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# Integrating existing climate adaptation planning into future visions: A strategic scenario for the central Arizona–Phoenix region

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# Integrating existing climate adaptation planning into future visions: A strategic scenario for the central Arizona–Phoenix region

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ABSTRACT

Cities face a number of challenges to ensure that people's well-being and ecosystem integrity are not only maintained but improved for current and future generations. Urban planning must account for the diverse and changing interactions among the social, ecological, and technological systems (SETS) of a city. Cities struggle with long-range approaches to explore, anticipate, and plan for sustainability and resilience—and scenario development is one way to address this need. In this paper, we present the framework for developing what we call 'strategic' scenarios, which are scenarios or future visions created from governance documents expressing unrealized municipal priorities and goals. While scenario approaches vary based on diverse planning and decision-making objectives, only some offer tangible, systemic representations of existing plans and goals for the future that can be explored as an assessment and planning tool for sustainability and resilience. Indeed, the strategic scenarios approach presented here (1) emphasizes multi-sectoral and interdisciplinary interventions; (2) identifies systemic conflicts, tradeoffs, and synergies among existing planning goals; and (3) incorporates as yet unrealized goals and strategies representative of urban short-term planning initiatives. We present an example strategic scenario for the Central Arizona–Phoenix metropolitan region, and discuss the utility of the strategic scenario in long-term thinking for future sustainability and resilience in urban research and practice. This approach brings together diverse—sometimes competing—strategies and offers the opportunity to explore outcomes by comparing and contrasting their implications and tradeoffs, and evaluating the resulting strategic scenario against scenarios developed through alternative, participatory approaches.

## 1. Introduction

Cities face numerous challenges to plan for a better future. Local and regional planning must account for complex and changing interactions among people, infrastructure, land, water, energy, and climate. Yet, cities struggle with future uncertainty and therefore need long-range approaches to explore, anticipate, and plan sustainable and resilient futures (Bulkeley, 2010). Cities are systems made up of interacting social (S), ecological (E), and technological (T) components. The interactions among social-ecological-technological system (SETS) components create complex issues, such as the need to address continued infrastructural and technological development (Markolf et al., 2018; McPhearson, Haase, Kabisch, & Gren, 2016a; Redman & Miller, 2015), shifting needs, preferences, and values (Ansell & Gash, 2008), and rapidly changing climatic conditions and ecosystem integrity (Childers, Pickett, Grove, Ogden, & Whitmer, 2014; Grimm et al., 2008, 2016). In the face of complex sustainability problems, cities implement diverse S-E-T strategies to address these challenges and benefit from the application of a systems approach (Advisory Committee for Environmental Research and Education (AC-ERE), 2018).

Scenarios offer tangible, holistic representations of the future, and through their development, can be an instrument for understanding future systems relationships (Carpenter, Booth, Gillon, Kucharik, & Loheide, 2015). It is rare, however, for scenarios to explore suites of SETS interventions or strategies. Even more seldom do scenarios examine the coherence among *existing* goals and initiatives across

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multiple institutions. For example, the diverse goals and strategies across several municipalities—or among several departments within a city—may lead to unforeseen conflicts and require negotiation of normative tradeoffs. To assess the coherence of goals and strategies, a systems approach is needed to synthesize and represent tradeoffs among diverse, concurrent SETS goals and initiatives among sectors, city departments, non-governmental organizations, neighborhoods, and municipalities within an urbanized region. The resulting coherent synthesis of goals and strategies is used to create a *strategic scenario,* described below. With this approach, city planners and other urban stakeholders can make better-informed decisions and ultimately operationalize current and future goals.

Scenarios initiatives may vary significantly based on approach, scope, and objectives (see examples from Biggs et al., 2007; Bishop, Hines, & Collins, 2007; Crawford, 2019). The scenario process presented here is developed to provide SETS representations of diverse strategies from existing plans and visions. In doing this, we combine key aspects from three distinct modes of scenario development: business-as-usual scenarios, exploratory scenarios, and positive visions (Fig. 1). Business-as-usual (BAU) scenarios reveal potential implications of current trajectories with possibly unsustainable and deleterious outcomes (Cameron & Potvin, 2016). BAU scenarios do not account for unrealized priorities and goals, and instead, rely on projections from existing or past conditions. Exploratory scenarios explicitly consider emerging trends from a variety of alternative "what ifs" and uncertainties. Exploratory approaches may represent existing priorities, goals, and values. However, exploratory scenarios are generally specific to a single sector (e.g., energy, land use, or transportation; Shiftan, Kaplan, & Hakkert, 2003; Wu, Zhang, & Shen, 2011). That is, an exploratory scenario is intended to be intervention-specific, not representative of an S-E-T system of interacting strategies. Visioning approaches, on the other hand, explore normative, desirable futures and often use backcasting to articulate pathways to a desirable future state (Bennett et al., 2016; Pereira, Hichert, Hamann, Preiser, & Biggs, 2018; Raudsepp-Hearne et al., 2019; Vergragt & Quist, 2011; Wiek & Iwaniec, 2014). Visions are often worldbuilding; they are meant to make tangible the experience of the future city. Like BAU and exploratory approaches, positive visions generally do not include nuanced or systemic consideration of interactions, tradeoffs, and further implications (Iwaniec, Childers, VanLehn, & Wiek, 2014; McPhearson, Iwaniec, & Bai, 2016b).

In this paper, we put forth a complimentary approach to address these particular gaps by emphasizing the importance of (1) incorporating diverse S-E-T strategies, (2) identifying systemic conflicts, tradeoffs, and synergies among interacting goals within a system, and (3) building upon as-yet unrealized goals and strategies representative of urban short-term planning initiatives. Thus, we offer a distinct type of scenario, hereafter referred to as a *strategic* scenario[1], as a decision-support tool. The strategic scenario incorporates elements of *BAU* futures and *positive visions* through the analysis of existing trends and the incorporation of unrealized goals and strategies extracted from governance documents and plans. We first explain the general overarching approach to develop a strategic scenario (Section 2). We then apply the process to a case study of the Central Arizona–Phoenix (CAP) metropolitan region, to provide more detailed examples evaluating systems-based features of municipal governance documents and describing potential future pathways (Section 3).

## 2. Development of strategic scenarios

The strategic scenario requires the identification of current strategies in existing planning documents, including as-yet-unrealized goals and plans. Here, we overview the general approach of developing

[1] Our use of this term differs from Godet (2000) "scenarios and strategic planning".

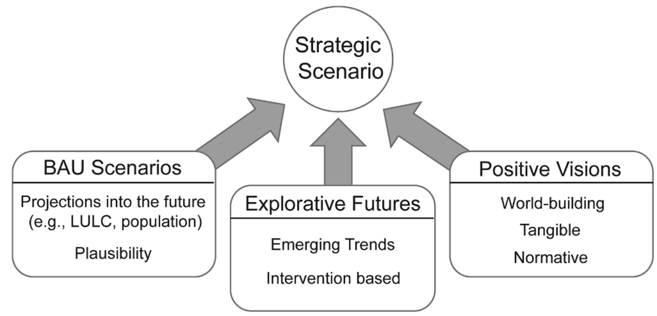


**Fig. 1.** The strategic scenario combines aspects from scenarios of business as usual, explorative futures, and positive visions.

strategic scenarios (*Scoping and Framing Phase* and *Integrative Scenario Development Phase*; Fig. 2). The first phase focuses on parsing planning goals to identify governance perspectives and priorities. The second phase recombines these perspectives and priorities into new forms—as a strategic scenario.

### *2.1. Scoping and framing phase*

#### *2.1.1. Identify existing goals*

Next, the overarching goals are identified. For example, if a strategic scenario explicitly focuses on climate resilience goals, the sources for determining the goals may include reports, visioning statements, or formal planning documents such as climate action plans, disaster preparation, and hazard mitigation plans. To ensure relevance, the selection of planning goals should be informed by and validated with stakeholders, using methods such as interviews, Delphi approaches, focus groups, or workshops (Börjeson, Höjer, Dreborg, Ekvall, & Finnveden, 2006).

#### *2.1.2. Code and synthesize priorities and strategies*

Next, the content of selected and validated planning goals is analyzed through inductive and deductive coding. Coding refers to the identification and grouping of text into thematically consistent categories. A coding scheme, or codebook, is built to organize themes and sub-themes hierarchically. Coding schemes are developed to identify the framing, key strategies, and priorities that institutions use to address particular challenges and meet their stated goals.

The developed codebook and data collection process will vary to reflect the intended application of the strategic scenario. The type of planning documents may also inform the coding approach. For instance, general plans and comprehensive development plans yield information related to larger planning paradigms (e.g., smart city, eco-city, or equity imaginaries) since they represent long-term visions for a city. Other plans, such as disaster management plans, may include significantly more detailed information and targets (e.g., zoning ordinances govern specific land use or regulate building setbacks or floodplain designations). Additionally, formal government plans and policies will differ in structure, content, and focus, compared to non-governmental institutions' planning documents, and thus each may require distinct coding approaches.

In the final step of *Scoping and Framing*, the landscape of current planning goals and strategies is analyzed and synthesized within the project scope, while also serving as input to the *Integrative Scenario Development* phase (Fig. 2). The type of analysis will vary: planning goals can be categorized based on different needs; governance documents can be organized by domain or sector (e.g., water, transit, land use); cluster analysis can be used to group plans or strategies; or, goals and strategies can be bundled based on qualitative criteria such as plausibility (i.e., how likely the strategy is to be achieved), desirability (whether it is perceived as useful or valuable), or to explore the themes of resilience and sustainability. Whether taken concurrently or in

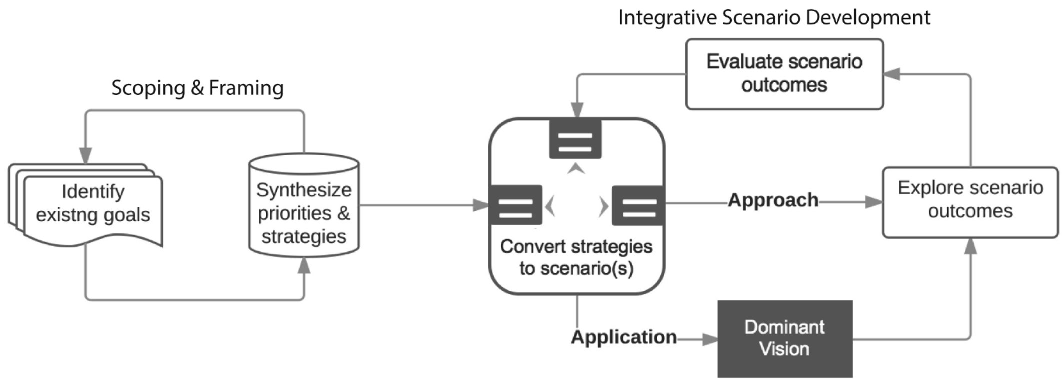


**Fig. 2.** Strategic scenario development workflow. Key outcomes from the Scoping & Framing phase include the identification and extraction of relevant strategies from governance documents. Key outcomes of the Integrative Scenario Development phase include the exploration of implications and tradeoffs of interacting SETS strategies. The generalized approach to develop strategic scenarios may be used to contrast different existing visions and used—as applied in this case study—to develop a dominant vision to seed issues to be further addressed in subsequent participatory scenarios activities.

sequence, analyses should reveal a suite of strategies being considered for the future. These strategies are brought together in a world-building exercise in the *Integrative Scenario Development* phase.

### 2.2. Integrative scenario development

#### 2.2.1. Convert strategies to scenario(s)

The suite of strategies identified from the previous phase is combined into new forms to produce the strategic scenario(s). The intended use of the strategic scenario dictates which strategies are synthesized into the strategic scenario(s), and how they are combined. For example, several scenarios could be constructed at different scales (e.g., neighborhood, municipality, county) to identify areas of overlap and tradeoffs among governance strategies. For the purpose of exploring SETS dynamics, the strategies are grouped (S, E, and T) to identify their interactions or lack thereof. This approach can also be used to expose scale mismatches, omissions in governance, or to compare dominant strategies to alternative, marginal perspectives.

#### 2.2.2. Explore and evaluate scenario outcomes

The strategic scenario outcomes created in the previous step may be explored and represented in diverse ways. These include both quantitative approaches, such as modeling, and qualitative approaches, such as story-telling. For example, quantitative approaches can be used to model the implications of alternative land-use decisions (e.g., InVEST; Goldstein et al., 2012; Iwaniec et al., 2020). Design-based approaches can better illustrate problem framings and provide insight into how knowledge is acquired and synthesized (Gaziulusoy & Ryan, 2017). Narrative exercises can help fill information gaps and enhance communication about future change (Veland et al., 2018). Such qualitative explorations are useful in providing a richer, more tangible representation of the future. Less common are combined qualitative and quantitative approaches to scenario exploration (Carpenter et al., 2015; Iwaniec et al., 2020).

## 3. Application: case study of Central Arizona-Phoenix

In this section, we apply the generalized strategic scenario development process to a case study, providing further detail in the context of a specific example for how the process may be implemented. The example given here highlights a range of methods to be used at each stage of scenario development, but alternative methods may be implemented depending on the context and goals of strategic scenario development. Scenario outcomes of the case study are provided to exemplify qualitative and quantitative approaches to explore systems-based features of municipal governance documents.

### 3.1. Scoping and framing phase

The Central Arizona–Phoenix Long-Term Ecological Research (CAP LTER) Sustainable Future Scenarios project brought together a diverse group of social and environmental leaders from across the Phoenix metropolitan region to explore the unique challenges and opportunities of this urban, desert region (website: sustainablefutures.asu.edu). In this context, the strategic scenario represents the aspirations articulated in the existing governance documents and city plans and serves as a baseline for comparison to other scenarios that were co-developed in a participatory workshop setting (Iwaniec et al., 2020).

In our application of the strategic scenario, we developed a single vision reflecting existing and dominant municipal-planning strategies across several governance institutions in the CAP LTER region. Based on prior scoping and framing (see Iwaniec et al., 2020), the strategic scenario focused on three key climate resilience challenges: heat, drought, and flood. These challenges were used to constrain our initial analysis of governance documents.

#### 3.1.1. Identify existing goals

To reflect the heterogeneity of factors that influence city planning in the Central Arizona–Phoenix valley (e.g., water supply, demography, geography), we identified five distinct municipalities: Goodyear, Mesa, Phoenix, Scottsdale, and Tempe (Table S1). Initial web searches of selected municipalities yielded diverse and distinct types of plans for each city. To address the heterogeneity in plans, we narrowed the list of plans for each city based on the following criteria: 1) at least one recent, comprehensive municipal plan (e.g., General Plan, Comprehensive Development Plan) that lays out long-term (5–10 + years) goals and priorities for the city's future; 2) additional three to five plans that include goals and strategies pertinent to urban climate resilience to heat, drought, and flood. Governance planning documents from this second category focused on water resources, green infrastructure, transportation, and parks and recreation plans, reflecting the multi-sectoral nature of strategies that can influence climate resilience planning (Table S1). The list of governance plans for each city was reviewed and validated by city staff.

#### 3.1.2. Code and synthesize priorities & strategies

This research focused on regional planning for extreme events (i.e., heat, drought, and flooding). A main objective was to explore how different municipalities and governance institutions in the same region think about their long-term future development; specifically, how they account for climate-related extreme events. To get at these perspectives, we used a mixed-method approach that employed both deductive and inductive coding techniques. Initial explorations captured strategies explicitly associated with extreme events while a second-level analysis captured all strategies that might address extreme weather events but were not necessarily associated with an extreme weather event. The extraction of these captured strategies from the government documents was performed by a single researcher, at the sentence level, for the coding and subsequent frequency analysis. A second researcher applied the approach to a sample from each document. This was conducted iteratively to refine the codebook and evaluated for an inter-rater reliability score of 80% or greater.

Our coding scheme involved identifying climate drivers, levers, qualifiers, targets, and metrics in each plan, as defined below (after Wiek & Iwaniec, 2014). Climate-related extreme events were identified as *climate drivers* (e.g., extreme heat, flooding, or drought). Governance mechanisms that may be manipulated to mitigate, adapt, or respond to the impact of climate drivers were coded as *levers*. Levers could also describe a broad range of S-E-T strategies, such as land use, urban form, green and gray infrastructure, programmatic development, education programs, and regulations and incentives. In some cases, *qualifiers* (e.g., increase, decrease, maintain, etc.) were assigned to provide additional detail. For example, if a plan suggested the strategy "increase tree canopy cover to reduce the impact of heat exposure", heat would be coded as the climate driver, trees would be the lever, and increase would be the qualifier. Qualitative and quantitative *targets*, such as "20% increase in canopy cover", were not coded but were captured for subsequent modeling inputs. However, targets were rarely identified in plans; 11% of the 385 strategies extracted from the municipal governance documents specified a spatial or temporal target and only 2% explicitly stated a quantitative target. If applicable, we also captured indicators or *metrics* associated with levers, which provided more detail on the intended purpose of the proposed strategy. Each extracted strategy was then coded by SETS domain (e.g., a tree canopy strategy would be coded as E, financial incentives would be coded as S, and green walls would be coded as both E and T). Coding of climate drivers, levers, qualifiers, targets, metrics, and SETS domain were validated by at least three researchers.

To synthesize the strategies across and within governance planning documents, we analyzed the relationships across climate drivers, levers, metrics, and SETS domain. Specifically, we examined the potential conflicts, tradeoffs, and synergies among interacting strategies. For example, we identified tradeoffs and synergies among goals for tree planting, heat mitigation, and water conservation in an arid environment (Fig. 3). Trees can create more demand for outdoor water use and thereby stress water systems in times of drought (a tradeoff); however, trees also provide heat relief as well as flood mitigation (a synergy).

Our analysis allowed us to explore how cities in the same metropolitan region, experiencing similar degrees of climate-related extreme events, are prioritizing land use, infrastructure, and climate adaptation strategies. While all municipalities addressed heat, drought, and flood, they were prioritized differently across cities (Fig. 4). Goodyear and Phoenix prioritized drought and heat (respectively) more than other drivers, whereas Scottsdale gave approximately equal weight to the three climate drivers (heat, drought, and flood).

Similarly, patterns emerged in the kind of strategies that were favored by cities (Fig. 4). Flood strategies were primarily ecological, whereas strategies to cope with drought included social, ecological, and technological solutions (Fig. 4). Heat strategies were dominated by technological and ecological strategies and few social solutions were proposed in the plans to address urban heat stress (Fig. 5). We also found that strategies tended to be either explicitly social, ecological, or technological with less emphasis on the interactions among these three domains; that is, S-E, E-T, S-T, or SET strategies represented only 19% of strategies across all cities.

Overall, these results highlight how cities are incorporating a diversity of strategies and solutions to address climate-related extreme events. By identifying the S, E, and T domains of the strategies, the framework presented here can explicitly consider the synergies and tradeoffs among them that are not otherwise identified, providing opportunities for envisioning solutions that feature a greater amount of interaction or even hybridization among the S, E, and T domains.

### 3.2. Integrative scenario development phase

#### 3.2.1. Convert strategies to scenario(s)

To develop a tangible representation of the diverse strategies proposed in the governance plans, we synthesized across the multiple plans, and within and among municipalities, to develop a single *dominant vision* for the region. Specifically, we organized strategies in a database that categorized strategies by sector, such as energy, water, land use, and transportation, with details of each plan's relevant strategies including goals and targets (when available). The synthesized strategic scenario focused primarily on the dominant strategies and was not representative of any single municipality but rather a reflection of the region as a whole. The dominant strategic vision served two key purposes: first, it abstracted city-specific priorities and goals to set the context for a dominant vision; second, it created a single strategic scenario that enabled normative comparisons with co-developed scenarios (Iwaniec et al., 2020). Finally, in the CAP LTER case study, the strategic scenario was validated by local stakeholders in a series of participatory workshops involving local non-academic and academic

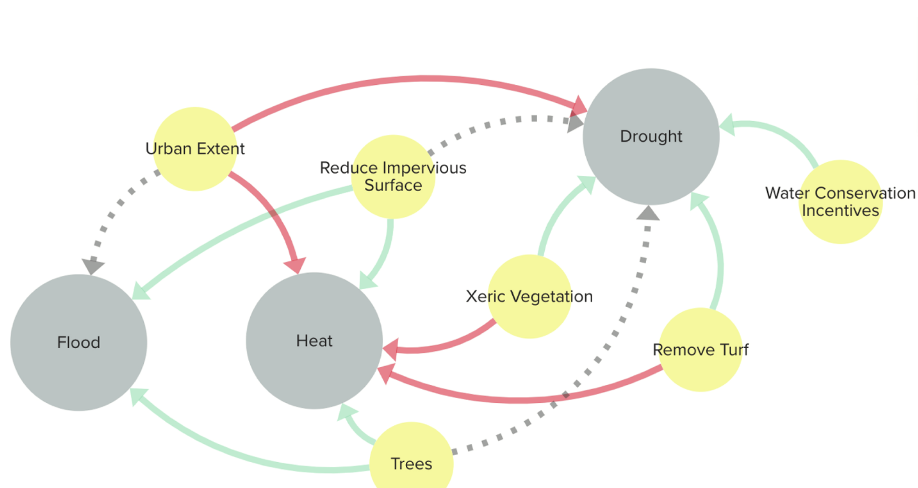


**Fig. 3.** Synergies and tradeoffs among common strategies (yellow circles) coded in planning documents to address key extreme events (grey circles). Red arrows represent potential negative impacts (tradeoffs), green arrows indicate strategies that mitigate impacts (synergies), dashed lines suggest potential impact.

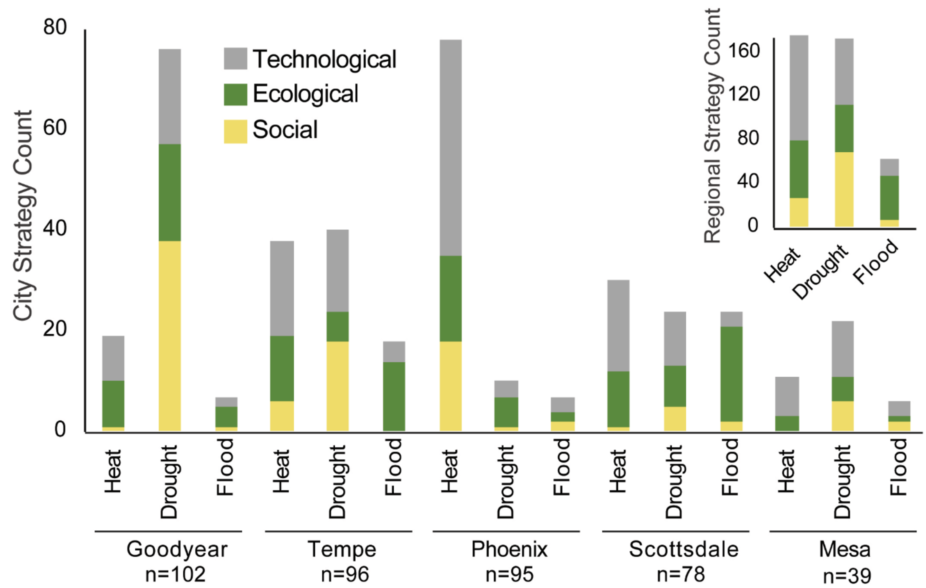


**Fig. 4.** Frequency of explicit mentions of heat, drought, and flood in city planning documents by municipality and the type of strategy (i.e., social, ecological, technological). The inset figure highlights the count of S, E, T strategies across all cities.

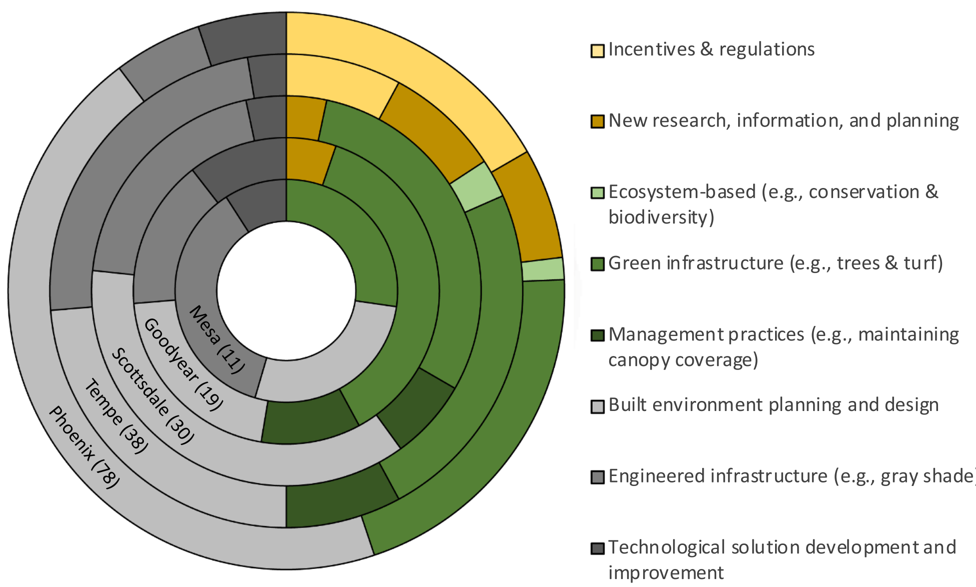


**Fig. 5.** Distribution of top heat strategies by city. Phoenix had the highest number and most diversified set of strategies (n = 78) to address heat compared to Mesa (n = 11), which had the smallest number and types of strategies.

stakeholders (described in more detail in Iwaniec et al., 2020).

*3.2.2. Explore and evaluate scenario outcomes*

Representing and modeling the regional strategic scenario required that data gaps, such as the lack of specific targets for planned land use, infrastructure, and change in urban form, be addressed. In the CAP LTER case study, the models relied heavily on land-use and land-cover (LULC) information that required additional mining of policies, plans, and trends, including regional light rail extension plans, population growth estimates, and water-provider data. Land cover was classified for the year 2010 from Landsat Thematic Mapper (TM) data (30-m resolution). Detailed delineation among similar land-cover types using ancillary data (assessor data and U.S. census data) permitted a resampling of the map to a 15-m resolution. Linear regression models were developed relating reflectance to vegetation cover from high-resolution aerial photography (Li et al., 2014). Changes to the LULC classes were projected forward to 2060 using a coded, rule-based approach for individual pixel reassignment, based on the strategic scenario goals.

With this comprehensive dataset and projected land-cover map, we conducted formal analysis and modeling of the strategic scenario (see also Iwaniec et al., 2020 for additional details). Overall, the dominant LULC in the strategic scenario for the central Arizona region was low-medium density urban residential, as it is today (Fig. 6). There was an increase in density within existing urban cores, particularly along transit corridors where vacant lots were developed into compact, mixed-use zones. Whereas high-density zoning is the main strategy to reduce sprawl, the overall urban extent still increased, with new urbanization occurring on existing *peri*-urban agriculture and desert open space (Fig. 6). In addition to examining LULC changes in the strategic scenario, regional temperature, microclimate, and water availability and use implications were explored (see Iwaniec et al., 2020 for details). Finally, design-based visualizations were created to represent diverse places within the urban area of the strategic scenario (Fig. 6).

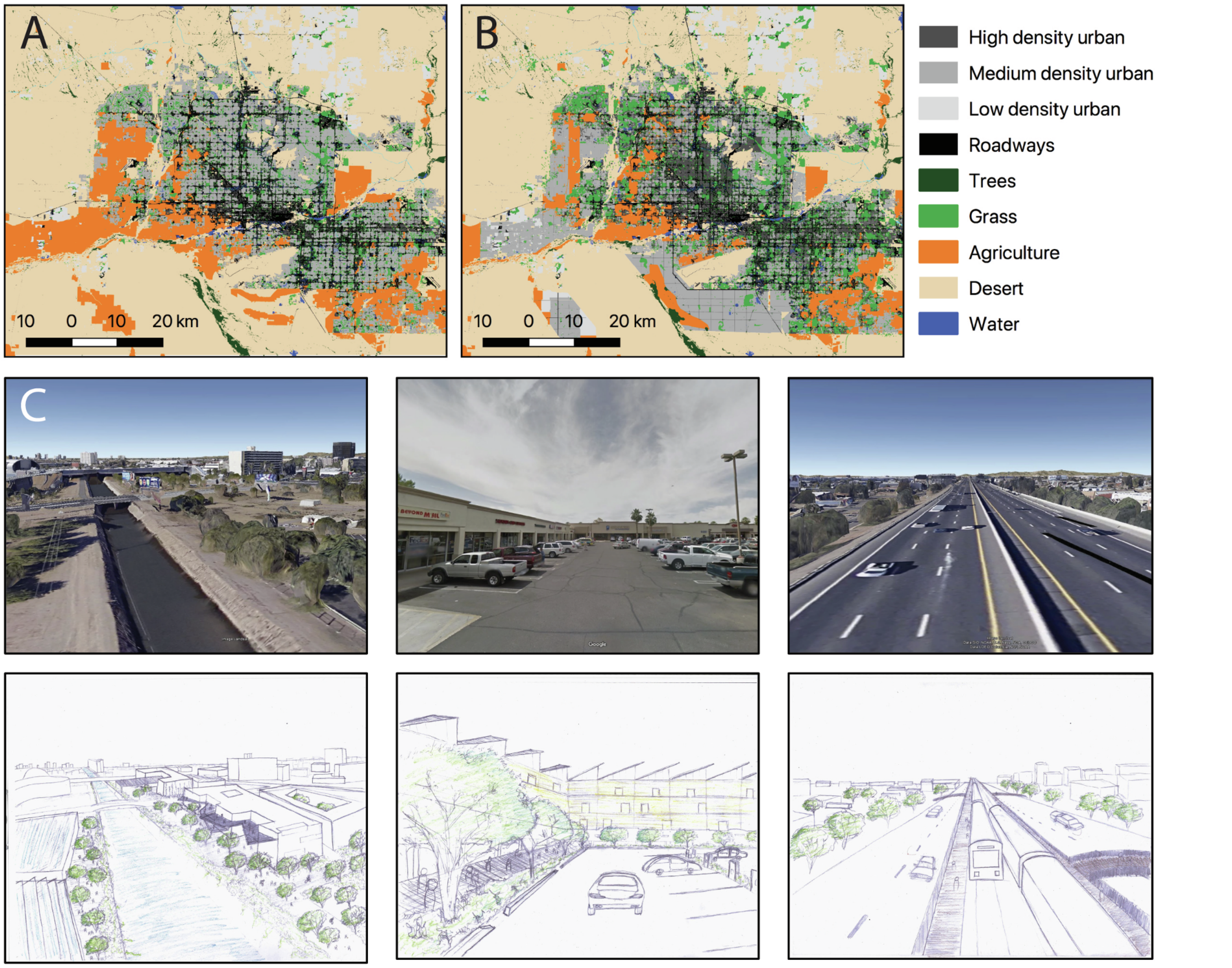


**Fig. 6.** (A) Existing (2010) LULC; (B) strategic scenario (2060) LULC; (C) place-based photos of current form and renderings of future changes anticipated with the strategic scenario.

## 4. Discussion

Management and planning approaches in cities need to consider complex interactions between social, ecological, and technological dimensions. Cities face challenges in future planning to balance equity, economic opportunities, ecological integrity, and infrastructure development (McPhearson et al., 2016a). Even more, societies struggle with long-range approaches to envisioning alternative futures. Drawing from scenario approaches that have been widely used in planning and other disciplines—specifically, business-as-usual (BAU), exploratory, and positive-vision scenario planning (Fig. 1)—strategic scenarios can be a tool to explore alternative visions, systems interactions, and to guide long-term decisions. BAU approaches are encompassed in strategic scenarios by incorporating emergent trends, such as population growth, into the future projections. In contrast to BAU scenarios, however, strategic scenarios also incorporate unrealized goals from existing planning documents and call attention to the implications and interactions among cities' documented goals and plans. In the CAP region, for example, the goal of imposing growth boundaries produced a great deal of densification that would not have been expressed in a classical BAU approach.

Similar to exploratory scenarios, strategic scenarios are an intervention-based approach (i.e., existing goals from planning documents are the inputs to a strategic scenario); however, rather than asking "what if?" for single interventions, strategic scenarios concurrently examine myriad interacting interventions. In the CAP case study, the projected land-use map incorporates growth boundaries, changes in vegetative cover, infill of vacant lots, and preservation of open space, allowing for a nuanced exploration of future land-use change.

From positive visioning, strategic scenarios incorporate normative and world-building approaches. Specifically, strategic scenarios combine emerging trends and interventions with planning aspirations of cities and city stakeholders as reflected in the governance documents. The strategic scenarios framework applies a systems approach to creating alternative future scenarios that are tangible, richly described, and consistent with social, geographic, political, technological, and environmental constraints. In this way, for our CAP case study, visualizations bring the future world to life (Fig. 6).

The strategic scenarios may be developed for multiple alternative visions. The example strategic scenario represents a synthesized, dominant vision for the Central Arizona–Phoenix region, which was created as an enhanced BAU scenario for the purpose of comparison with co-developed scenarios (Iwaniec et al., 2020). However, city-specific visions, rather than a synthesized regional vision, would allow for cross-city comparisons and account for heterogeneity in biophysical features (e.g., groundwater supply, proximity to rivers, or topography), governance goals, city-specific pathways, or demographics.

Strategic scenarios also can be a tool to explore marginalized and dominant visions from diverse actors and sectors within a city or region. Dominant visions can be compared to marginalized perspectives. For example, a strategic scenario for the CAP region could be created for less-dominant visions, such as those of tribal or Latino communities, by analyzing planning documents from those communities. In addition to challenging a dominant vision, a strategic scenario incorporating underrepresented sustainability and resilience visions can be used to explore and prioritize those strategies in future urban planning. Doing so may help to overcome deeply embedded injustice and vulnerability arising from past decisions (Bolin, Grineski, & Collins, 2005).

The literature on local planning for climate-change adaptation reveals a general disparity between the awareness of climate-related challenges and tangible actions to address those challenges (Bulkeley & Castan Broto, 2013; Carmin, Nadkarni, & Rhie, 2012; Tang, Brody, Quinn, Chang, & Wei, 2010). Among CAP municipal planning strategies, only 11% identified concrete targets for implementation. The strategic scenario approach, in creating a tangible representation of municipal goals, provides an opportunity to improve and identify specific targets.

Exploring different strategies with the strategic scenario provides a holistic representation of how urban planning treats climate-change adaptation. Using an interdisciplinary, systems framework, such as SETS, also allows users to identify potential systems tradeoffs, synergies, and conflicts among governance strategies. From the governance planning documents, the CAP regional strategic scenario considers heat and water tradeoffs that could be inferred among the suite of social, ecological, and technological strategies. For instance, the strategic scenario highlights that while enhancing vegetative cover remains a common strategy for mitigating heat exposure, cities in the CAP region are incorporating gray shade infrastructure and, increasingly, solar shade to form the urban canopy.

When considered as independent outcomes (rather than a synthesized strategic scenario), we found that few of the strategies (19%) addressed interactions among the three SETS domains (e.g., S-E, E-T, S-T, or SET). Siloed institutions and disciplinary norms likely factor into explaining this finding. For example, parks and recreation department plans tend to have more ecological strategies, whereas governance planning for resilience is predominantly framed from engineering and socio-technical epistemologies: disaster risk management (Aldunce, Beilin, Howden, & Handmer, 2015), hazard mitigation (Berke, Smith, & Lyles, 2012), and local climate-change adaptation (Tang et al., 2010; Woodruff & Stults, 2016). Furthermore, we found that while governance plans were quick to highlight the importance of co-beneficial strategies (e.g., shade and solar energy) they often failed to call out potential tradeoffs, which are equally important considerations. Indeed, synergies (and co-benefits) are commonly highlighted in decision-making, but tradeoffs often are hidden or rarely identified (Daw et al., 2015). The strategic scenario provides decision-makers with a tool to integrate siloed perspectives, examine their interactions (both positive and negative), and optimize their potential outcomes.

## 5. Conclusion

We present an approach for the development of future scenarios that emphasizes 1) multi-sectoral and interdisciplinary perspectives and 2) systemic conflicts, tradeoffs, and synergies among existing planning goals. The development of strategic scenarios builds upon traditional planning and visioning approaches but enhances them with a social-ecological-technological systems (SETS) view and a means for visualizing and exploring the consequences of implementing enumerated goals.

Long-term-futures thinking ensures planning beyond the short term and development of strategies for resilience in the face of extreme events. Moreover, long-term planning promotes trajectories toward sustainable development (Voß, Smith, & Grin, 2009). Through the development of general and specific plans to address challenges such as hazard mitigation, a wealth of information is captured about cities' goals and values. The strategic scenario framework enables the extraction and synthesis of these goals, along with the examination of unanticipated tradeoffs or synergies and visualization of how unrealized goals may look in the future. Moving beyond commonly used scenario approaches, the strategic scenario incorporates knowledge from BAU projections, knowledge about envisioned S-E-T strategies, and knowledge of future implications of SETS interactions. As such, in this case study it served as a baseline for comparison: among alternative plans, among cities within a region, and among dominant planning paradigms. Bringing together the diverse, sometimes competing, strategies to explore, compare, and contrast implications and tradeoffs is an important next step in future planning. Furthermore, illuminating often-unrealized municipal goals underscores the importance not just of current trends, but of incorporating city goals and priorities to shape our future.

## CRediT authorship contribution statement

**David M. Iwaniec:** Conceptualization, Funding acquisition, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing. **Elizabeth M. Cook:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing. **Melissa J. Davidson:** Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft. **Marta Berbés-Blázquez:** Investigation, Writing - original draft. **Nancy B. Grimm:** Conceptualization, Funding acquisition, Investigation, Writing - original draft, Writing - review & editing.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2020.103820.

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