of ethics for landscape visualization. Landscape and Urban Planning 54:183–199

Sheppard SRJ (2005) Landscape visualisation and climate change: the potential for influencing perceptions and behaviour. Environmental Science & Policy 8:637–654

Sheppard SRJ, Meitner M (2005) Using multi-criteria analysis and visualisation for sustainable forest management planning with stakeholder groups. Forest Ecology and Management 207:171–187

Shipley R (2002) Visioning in planning: is the practice based on sound theory? Environment and Planning A 34:7–22

Shipley R, Michela J (2006) Can vision motivate planning action? Planning Practice and Research 21:223–244

Shipley R, Newkirk R (1999) Vision and visioning in planning: what do these terms really mean? Environment and Planning B: Planning and Design 26:573–591

Shneiderman B, Fischer G, Czerwinski M, Resnick M, Myers B, Candy L, Edmonds E, Eisenberg M, Giaccardi E, Hewett T, Jennings P, Kules B, Nakakoji K, Nunamaker J, Pausch R, Selker T, Sylvan E, Terry M (2006) Creativity support tools: Report from a U.S. National Science Foundation sponsored workshop. International Journal of Human-Computer Interactions 20:61–77

Smith A, Stirling A, Berkhout F (2005) The governance of sustainable socio-technical transitions. Research Policy 34:1491–1510

Smith R, Wiek A (2012) Achievements and opportunities in initiating governance for urban sustainability. Environment and Planning C 30:429–447

Sondeijker S, Geurts J, Rotmans J, Tukker A (2006) Imagining sustainability: the added value of transition scenarios in transition management. Foresight 8:15–30

Susskind L, McKearnan S, Thomas-Larmer J (1999) The consensus building handbook: A comprehensive guide to reaching agreement. SAGE Publications, Thousand Oaks, California

Swart R, Raskin P, Robinson JB (2004) The problem of the future: sustainability science and scenario analysis. Global Environmental Change 14:137–146

Talwar S, Wiek A, Robinson J (2011) User engagement in sustainability research. Science and Public Policy 38:379–390

Tietje O (2005) Identification of a small reliable and efficient set of consistent scenarios. European Journal Of Operational Research 162:418–432

Trutnevyte E, Stauffacher M, Scholz RW (2011) Supporting energy initiatives in small communities by linking visions with energy scenarios and multi-criteria assessment. Energy Policy 39:7884–7895

Uyesugi J, Shipley R (2005) Visioning diversity: Planning Vancouver's multicultural communities. International Planning Studies 10:305–322

van de Kerkhof M, Wieczorek A (2005) Learning and stakeholder participation in transition processes towards sustainability: Methodological considerations. Technological Forecasting and Social Change 72:733–747

van de Kerkhof M (2006) Making a difference: On the constraints of consensus building and the relevance of deliberation in stakeholder dialogues. Policy Sci 39:279–299

van den Hove S (2006) Between consensus and compromise: Acknowledging the negotiation dimension in participatory approaches. Land Use Policy 23:10–17

van der Helm R (2009) The vision phenomenon: Towards a theoretical underpinning of visions of the future and the process of envisioning. Futures 41:96–104

van Kerkhoff L, Lebel L (2006) Linking knowledge and action for sustainable development. Annual Review of Environment and Resources 31:445–477

City of Vancouver (2005) CityPlan, http://vancouver.ca/commsvcs/planning/cityplan/visions (accessed July 2012)

Varum C, Melo C (2010) Directions in scenario planning literature-A review of the past decades. Futures 42:355–369

Vervoort JM, Kok K, van Lammeren R, Veldkamp T (2010) Stepping into futures: Exploring the potential of interactive media for participatory scenarios on social-ecological systems. Futures 42:604–616

Vester F (1988) The biocybernetic approach as a basis for planning our environment. Systems Practice and Action Research 1:399–413

Vidal RVV (2004) The Vision Conference: Facilitating creative processes. Systemic Practice and Action Research 17:385–405

Vidal RVV (2006) Creative and participative problem solving: The art and the science. informatics and mathematical modelling, Technical University of Denmark

Videira N, Antunes P, Santos R, Lopes R (2010) A participatory modelling approach to support integrated sustainability assessment processes. Systems Research and Behavioral Science 27:446–460

Wangel J (2011) Exploring social structures and agency in backcasting studies for sustainable development. Technological Forecasting and Social Change 78: 872–882

Walzer W (ed) (1996) Community Strategic Visioning Programs. Praeger, Westport, CT

Weaver PM, Rotmans J (2006) Integrated sustainability assessment: What is it, why do it and how? International Journal of Innovation and Sustainable Development 1:284–303

Wiek A, Binder C (2005) Solution spaces for decision-making—a sustainability assessment tool for city-regions. Environmental Impact Assessment Review 25:589–608

Wiek A, Larson KL (2012) Water, people, and sustainability—A systems framework for analyzing and assessing water governance regimes. Water Resources Management 26:3153-3171

Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability—A reference framework for academic program development. Sustainability Science 6:203-218

Wiek A, Ness B, Schweizer-Ries P, Brand FS, Farioli F (2012) From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. Sustainability Science 7(Supplement 1):5–24

Wiek A, Zemp S, Siegrist M, Walter AI (2007) Sustainable governance of emerging technologies—Critical constellations in the agent network of nanotechnology. Technology in Society 29:388–406

World Commission on Environment and Development (WCED) (1987) Our common future. Oxford University Press, Oxford, UK

Wright EO (2010) Envisioning Real Utopias. Verso, London

Chapter 3

Arnstein SR (1969) A ladder of citizen participation. Journal of the American Planning Association 35:216–224

de Brabandere L, Iny A (2010) Scenarios and creativity: Thinking in new boxes. Technological Forecasting and Social Change 77:1506–1512

City of Phoenix (2010) Phoenix General Plan Update: Transitioning to a sustainable future, Public Hearing Draft. City of Phoenix, AZ

Eickhoff P, Geffer SG (2009) Power of imagination studio: a further development of the future workshop concept. In: Holman P, Devane T, Cady S (eds) The Change Handbook - The Definitive Resource on Today's Best Methods for Engaging Whole Systems. Trade Paperback, Berrett-Koehler Publishers, San Francisco:27–35

Gibson RB (2006) Sustainability assessment: Basic components of a practical approach. Impact Assessment and Project Appraisal 24:170–182

Grunwald A (2007) Converging technologies: Visions, increased contingencies of the conditio humana, and search for orientation. Futures 39:380–392

de Haan G (2006) The BLK '21' programme in Germany: a 'Gestaltungskompetenz'-based model for education for sustainable development. Environmental Education Research 12:19–32

Iwaniec D, Wiek A (in review) Sustainability visioning research in planning – The General Plan revision in Phoenix, Arizona. Planning Practice and Research

Johnson C, Upton C, Wiek A, Golub A (2011) Reinvent Phoenix: Cultivating equity, engagement, economic development and design excellence with TOD. HUD Grant Proposal

Jungk R, Müllert N (1987) Future workshops: How to create desirable futures. Institute for Social Inventions, London

Lang DJ, Wiek A, Bergmann M, Stauffacher M, Martin P, Moll P, Swilling M, Thomas C (2012) Transdisciplinary research in sustainability science: practice, principles, and challenges. Sustainability Science 7:25–43

Machler L, Golub A, Wiek A (2012) Using a "Sustainable Solution Space" approach to develop a vision of sustainable accessibility in a low-income community in Phoenix, Arizona. International Journal of Sustainable Transportation 6:298–319

Meadows D (1996) Envisioning a sustainable world. In: Costanza R, Segura O, Martinez-Alier J (eds) Getting down to Earth: Practical Applications of Ecological Economics. Island Press, Washington DC

McDowall W, Eames M (2007) Towards a sustainable hydrogen economy: A multi-criteria sustainability appraisal of competing hydrogen futures. International Journal of Hydrogen Energy 4611–4626

Minowitz A, Wiek A (2012) Visioning in urban planning – a literature review, Working Paper. School of Sustainability, Arizona State University, Tempe

Minowitz A, Wiek A (2013) A method for sustainability appraisal in visioning, Working Paper. School of Sustainability, Arizona State University, Tempe

Myers D, Banerjee T (2005) Toward greater heights for planning: Reconciling the differences between profession, practice, and academic field. Journal of the American Planning Association 71:121–129

Nassauer JI, Corry RC (2004) Using normative scenarios in landscape ecology. Landscape Ecology 19:343–356

Ness B, Urbel-Piirsalu E, Anderberg S, Olsson L (2007) Categorising tools for sustainability assessment. Ecological Economics 60:498–508

Potschin MB, Klug H, Haines-Young RH (2010) From vision to action: Framing the Leitbild concept in the context of landscape planning. Futures 42:656–667

Robèrt M (2005) Backcasting and econometrics for sustainable planning. Journal of Cleaner Production 13:841–851

Rockström J, Steffen W, Noone K, Persson Å, Chapin FS, et al. (2009) A safe operating space for humanity. Nature 461:472–475

Sarewitz D, Clapp R, Crumbley C, et al. (2012) The Sustainability Solutions Agenda. New Solutions: A Journal of Environmental and Occupational Health Policy 22:139–151

Schön DA (1983) The reflective practitioner: How professionals think in action. Temple Smith, London

Shaw A, Sheppard S, Burch S, Flanders D, Wiek A, Carmichael J, Robinson J, Cohen S (2009) Making local futures tangible—Synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building. Global Environmental Change 19:447–463

Shipley R (2002) Visioning in planning: is the practice based on sound theory? Environment and Planning A 34:7–22

Shipley R, Utz S (2012) Making it count: A Review of the value and techniques for public consultation. Journal of Planning Literature 27:22–42

Shneiderman B, Fischer G, Czerwinski M, Resnick M, Myers B, Candy L, Edmonds E, Eisenberg M, Giaccardi E, Hewett T, Jennings P, Kules B, Nakakoji K, Nunamaker J, Pausch R, Selker T, Sylvan E, Terry M (2006) Creativity support tools: Report from a U.S. National Science Foundation sponsored workshop. International Journal of Human-Computer Interactions 20:61–77

Swart R, Raskin P, Robinson JB (2004) The problem of the future: Sustainability science and scenario analysis. Global Environmental Change 14:137–146

Talwar S, Wiek A, Robinson J (2011) User engagement in sustainability research. Science and Public Policy 38:379–390

Tietje O (2005) Identification of a small reliable and efficient set of consistent scenarios. European Journal of Operational Research 162:418–432

Uyesugi J, Shipley R (2005) Visioning diversity: Planning Vancouver's multicultural communities. International Planning Studies 10:305–322

van de Kerkhof M, Wieczorek A (2005) Learning and stakeholder participation in transition processes towards sustainability: Methodological considerations. Technological Forecasting and Social Change 72:733–747

van Kerkhoff L, Lebel L (2006) Linking knowledge and action for sustainable development. Annual Review of Environment and Resources 31:445–477

Varum C, Melo C (2010) Directions in scenario planning literature - A review of the past decades. Futures 42:355–369

Vester F (1988) The biocybernetic approach as a basis for planning our environment. Systems Practice and Action Research 1:399–413

Videira N, Antunes P, Santos R, Lopes R (2010) A participatory modelling approach to support integrated sustainability assessment processes. Systems Research and Behavioral Science 27:446–460

Weaver PM, Rotmans J (2006) Integrated sustainability assessment: What is it, why do it and how? International Journal of Innovation and Sustainable Development 1:284–303

Wiek A, Binder C (2005) Solution spaces for decision-making—a sustainability assessment tool for city-regions. Environmental Impact Assessment Review 25:589–608

Wiek A, Speerli V, Binder C (2008) Participatory sustainability visioning for urban development. Working Paper. School of Sustainability, Arizona State University, Tempe

Wiek A, Walter AI (2009) A transdisciplinary approach for formalized integrated planning and decision-making in complex systems. European Journal of Operational Research 197:360–370

Wiek A (2010) Transformational planning for sustainable cities, Working Paper. Sustainability Transition and Intervention Research Lab, School of Sustainability, Arizona State University, Tempe

Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability—A reference framework for academic program development. Sustainability Science 6:203-218

Wiek A, Ness B, Schweizer-Ries P, Brand FS, Farioli F (2012) From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. Sustainability Science 7:5–24

Wiek A, Larson KL (2012) Water, people, and sustainability—A systems framework for analyzing and assessing water governance regimes. Water Resources Management 26:3153-3171

Wiek A, Iwaniec D (2013, in press) Quality criteria for visions and visioning in sustainability science. Sustainability Science

Wiek A, Iwaniec D, Kay B (2013) A criteria-based approach to visioning in transformational sustainability research, Working Paper. Sustainability Transition and Intervention Research Lab, School of Sustainability, Arizona State University, Tempe

Wiek A, Withycombe Keeler L, Schweizer V, Lang DJ (in press) Plausibility indications in future scenarios. International Journal of Foresight and Innovation Policy

Wierzbicki AP (2007) Modelling as a way of organising knowledge. European Journal of Operational Research 176:610–635

Wright EO (2010) Envisioning Real Utopias. Verso, London

Xiong A, Talbot K, Wiek A, Kay B (2012) Integrated health care for communities – Participatory visioning and strategy building for a New Mountain Park Health Center Clinic in Phoenix. Project Report. Sustainability Transition and Intervention Research Lab, School of Sustainability, Arizona State University, Tempe

Chapter 4

Arnstein SR (1969) A ladder of citizen participation. Journal of the American Planning Association 35:216–224

Berke PR, Conroy MM (2000) Are we planning for sustainable development? Journal of the American Planning Association 66:21–33

Berke P, Backhurst M, Day M, Ericksen N, Laurian L, Crawford J, Dixon J (2006) What makes plan implementation successful? An evaluation of local plans and implementation practices in New Zealand. Environment and Planning B: Planning and Design 33: 581–600

Brewer GD (2007) Inventing the future: scenarios, imagination, mastery and control. Sustainability Science 2:159–177

Brown G, Wei Chin SY (2013) Assessing the effectiveness of public participation in neighborhood planning. Planning Practice and Research 28:563–588

Bulkeley, H. (2006) Urban sustainability: learning from best practice? Environment and Planning A, 38:1029–1044

City of Phoenix (1979) Phoenix Concept Plan 2000: A Program for Planning. Urban Form Directions Steering Committee, Phoenix

City of Phoenix (1984) Goals Formation Report. City of Phoenix, Phoenix

City of Phoenix (1986) City of Phoenix Village Planning. City of Phoenix, Phoenix

City of Phoenix (2002) Phoenix General Plan. City of Phoenix, Phoenix

City of Phoenix (2002) City of Phoenix Community Attitude Survey. City of Phoenix, Phoenix

City of Phoenix (2010) Phoenix General Plan Update: Transitioning to a sustainable future, Public Hearing Draft. City of Phoenix, Phoenix

Friedmann J (1987) Planning in the public domain: From knowledge to action. Princeton University Press, Princeton

Gibson RB (2006) Sustainability assessment: basic components of a practical approach. Impact Assessment and Project Appraisal 24:170–182

Guston DH (2008) Innovation policy: Not just a jumbo shrimp. Nature 454:940-941

Helling A (1998) Collaborative visioning: Proceed with caution!: Results from evaluating Atlanta's Vision 2020 project. Journal of the American Planning Association 64:335–349

Hodge G (1998) Planning Canadian communities: An introduction to the principles, practice, and participants. ITP Nelson, Toronto

Hurley PT, Walker PA (2004) Whose vision? Conspiracy theory and land-use planning in Nevada County, California. Environment and Planning A 36:1529–1547

Innes JE, Booher DE (2003) The impact of collaborative planning on governance capacity. University of California, Berkley

Jepson Jr EJ, Edwards MM (2010) How possible is sustainable urban development? An analysis of planners' perceptions about new urbanism, smart growth and the ecological city. Planning Practice and Research 25:417–437

Johnson C, Upton C, Wiek A, Golub A (2011) Reinvent Phoenix: Cultivating equity, engagement, economic development and design excellence with TOD. HUD Grant Proposal. Planning Department, City of Phoenix, Phoenix

Krütli P, Stauffacher M, Flüeler T, Scholz RW (2010) Functional-dynamic public participation in technological decision-making: site selection processes of nuclear waste repositories. Journal of Risk Research 13:861–875

McCann E (2001) Collaborative visioning or urban planning as therapy? The politics of public-private policy making. Professional Geographer 53:207–218

Minowitz A, Wiek A (2012) Visioning in urban planning – a literature review, Working Paper. School of Sustainability, Arizona State University, Tempe

Myers D, Banerjee T (2005) Toward greater heights for planning: Reconciling the differences between profession, practice, and academic field. Journal of the American Planning Association 71:121–129

Newman P (2005) Pipe dreams and ideologues: values and planning. People and Place 13:41–53

Newman P, Jennings I (2008) Cities as sustainable ecosystems: principles and practices. Island Press, Washington, DC

Oels A (2009) The power of visioning: The contribution of Future Search Conferences to decision-making in Local Agenda 21 processes. In: Coenen FHJM (ed) Public participation and better environmental decisions. Springer Science, New York:73–88

Okubo D (2000) The community visioning and strategic planning handbook (Denver: National Civic League Press).

Phdungsilp A (2011) Futures studies' backcasting method used for strategic sustainable city planning. Futures 43:707–714

Portney KE (2003) Taking sustainable cities seriously: economic development, the environment, and quality of life in American cities. MIT Press, Cambridge

Qadeer MA (2000) Urban planning and multiculturalism beyond sensitivity. Plan Canada 40:16–18

Quay R (2010) Anticipatory governance. Journal of the American Planning Association 76:496–511

Robinson JB (2003) Future subjunctive: backcasting as social learning. Futures 35:839–856

Robinson JB, Burch S, Talwar S, O'Shea M, Walsh M (2011) Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. Technological Forecasting and Social Change 78:756–768

Ross A (2011) Bird on fire: Lessons from the world's least sustainable city. Oxford University Press, Oxford

Schmitt Olabisi LK, Kapuscinski AR, Johnson KA, Reich PB, Stenquist B, Draeger KJ (2010) Using scenario visioning and participatory system dynamics modeling to investigate the future: lessons from Minnesota 2050. Sustainability 2:2686–2706

Schön DA (1983) The reflective practitioner: How professionals think in action. Temple Smith, London

Sheppard SRJ, Shaw A, Flanders D, Burch S, Wiek A, Carmichael J, Robinson J, Cohen S (2011) Future visioning of local climate change: a framework for community engagement and planning with scenarios and visualization. Futures 43:400–412

Shipley R (2000) The origin and development of vision and visioning in planning. International Planning Studies 5:225–236

Shipley R (2002) Visioning in planning: is the practice based on sound theory? Environment and Planning A 34:7–22

Shipley R, Michela J (2006) Can vision motivate planning action? Planning Practice and Research 21:223–244

Shipley R, Newkirk R (1998) Visioning: Did anybody see where it came from? Journal of Planning Literature. 12:407–416

Shipley R, Newkirk R (1999) Vision and visioning in planning: what do these terms really mean? Environment and Planning B: Planning and Design 26:573–591

Shipley R, Feick R, Hall B, Earley R (2004) Evaluating municipal visioning. Planning Practice and Research 19:195–210

Smith R, Wiek A (2012) Achievements and opportunities in initiating governance for urban sustainability. Environment and Planning C 30:429–447

State of Arizona (1998) Growing Smarter Act. State of Arizona, Phoenix

State of Arizona (2000) Growing Smarter Plus. State of Arizona, Phoenix

Susskind L, McKearnan S, Thomas-Larmer J (1999) The consensus building handbook: A comprehensive guide to reaching agreement. SAGE Publications, Thousand Oaks, California

Svara JH (2011) The early stage of local government action to promote sustainability, in: The Municipal Year Book. ICMA, Washington, DC 2011:43–60

Talwar S, Wiek A, Robinson J (2011) User engagement in sustainability research. Science and Public Policy 38:379–390

Truffer B, Störmer E, Maurer M, Ruef A (2010) Local strategic planning processes and sustainability transitions in infrastructure sectors. Environmental Policy and Governance 20:258–269

Uyesugi J, Shipley R (2005) Visioning diversity: Planning Vancouver's multicultural communities. International Planning Studies 10:305–322

van Asselt, MBA, Rijkens-Klomp N (2002) A look in the mirror: reflection on participation in Integrated Assessment from a methodological perspective. Global Environmental Change 12:167–184

van de Kerkhof M (2006) Making a difference: On the constraints of consensus building and the relevance of deliberation in stakeholder dialogues. Policy Sci 39:279–299

Wiek A, Binder C (2005) Solution spaces for decision-making—a sustainability assessment tool for city-regions. Environmental Impact Assessment Review 25:589–608

Wiek A, Walter AI (2009) A transdisciplinary approach for formalized integrated planning and decision-making in complex systems. European Journal of Operational Research 197:360–370

Wiek A (2010) Transformational planning for sustainable cities, Working Paper. Sustainability Transition and Intervention Research Lab, School of Sustainability, Arizona State University, Tempe

Wiek A, Selin C, Johnson C (Eds.) (2010) The future of Phoenix – Crafting sustainable development strategies, Project Report. School of Sustainability, Arizona State University, Tempe

Wiek A, Larson KL (2012) Water, people, and sustainability—A systems framework for analyzing and assessing water governance regimes. Water Resources Management 26:3153-3171

Wiek A, Ness B, Schweizer-Ries P, Brand FS, Farioli F (2012) From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. Sustainability Science 7:5–24

Wiek A, Golub A, Kay B. et al. (2013). Sustainable vision for the Eastlake-Garfield district, Phoenix. Project Report to the Reinvent Phoenix Project, City of Phoenix, Phoenix

Wiek A, Iwaniec D (2013) Quality criteria for visions and visioning in sustainability science. Sustainability Science 1–16

Chapter 5

Astier M, García-Barrios L, Galván-Miyoshi Y, González-Esquivel CE, Masera OR (2012) Assessing the Sustainability of Small Farmer Natural Resource Management Systems. A Critical Analysis of the MESMIS Program (1995-2010). Ecology and Society 17:art25

Bishop P, Hines A, Collins T (2007) The current state of scenario development: an overview of techniques. Foresight 9:5–25

Bousquet F, Trébuil G (2005) Companion modeling and multi-agent systems for integrated natural resource management in Asia. International Rice Research Institute. Los Baños, Philippines

Börjeson L, Höjer M, Dreborg K-H, et al. (2006) Scenario types and techniques: Towards a user's guide. Futures 38:723–739

Bradfield R, Wright G, Burt G, et al. (2005) The origins and evolution of scenario techniques in long range business planning. Futures 37:795–812

Chermack TJ, Lynham SA (2001) A review of scenario planning literature. Futures Research Quarterly. 17:7-32

Cherp A, George C, Kirkpatrick C (2004) A methodology for assessing national sustainable development strategies. Environmental Planning C 22:913–926

Childers, DL, Pickett STA, Grove JM, Ogden L, Whitmer A (in review) Advancing urban sustainability theory and action: Challenges and opportunities. Landscape & Urban Planning

Clark WC, Dickson NM (2003) Sustainability science: the emerging research program. Proceedings of the National Academy of Sciences of the United States of America 100:8059–8061

Dreborg K (1996) Essence of backcasting. Futures 28:813–828

Gaziulusoy Aİ, Boyle C, McDowall R (2012) System innovation for sustainability: a systemic double-flow scenario method for companies. Journal of Cleaner Production

Gibson RB (2006) Sustainability assessment: basic components of a practical approach. Impact Assessment and Project Appraisal 24:170–182

Helling A (1998) Collaborative visioning: Proceed with Caution!: Results from evaluating Atlanta's Vision 2020 project. Journal of the American Planning Association 64:335–349

Hovmand PS, Brennan L, Chalise N (2011) Whose model is it anyway? International Conference of the System Dynamics Society, Washington, DC

Höjer M (2000) Determinism and backcasting in future studies. Futures 32:613–634

Iwaniec D, Wiek A (in review) Advancing sustainability visioning practice in planning – The General Plan revision in Phoenix, Arizona. Planning Practice and Research

Lemp JD, Zhou BB, Kockelman KM, Parmenter BM (2008) Visioning versus modeling: Analyzing the land-use-transportation futures of urban regions. Journal of Urban Planning and Development 134:97–109

Marshall N, Grady B (2005) Travel demand modeling for regional visioning and scenario analysis. Transportation Research Record 1921:44–52

Meadows D (2008) Thinking in systems: A primer. Chelsea Green Publishing

Oreskes N, Shrader-Frechette K, Belitz K (1994) Verification, validation, and confirmation of numerical models in the earth sciences. Science 263:641–646

Ostrom E (2009) Understanding institutional diversity. Princeton University Press, Princeton

Quist J (2007) Backcasting for a sustainable future: the impact after 10 years. Uburon Academic Publishers, Uburon

Reed MS (2008) Stakeholder participation for environmental management: A literature review. Biological Conservation 141:2417–2431

Robinson JB (2003) Future subjunctive: backcasting as social learning. Futures 35:839–856

Sarewitz D, Clapp R, Crumbley C, et al. (2012) The Sustainability Solutions Agenda. New Solutions: A Journal of Environmental and Occupational Health Policy 22:139–151

Schlüter M, Müller B, Frank K (2012) MORE – Modeling for Resilience Thinking and Ecosystem Stewardship. SSRN Journal

Sheppard S, Shaw A, Flanders D, et al. (2011) Future visioning of local climate change: a framework for community engagement and planning with scenarios and visualisation. Futures 43:400–412

Shipley R (2002) Visioning in planning: is the practice based on sound theory? Environment and Planning A 34:7–22

Shipley R (1997) Visioning in strategic planning: theory, practice and evaluation. University of Waterloo

Shipley R, Michela J (2006) Can vision motivate planning action? 21:223–244

Shneiderman B, Fischer G, Czerwinski M, Resnick M, Myers B, Candy L, Edmonds E, Eisenberg M, Giaccardi E, Hewett T, Jennings P, Kules B, Nakakoji K, Nunamaker J, Pausch R, Selker T, Sylvan E, Terry M (2006) Creativity support tools: Report from a U.S. National Science Foundation sponsored workshop. International Journal of Human-Computer Interactions 20:61–77

State of Arizona (1998) Growing Smarter Act (Phoenix, State of Arizona)

State of Arizona (2000) Growing Smarter Plus (Phoenix, State of Arizona)

van der Helm R (2009) The vision phenomenon: Towards a theoretical underpinning of visions of the future and the process of envisioning. Futures 41:96–104

VanLehn, K (2013) Model construction as a learning activity: A design space and review. Interactive Learning Environments 21:371-413

VanLehn K, Childers DL, Van de Sande B, Iwaniec D (in review) Model construction as a learning activity: A design space and review. International Conference Of The Learning Sciences, Boulder, CO

Varum C, Melo C (2010) Directions in scenario planning literature-A review of the past decades. Futures 42:355–369

Vennix J (1996) Group model building: Facilitating team learning using system Dynamics. Wiley

Vennix JAM (1999) Group model-building: tackling messy problems. Syst Dyn Rev 15:379–401

Vester F (2007) The art of interconnected thinking. Munich:Mcb Verlag

Vidal RVV (2006) Creative and participative problem solving: The art and the science. informatics and mathematical modelling, Technical University of Denmark

Videira N, Antunes P, Santos R, Lopes R (2010) A participatory modelling approach to support integrated sustainability assessment processes. Systems Research and Behavioral Science 27:446–460

Voinov A, Bousquet F (2010) Modelling with stakeholder. Environmental Modelling & Software 25:1268–1281

Wiek A and Larson K (2012) Water, people, and sustainability — A systems framework for analyzing and assessing water governance regimes. Water Resource Management 26:3153–3171

Wiek A, Farioli F, Fukushi K, et al. (2012) Sustainability science: bridging the gap between science and society. Sustainability Science 1–4

Wiek A, Ness B, Schweizer-Ries P, et al. (2012b) From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. Sustainability Science 7:5–24

Wiek A, Iwaniec D (2013) Quality criteria for visions and visioning in sustainability science. Sustainability Science 1–16

Chapter 6

Brandt P, Ernst A, Gralla F, Luederitz C, Lang D, Newig J, Reinert F, Abson D, von Wehrden H (2013) A review of transdisciplinary research in sustainability science. Ecological Economics 92:1–15

Eames M, Egmose J (2011) Community foresight for urban sustainability: Insights from the Citizens Science for Sustainability (SuScit) project. Technological Forecasting and Social Change 78: 769–784

Helling A (1998) Collaborative visioning: Proceed with caution!: Results from evaluating Atlanta's Vision 2020 project. Journal of the American Planning Association 64:335–349

Helling A, Thomas JC (2001) Encouraging community dialog: Approach, promise, and tensions. International Journal of Public Administration 24:749-770

Iwaniec D, Wiek A (in review) Advancing sustainability visioning practice in planning – The General Plan revision in Phoenix, Arizona. Planning Practice and Research

Lang DJ, Wiek A, Bergmann M, Stauffacher M, Martin P, Moll P, Swilling M, Thomas C (2012) Transdisciplinary research in sustainability science: practice, principles, and challenges. Sustainability Science 7:25–43

McDowall W, Eames M (2007) Towards a sustainable hydrogen economy: A multi-criteria sustainability appraisal of competing hydrogen futures. International Journal of Hydrogen Energy 32:4611–4626

Minowitz A, Wiek A (2012) Visioning in urban planning – a literature review, Working Paper. School of Sustainability, Arizona State University, Tempe

Nassauer JI, Corry RC (2004) Using normative scenarios in landscape ecology. Landscape Ecology 19:343–356

Oels A (2009) The power of visioning: The contribution of Future Search Conferences to decision-making in Local Agenda 21 processes. In: Coenen FHJM (ed) Public participation and better environmental decisions. Springer Science, New York:73–88

Quist, J, Thissen W, Vergragt P (2011) The impact and spin-off of participatory backcasting: From vision to niche. Technological Forecasting and Social Change 78: 883–897

Shipley R, Feick R, Hall B, Earley R (2004) Evaluating municipal visioning. Planning Practice and Research 19:195–210

Shipley R, Michela J (2006) Can vision motivate planning action? Planning Practice and Research 21:223–244

Shipley R, Utz S (2012) Making it count: A Review of the value and techniques for public consultation. Journal of Planning Literature 27:22–42

Shneiderman B, Fischer G, Czerwinski M, Resnick M, Myers B, Candy L, Edmonds E, Eisenberg M, Giaccardi E, Hewett T, Jennings P, Kules B, Nakakoji K, Nunamaker J, Pausch R, Selker T, Sylvan E, Terry M (2006) Creativity support tools: Report from a U.S. National Science Foundation sponsored workshop. International Journal of Human-Computer Interactions 20:61–77

Uyesugi J, Shipley R (2005) Visioning diversity: Planning Vancouver's multicultural communities. International Planning Studies 10:305–322

Wangel J (2011) Exploring social structures and agency in backcasting studies for sustainable development. Technological Forecasting and Social Change 78:872–882

Weaver PM, Rotmans J (2006) Integrated sustainability assessment: What is it, why do it and how? International Journal of Innovation and Sustainable Development 1:284–303

Wiek A, Binder C (2005) Solution spaces for decision-making—a sustainability assessment tool for city-regions. Environmental Impact Assessment Review 25:589–608

Wiek A, Walter AI (2009) A transdisciplinary approach for formalized integrated planning and decision-making in complex systems. European Journal of Operational Research 197:360–370

Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability: a reference framework for academic program development. Sustainability Science 6:203–218

Wiek A and Larson K (2012) Water, people, and sustainability — A systems framework for analyzing and assessing water governance regimes. Water Resource Management 26:3153–3171

Wiek A, Withycombe Keeler L, Schweizer V, Lang DJ (in press) Plausibility indications in future scenarios. International Journal of Foresight and Innovation Policy

APPENDIX A

PERMISSION TO USE CO-AUTHORED CONTENT

All co-authors have given their permission to use all content herein.

APPENDIX B

HUMAN SUBJECT AUTHORIZATION

The human subject research, that appears in this dissertation, has been approved by the Arizona State University Office of Research Integrity and Assurance.

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Kurt Vanlehn BYENG
From:	Mark Roosa, Chair Soc Beh IRB
Date:	09/17/2013
Committee Action:	**Exemption Granted**
IRB Action Date:	09/17/2013
IRB Protocol #:	1309009639
Study Title:	Study 3 of Laits project (Learning by Authoring Tutoring Systems)

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(1) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

ARIZONA STATE UNIVERSITY
RESEARCH AND ECONOMIC AFFAIRS

Office of Research Integrity and Assurance

To:	Arnim Wiek GIOS Build
From:	for Mark Roosa, Chair DM JTT Soc Beh IRB
Date:	02/12/2010
Committee Action:	**Exemption Granted**
IRB Action Date:	02/12/2010
IRB Protocol #:	1002004817
Study Title:	City of Phoenix Visioning Workshop

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) (4) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

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