# Identifying mindsets for urban sustainability transformation: insights from Urban Labs

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## Abstract

Increasing calls for transformation to address climate change and related challenges underscore the societal imperative to shift from mindsets that drive environmentally unsustainable and socially unjust processes to mindsets that enable urban sustainability transformations. However, it is not always clear what such mindsets comprise, if and how they can be shifted and under which conditions. Fragmented understandings of the concept of mindsets across disciplines and limited empirical analysis beyond Europe and North America have hindered progress in this field. To address these gaps, this article proposes a novel conceptual and analytical framework for identifying mindsets. The framework is applied to data collected from an exploratory survey involving over 150 participants from five Urban Labs in Argentina, Brazil and Mexico. Through cluster analysis, three distinct personas are identified: the Skeptical Activist, the Optimist Technocrat and the Bystander with Mixed Feelings. These are fictional characters that represent groups of individuals with defining mindsets, demographic characteristics, capacities, trust levels and network features. Results offer valuable insights into the emotions, beliefs, values, perceptions, attitudes and worldviews that guide the behavior of diverse stakeholders, from policymakers to often marginalized community groups, in urban climate governance. Despite its limitations, namely the relative homogeneity of our non-randomized sample, the article advances the understanding of the human dimension of climate change and its interlinkages with urban development goals. It also proposes social innovation strategies to trigger mindset shifts, foster climate action and accelerate urban sustainability transformations.

**Keywords** Cities · Climate change · Mindsets · Personas · Social innovation · Transformations

## Introduction

The need for transformation has been increasingly stressed in scholarly literature covering topics from climate change to inequality, particularly in cities where these and other complex and interconnected problems are concentrated (Crane et al. 2021; Elmqvist et al. 2019; McCormick et al. 2013; Pickering et al. 2022; Ziervogel et al. 2021). One recurrent argument is that multi-level, multi-stakeholder and

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transdisciplinary approaches are essential for the design and implementation of novel solutions that tackle these systemic challenges simultaneously.

Put simply, transformation involves many people working together in new ways to create innovative solutions. In order for this to happen at the speed and scale required to achieve the United Nations' Sustainable Development Goals and the Paris Agreement on Climate Change, different and often conflicting interests, values and worldviews must be reconciled, or at best co-exist (IPCC 2023; O'Brien 2018). Furthermore, transformation must include technological as well as social innovations (Nevens et al. 2013; Wittmayer et al. 2019).

Social innovation research has gained traction at the same time as interest in transformation discourses intensified (O'Brien and Sygna 2013). Social innovation involves changes in social relations and practices and typically entails new ways of knowing, thinking, doing and organizing. It is thus a process of fundamentally transforming

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the individual and the collective, relying on citizen awareness, empowerment and agency as both preconditions and intended outcomes (Avelino et al. 2020; Wamsler and Brink 2018). Social innovations can take the form of, for example, new narratives, new modes of governance, new policy instruments or alternative business models (Wittmayer et al. 2020).

Within sustainability transformation research, scholars call for changes in both the outwardly visible forms of infrastructure and policy as well as in the values, emotions and beliefs that drive human behavior, both individual and collective (Avelino et al. 2020; Berzonsky and Moser 2017). Many argue in favor of paying increasing attention to human beings' 'inner dimensions', namely mindsets as deep leverage points for fundamental change in a system (Berzonsky and Moser 2017; Meadows 1999; O'Brien 2018; Page et al. 2016; Wamsler and Brink 2018; Woiwode et al. 2021). They emphasize the societal imperative to shift from mindsets that drive environmentally unsustainable and socially unjust processes to mindsets that enable sustainability transformations. However, it is not always clear what such mindsets comprise, if and how they can be shifted and under which conditions.

Rising concerns related to the human dimensions of climate change and emerging interest in socio-techno-ecologically innovative approaches, particularly Urban Labs, are paving the way for empirical research on urban sustainability transformations, some of which already began looking into mindsets (Krueger et al. 2022; Pereira et al. 2015; Wamsler and Brink 2018; Woiwode et al. 2021). However, this line of research has relied mostly on European and North American case studies (e.g., Kok et al. 2023; McCrory et al. 2022), meaning that to date the dynamics of urban transformations toward sustainability in other parts of the globe remain less well understood (Ely et al. 2020).

Urban Labs are symbols of experimental, inclusive and potentially transformative urban governance. Although different types exist, including 'urban transition labs' (Nevens et al. 2013), 'urban living labs' (Bulkeley et al. 2017) and 'transformation labs' (Ely et al. 2020), they all share a common purpose: to offer a space for diverse individuals to co-create, test and learn about innovative solutions to complex challenges. In addition to their nomenclature, Urban Labs can also differ according to their spatial context or scope, forms of collaboration, innovation type, aim or sustainability orientation (McCrory et al. 2022).

In low- and middle-income countries, the fundamental issue is as much about enabling 'sustainability' transformations through climate mitigation and adaptation measures as it is about promoting 'just' transformations that tackle existing social injustices, inequalities and exclusion (Krueger et al. 2022; Pereira et al. 2015; Ramos-Mejía et al. 2018). We argue that articulating these agendas, in cities and elsewhere, to advance climate just transformations requires not only systemic, political and practical reforms but also inner or personal changes, which are ultimately interlinked (Newell et al. 2021; O'Brien and Sygna 2013; Patterson et al. 2018; Steg 2023; Woiwode et al. 2021).

This article aims to start filling these gaps by presenting a novel conceptual and analytical framework to identify mindsets for urban sustainability transformation. It draws on longitudinal research led under the Transformative Urban Coalitions (TUC) project. TUC supports cities to develop new strategies for addressing challenges in urban development and inequality while at the same time reducing emissions. For this, five Urban Labs (UL) were established in 2022: UL León and UL Naucalpan (Mexico), UL Recife and UL Teresina (Brazil) and UL Villa 20, Buenos Aires (Argentina). Since then, different stakeholders representing, inter alia, government, academia, civil society and the private sector have joined as Urban Lab members. These actors, who might not otherwise work together, have been engaged to co-create and test various innovative solutions for pressing sustainability challenges in their cities, particularly climate change and inequality (Hardoy et al. 2022). Unlike most Urban Labs in Europe and North America, TUC Urban Labs prioritize socially innovative approaches over technology-driven solutions. In this manner, Urban Lab activities are expected to facilitate urban sustainability transformations by addressing climate change through more inclusive and socially just approaches.

## Mindsets

Urban sustainability transformation is hereby understood as a set of fundamental changes across urban systems that contribute toward more just and zero carbon cities. It includes social innovations or changes in terms of personal and shared mindsets about climate change and its interlinkages with development as well as changes in individual and collective climate action. This article does not dwell further on the definitional and normative debates around urban sustainability transformations (see Elmqvist et al. 2019; Hölscher and Frantzeskaki 2021; Rosenzweig and Solecki 2018; Termeer et al. 2017).

Our aim is to map the mindsets of different stakeholders who are working together toward urban sustainability transformations and understand if distinct mindsets co-exist, thus paving the way to assess if and how mindsets can be shifted to accelerate such transformations and under which conditions. For that, we first clarify how mindsets are framed and operationalized in this study, which leads us to a novel conceptual and analytical framework to identify mindsets for urban sustainability transformation.

The concept of mindsets has been interpreted in many ways from multiple perspectives, not just psychology but

also sociology, communication studies and environmental science. Differences in conceptualizations have led to fragmented applications where the term 'mindsets' is typically used interchangeably with other subjective aspects such as beliefs, perceptions, attitudes, values or worldviews.

In psychology, mindsets are often conceptualized as lay theories or generalized beliefs that people hold about the nature of things. Beliefs do not usually draw on scientific findings or expert opinions but rather represent assumptions that naturally arise from people's life experiences (Rattan 2019). Beliefs are what people hold for 'true' about a subject and can also be grounded on certain emotions (Brink and Wamsler 2019). In this article, we assess one's beliefs regarding climate change, which are anchored in one's acceptance or denial of climate change.

Dweck's theory of implicit beliefs distinguishes between 'fixed' and 'growth' mindsets as two extremes of a continuum (Dweck and Leggett 1988). Investigating where individuals rank on this continuum, although being too simplistic on its own for our research on mindsets, can help us understand people's beliefs around climate change. It can also give us a measure of one's openness to change, or openness to mindset shifts, by assessing whether people perceive their world as a changeable entity that can be shaped (growth mindset) or a static one that cannot be changed or improved (fixed mindset) (Duchi et al. 2020).

Environmental science literature typically approaches mindsets research by focusing on perceptions (on risk perceptions see, e.g., Wamsler and Brink 2018). Perceptions refer to the way(s) in which something is regarded, understood or interpreted. For us, this encompasses the perceived feasibility, priority and barriers for climate goals and action. Scholars have found that specific knowledge about climate change can shape public perceptions about the topic (Shi et al. 2016).

Perceptions influence one's attitudes which reflect ways of thinking (i.e., positive or negative) about a subject (Duchi et al. 2020; Dunlap and Van Liere 2008). We assess one's attitudes toward various solutions aimed at tackling climate change, namely different governance modes, participatory approaches, technology and lifestyle or behavior changes. The theory of planned behavior suggests that attitudes may influence intentions and ultimately lead to more climate-friendly behavior (Shi et al. 2016).

Also relevant for the analysis of mindsets, and closely linked to perceptions and attitudes, are values (Rhead et al. 2015; Shi et al. 2016). Values represent what is intrinsically desirable for individuals and may underlie one's motivation to act in ways that help tackle climate change (Steg 2023). Similar to previous research, we consider three broad value orientations for climate action: economic, social or ecological (Brink and Wamsler 2019). According to the value belief norm theory, strong biospheric or ecological values make individuals more aware of the impact of their actions on climate change. This makes them more likely to believe that they can contribute to the mitigation of climate change which in turn can strengthen personal norms, i.e., feeling responsible and morally obliged to act. This sense of personal responsibility can ultimately motivate individuals to engage in climate action (Bouman et al. 2018).

Different systems of values and beliefs are reflected in distinct worldviews. Based on cultural theory and drawing on the application by Brink and Wamsler (2019), we consider four main worldviews or 'ways of life'—individualist, hierarchical, communitarian and fatalist—that justify certain behavior. Individualist worldviews are centered on personal freedom, autonomy and self-interest. Individualists value individual choice and self-governance with minimal government intervention. Thus, they may prioritize personal responsibility and market-based solutions to address climate change. Individuals with hierarchical worldviews place importance on social order, hierarchy and top-down authority. They value tradition, social structure and stability and may prefer to rely on established institutions to tackle climate change. Communitarian (or sometimes referred to as egalitarian) worldviews emphasize equality, fairness and cooperation. Communitarians value collective action, social justice and the redistribution of power and resources. They may be more inclined to view climate change as a product of social inequality and advocate for systemic change to address it. Finally, individuals with fatalist worldviews perceive themselves as having little control over their lives and the broader social order. Fatalists may see climate change as inevitable and feel powerless to do anything about it (Thompson 2018).

Holding certain worldviews, as well as specific values, beliefs, attitudes and perceptions about climate change, can therefore directly or indirectly motivate individuals to engage in climate action by changing their consumption behavior and collective citizen and organizational behavior (Berzonsky and Moser 2017; Bouman et al. 2018; Shi et al. 2016; Steg 2023). The impact of emotions, beliefs, values and perceptions on behavior appears to be indirect, as they inform worldviews and attitudes that can subsequently exert a more direct influence on behavior. All of these dimensions are nevertheless interconnected and can mutually influence one another.

For this study, mindsets thus consist of an individual's emotions, beliefs, values, worldviews, perceptions and attitudes and can be closely linked to behavior, individual and collective (see Table 1). We posit that a comprehensive understanding of one's mindset can only be achieved through an integrated analysis encompassing all of these dimensions. Therefore, this conceptual framework lays the foundation for an innovative application of mindset analysis

**Table 1** Summary of intertwined mindset dimensions, definitions and indicator categories

| Dimensions | Definitions | Indicator categories |
|---|---|---|
| Beliefs | What people hold true about climate change | Distant/local phenomenon |
| | | Others'/local or personal responsibility |
| Emotions | What one feels toward climate change | Acceptance/denial |
| Perceptions | Way(s) in which something is regarded, understood or interpreted | Importance of climate change |
| | | Feasibility and compatibility of climate and urban development goals |
| | | Barriers to climate action (political, economic, social, technical) |
| Attitudes | Way(s) of thinking, positive or negative, about a subject | Lifestyle changes/technology |
| | | Government-led climate action |
| | | Participation |
| Values | What motivates climate action | Economic |
| | | Social |
| | | Ecological |
| Worldviews | Systems of values and beliefs | Individualist |
| | | Hierarchical |
| | | Communitarian |
| | | Fatalist |
| | | Growth/fixed mindset |
| Behavior | Way(s) in which one acts or conducts oneself toward a particular subject or others | Individual climate action |
| | | Collective climate action |

See Electronic Supplementary Material (S1) for the survey questionnaire and indicators

as a multi-dimensional methodological tool within urban sustainability transformation research.

## Methods

### Survey design and participants

The data used in the current study is sourced from the baseline of an annual survey conducted in the context of the Transformative Urban Coalitions (TUC) project. Data was collected using computer-assisted telephone interviews during an initial round (December 2021–February 2022) and an additional complementary round (June–August 2022). Survey participants were recruited from five Urban Labs in Argentina, Brazil and Mexico. The participants were either already members, or potential members, of the Urban Labs that were being set up at the time by TUC in these cities.

Our final sample included a total of 153 participants, with a majority of respondents from UL Buenos Aires (49), followed by UL Recife (33), UL León (28), UL Teresina (22) and UL Naucalpan (21). Most of the participants were identified as male (54%) compared to female (45%) and other (1%). Over 77% reported having lived in their municipality for a period of ten years or more. The age distribution varied across the five Urban Labs, ranging from 22 to 70 years

($M = 43$, SD $= 10.9$). Most participants (88%) reported a bachelor's level of education or higher. As indicated previously, the Urban Labs are composed of different stakeholder types and this is also reflected in our sample, consisting of a mix of government representatives (39%), community organizations and citizens (20%), research institutes (14%), non-governmental organizations (NGOs) (15%), private sector (10%), donors (1%) and media affiliates (1%). Table 2 provides further demographic details organized by Urban Lab.

### Questionnaire

The survey questionnaire is original; yet, it significantly relies on tested questions for mapping mindsets that were adapted from existing academic research (Brink and Wamsler 2019; Duchi et al. 2020; Dunlap and Van Liere 2008; Rhead et al. 2015) and question banks (Bouma and CentERdata 2021; CDC 2021; UK Data Service 2021; UK Office for National Statistics 2011). Overall, the survey has 40 questions and took on average 40 min to be completed.

The questionnaire is characterized by a mix of quantitative variables, categorical variables and 4-point Likert measures which collectively capture the mindset dimensions described in Table 1. Beyond this, the survey also contains questions on capacities, trust levels, organizations and

**Table 2** Demographic characteristics of survey respondents from the five Urban Labs

| | UL Buenos Aires (N=49) | UL Recife (N=33) | UL León (N=28) | UL Teresina (N=22) | UL Naucalpan (N=21) | Overall (N=153) |
|---|---|---|---|---|---|---|
| **Gender** | | | | | | |
| Man/male | 23 (47%) | 15 (45%) | 13 (59%) | 19 (68%) | 13 (62%) | 83 (54%) |
| Woman/female | 25 (51%) | 18 (55%) | 9 (41%) | 9 (32%) | 8 (38%) | 69 (45%) |
| Other | 1 (2%) | – | – | – | – | 1 (1%) |
| **Age** | | | | | | |
| Mean (SD) | 43.3 (10.7) | 41.8 (11.7) | 38.5 (9.81) | 44.5 (11.6) | 45.3 (9.98) | 42.8 (10.9) |
| **Education** | | | | | | |
| Primary | 3 (6%) | 1 (3%) | – | – | – | 4 (3%) |
| Secondary | 6 (12%) | 2 (6%) | 6 (27%) | – | – | 14 (9%) |
| Bachelor's level | 17 (35%) | 12 (36%) | 10 (45%) | 12 (43%) | 8 (38%) | 59 (39%) |
| Master's level | 17 (35%) | 11 (33%) | 5 (23%) | 10 (36%) | 11 (52%) | 54 (35%) |
| Above master's level | 6 (12%) | 7 (21%) | 1 (5%) | 6 (21%) | 2 (10%) | 22 (14%) |
| **Years lived in city** | | | | | | |
| Less than 1 year | – | 1 (3%) | – | 1 (4%) | – | 2 (1%) |
| Between 1 and 5 years | 4 (8%) | 3 (9%) | 1 (5%) | – | 2 (10%) | 10 (7%) |
| Between 5 and 10 years | – | 1 (3%) | 1 (5%) | 2 (7%) | 2 (10%) | 6 (4%) |
| 10 years or longer | 38 (78%) | 28 (85%) | 20 (91%) | 24 (86%) | 8 (38%) | 118 (77%) |
| **Stakeholder type** | | | | | | |
| Government agency | 18 (37%) | 14 (42%) | 10 (45%) | 9 (32%) | 9 (43%) | 60 (39%) |
| NGO | 7 (14%) | 7 (21%) | 1 (5%) | 5 (18%) | 2 (10%) | 22 (14%) |
| Community associations | 10 (20%) | 3 (9%) | 4 (18%) | 4 (14%) | 6 (29%) | 27 (18%) |
| Research institute | 12 (24%) | 2 (6%) | 3 (14%) | 3 (11%) | 2 (10%) | 22 (14%) |
| Private sector | – | 6 (18%) | 3 (14%) | 5 (18%) | 2 (10%) | 16 (10%) |
| International NGO | – | 1 (3%) | – | – | – | 1 (1%) |
| Donor | 1 (2%) | – | – | – | – | 1 (1%) |
| Media | 1 (2%) | – | – | – | – | 1 (1%) |
| Citizen (non-organized) | – | – | 1 (5%) | 2 (7%) | – | 3 (2%) |

networks that respondents are affiliated with and consider relevant for urban climate governance. However, for the purpose of this analysis, we focus primarily on the survey questions and variables that measure the various mindset-related dimensions. Where relevant, some considerations are made regarding other survey variables. See Electronic Supplementary Material (S1) for the full questionnaire.

To assess respondents' beliefs and emotions regarding climate change, they were asked to rate their agreement with statements that encompassed various aspects of the phenomenon, including their acceptance or denial of climate change, as well as their thoughts about its local and global impact. Responses to such questions were scored based on a 4-point Likert scale, where 1 = "strongly disagree" to 4 = "strongly agree".

Similarly, perceptions were assessed through questions about the importance of climate change, in general and when compared to the problems that respondents identified as most urgent in their city. They were further asked for their level of agreement with statements about the feasibility and compatibility of climate and urban development goals. They were also asked to choose and rank three out of eight items that reflected different perceived barriers for climate action at the city level. Answer options were categorized as either political barriers, economic barriers, technical barriers or social barriers, each corresponding to two statements.

Attitudes were captured by asking respondents to indicate their level of agreement with six statements regarding their satisfaction with government-led climate action and participation in urban planning processes. Another metric for attitudes was based on respondents' ratings of three statements about lifestyle changes—namely, the need for change, the willingness to change and the role of technology.

Values were assessed by asking respondents to rank three different motivational factors for climate action linked to either economic, ecological or social values.

Worldviews were analyzed based on respondents' rating of one statement to assess their openness to change ("Our world works according to ingrained rules and we cannot really do much to change them."), plus eight statements

aimed at capturing the extent to which their worldviews were individualist, hierarchical, communitarian or fatalist:

- Individualist statements: "A free society can only exist by giving companies the opportunity to prosper." and "If a person acquires wealth, that person should have the right to enjoy it the way he or she wants."
- Hierarchical statements: "Guidance and leadership for climate action should mostly come from the government." and "Stricter legislation is necessary to make people behave more climate-friendly."
- Communitarian statements: "Tackling climate change is only possible when many people and organizations work together." and "Community organizations and social movements are important drivers of climate action."
- Fatalist statements: "The future is too uncertain for a person to make serious plans." and "It feels pointless for me to take climate action if no one else does."

Finally, people's behavior was measured using an initial checklist of eight common climate actions comprised of consumer, citizen and organizational behavior, plus a free-text option. This allowed for the creation of a quantitative measure to track respondents' proclivity for climate action, both individual and collective.

## Data analysis

Our study of mindsets follows a two-pronged analytical approach consisting of (1) descriptive statistics pertaining to the mindsets across Urban Labs, including means and frequency tables, which highlight similarities and differences across mindset dimensions in each of the five cities and (2) cluster analysis that traces aggregate patterns in the data to identify different mindset profiles associated with urban sustainability transformation.

Our methodological approach to the task of identifying types of mindsets in the sample is analogous to the statistical problem of grouping observations based on similarities in their variables to find groups with shared traits and characteristics. Therefore, this task is well-suited to the domain of cluster analysis, since it allows us to leverage the structure of the data and group together individuals that exhibit similar response patterns to the survey's mindsets questions.

Prior research indicates that clustering is an effective tool for subgroup analysis and the characterization of common profiles or mindsets within a sample. For example, Barger et al. (2022) use clustering to separate individuals into groups along certain mindset measures to investigate the presence of false growth mindsets among a sample of adults. Similarly, Han et al. (2017) identify different profiles of academic mindsets from a large sample of first-year college students to assess the linkages between academic mindsets

and academic performance. To identify mindsets for urban sustainability transformation in this study, we deploy a form of multivariate cluster analysis—hierarchical clustering on principal components (HCPC)—that combines two standard techniques: principal components (PC) and hierarchical clustering (HC) (c.f. Husson et al. 2010). As such, our methodology follows previous works in this direction for cluster analysis and, in particular, a psychology study by Zheng et al. (2020) that grouped preschoolers into three clusters using HCPC and then characterized development profiles for each cluster.

The applicability of this method to the present case is based on its ability to accommodate key data-related requirements. More specifically, the use of PC-based methods prior to clustering helps to separate meaningful variance from noise in the data, thereby potentially increasing the stability of the cluster solution (Husson et al. 2010). This is important for the current analysis since we utilize a large dataset containing over 40 indicators (see Electronic Supplementary Material, S1). Similar arguments for the use of HCPC relative to other clustering methods have also been presented in previous cases of cluster analysis involving large datasets, for example in social sciences and climate-related research (Argüelles et al. 2014; Praene et al. 2019; Zheng et al. 2020).

However, a point of departure from the aforementioned works is the specific choice of principal components method applied to the data prior to HC. In this regard, our implementation draws on Multiple Factor Analysis (MFA) (Pagès, 2004), which is capable of handling mixed datasets with a group structure—that is, data containing different types of variables (categorical and quantitative) and where each set of variables defines one theme of the questionnaire. In the present study, these themes correspond to the mindset dimensions referenced in Table 1: emotions, beliefs, values, perceptions, attitudes, worldviews and behavior. Therefore, each variable used in the data analysis is grouped under a particular mindset dimension based on the theoretical underpinnings of our paper. We used the MFA function for a direct application of the group structure underlying our mindsets framework to the data analysis. The configuration of this function allowed us to delineate the 44 indicators according to their respective mindset dimension. For example, a total of nine Likert-type indicators used in our survey for measuring worldviews were grouped together and collectively labelled as "worldviews" in the function's configuration. This grouping and labelling process was repeated for all mindset dimensions. The upside of this grouping is that we can estimate the contribution of each dimension as a whole in our factor analysis and retain all indicators present in the survey. As such, all mindset dimensions and associated indicators were included in the cluster analysis.

Finally, HCPC improves the robustness of clustering Likert-type ordinal data through its use of Ward's classification

method in HC. Simulation results from previous studies have indicated that this method produces better results in clustering ordinal data with noisy variables relative to other tested methods (Walesiak and Dudek 2010). R was used to conduct all analysis for this study. Specifically, the implementation of MFA and HCPC algorithms for the current study drew on the *FactoMineR* package.

## Results

### Mindsets across Urban Labs

Overall, answers collected suggest that Urban Lab members across the five cities have mostly similar backgrounds and share some traits related to mindsets. There is substantial alignment across Urban Lab members in terms of their beliefs about climate change being a local phenomenon and their perceptions regarding its importance. For instance, we find that 98% of survey respondents across Argentina, Brazil and Mexico perceive climate change as a problem that is just as, or more, important relative to the most pressing challenges in their city. However, when asked to state the three most pressing problems in their city, 'climate change' was only frequently reported in Buenos Aires. Challenges related to 'transport' and 'inequality' were commonly mentioned across cities, except for León. León is the only case where 'insufficient provision of water' and 'pollution' ranked in the top 3 of most important urban problems. Moreover, survey responses indicated that almost every city has one defining top 3 problem which is not shared with the other cities. For Buenos Aires that is 'lack of green spaces', for Recife it is 'poor sanitation' and in Teresina it relates to 'shortcomings in the education system'. León and Naucalpan, both in Mexico, are the only municipalities where 'insecurity' ranked in the top 3 of urban challenges.

Results from the variance analysis indicate other key sources of mindset variation across Urban Labs, including respondents' emotions toward climate change and their beliefs regarding responsibilities for climate action as well as their climate-related attitudes, worldviews and behavior (see Electronic Supplementary Material, S2). For instance, we observed significant heterogeneity in respondents' emotions, with large variation in climate denial tendencies ($F = 4.48$, $p < 0.01$). Significant variation was also found in terms of respondents' beliefs regarding tackling climate change as the responsibility of the Global North ($F = 3.87$, $p = 0.01$) and their personal responsibility to act on climate change ($F = 2.95$, $p = 0.02$). The Urban Labs also differed significantly in terms of their attitudes—including attitudes toward the participation of local communities ($F = 3.91$, $p < 0.01$) and consideration of researchers' contributions in urban planning ($F = 9.41$, $p < 0.01$).

To identify the sources of this significant variation, we analyzed the relative Urban Lab means for these key mindsets dimensions. For example, regarding emotions and attitudes, respondents in Teresina demonstrated greater climate denial tendencies relative to respondents in Buenos Aires and León and were also less receptive to the participation of local communities and researchers in urban planning. In terms of beliefs about who is responsible for tackling the climate crisis, respondents from León were significantly less likely to view it primarily as the responsibility of the Global North compared to those in Buenos Aires. As an example of variation in worldviews, respondents from Naucalpan showed the lowest support for hierarchical worldviews, particularly when compared to Buenos Aires, Recife and Teresina ($F = 4.33$, $p < 0.01$). Regarding behavior, the average scores on the individual climate action metric were significantly different across Urban Labs ($F = 7.6$, $p < 0.01$), ranging from 2.91 to 4.38, with participants from Teresina and Naucalpan forming the lower and upper bounds for this category, respectively. For the collective climate action metric, we observed similar, significant disparities ($F = 3.63$, $p = 0.01$) in average scores which ranged from 0.76 to 1.62, with the lower and upper bounds formed by Urban Lab members in Recife and Naucalpan, respectively.

Taken together, these findings from descriptive statistics reflect that survey participants generally recognize the importance of climate change, yet there is heterogeneity across Urban Labs in terms of key mindset dimensions as well as the extent of active engagement in climate action. As such, our goal in the proceeding cluster analysis is to explore any aggregate structure associated with this heterogeneity and, in doing so, to establish whether different types of mindsets for urban sustainability transformation exist within the five Urban Labs.

### Mindset-based personas

Under the HCPC methodology, the computation of clusters follows after the data is pre-processed using MFA and involves two significant parameterizations, namely the numbers of factors to retain from the MFA and the number of clusters to find in hierarchical clustering (see support graphs in Electronic Supplementary Material, S3). First, the number of factors were set to six based on the parallel analysis method and visual inspection of factors' scree plot of eigenvalues (c.f. Ruscio and Roche 2012). When applied to the current dataset, this method indicated a total of six factors that explain 18.3% of the cumulative sample variance (see Table 3). The variance is relatively low, which was expected given the relative homogeneity of our non-randomized sample and the fact that our data consists largely of 4-point Likert-type items, which naturally limits variation in responses.

**Table 3** Percentage contribution of mindset dimensions to each of the six identified factors and sample variance explained by each factor
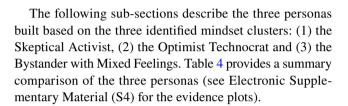
| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Average contribution |
|---|---|---|---|---|---|---|---|
| Beliefs | 9.21 | 4.73 | 3.18 | 29.12 | 3.56 | 6.59 | 9.40 |
| Emotions | 21.82 | 4.01 | 3.43 | 0.94 | 0.39 | 3.64 | 5.71 |
| Perceptions (quantitative) | 7.14 | 15.29 | 17.24 | 4.63 | 1.06 | 1.65 | 7.84 |
| Perceptions (categorical) | 16.88 | 24.2 | 25.44 | 34.42 | 43.61 | 42.73 | 31.21 |
| Attitudes | 7.16 | 29.07 | 1.41 | 1.92 | 3.99 | 0.54 | 7.35 |
| Values | 9.02 | 4.38 | 23.92 | 19.93 | 37.09 | 23.83 | 19.70 |
| Worldviews | 18.81 | 10.26 | 10.28 | 9.04 | 5.18 | 17.28 | 11.81 |
| Behavior | 9.97 | 8.05 | 15.09 | 0 | 5.12 | 3.74 | 7.00 |
| Total contribution | 4.47 | 3.23 | 3.09 | 2.84 | 2.41 | 2.22 | |

The first factor is the largest, explaining 4.47% of the overall sample variation, whereas the other five factors explain between 2.22 and 3.23% of the sample variance. Emotions toward climate change make the largest contribution to the first factor, although they have relatively lower influence on the remaining five factors. Perceptions, particularly the categorical variables that measure the most important urban problems and barriers to climate action, tend to make the largest contribution to the different factors.

After computing these factors, we used an inertia graph to determine the number of clusters to form (also available in Electronic Supplementary Material, S3). This graph plots cluster variances as a function of the number of clusters $k$ and we subsequently identified the elbow point to occur when $k = 3$ (c.f. Zheng et al. 2020). After this value, the drop-off decreased substantially, suggesting that a 3-cluster based solution is the best fit for the dataset and so this was set as the optimal number of clusters for the proceeding analysis. As a result, we obtained three mindset clusters from the sample of 153 total observations, with a visual representation of these clusters provided in Fig. 1.

Finally, we linked each cluster back to the demographic, capacity, trust and network components of our survey data, which form the basis of our cluster profiles, referred to as personas. These personas are fictional characters that represent different groups of individuals with defining mindsets, demographic characteristics, capacities, trust levels and network features. They allow us to better understand Urban Lab members and identify opportunities and approaches for mindset shifts.

The three-cluster solution separates the survey participants into clusters 1, 2 and 3, containing 59, 61 and 33 individuals respectively. A comparison of the resulting mindset clusters highlights key differentiating trends in a sample that otherwise shares several commonalities. Based on the cluster distinctions, we define three types of mindset profiles associated with the Urban Labs featured in this study.

The following sub-sections describe the three personas built based on the three identified mindset clusters: (1) the Skeptical Activist, (2) the Optimist Technocrat and (3) the Bystander with Mixed Feelings. Table 4 provides a summary comparison of the three personas (see Electronic Supplementary Material (S4) for the evidence plots).
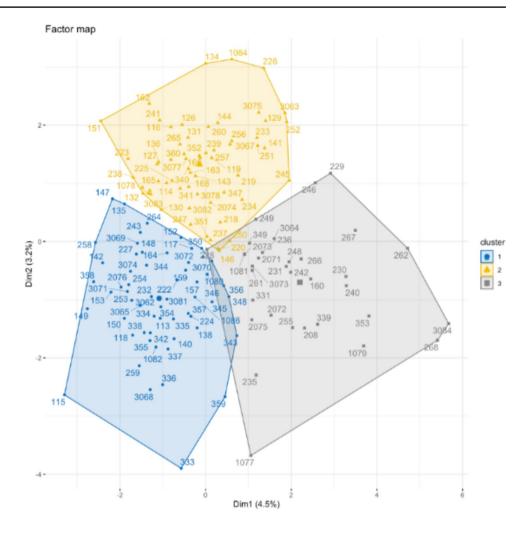
### The Skeptical Activist

The Skeptical Activist is characterized by strong communitarian worldviews and shows the highest resistance to hierarchical and individualist worldviews among the three personas (see Table 4). In particular, there is less emphasis on top-down governance, as only 44% agree that guidance and leadership regarding climate action should mostly come from the government (compared to 77% and 70% for the Optimist Technocrat and the Bystander with Mixed Feelings, respectively). Out of the three personas, the Skeptical Activist displays the lowest levels of trust in the city administration. Moreover, this persona expresses very high dissatisfaction with government-led climate (in)action and the (lack of) openness of planning processes and decisions in their city. The Skeptical Activist identifies political barriers, namely political unwillingness and different political priorities, as the largest barriers for climate action at the city level.

The name 'Skeptical Activist' reflects their relatively high skepticism (compared to the other personas) regarding the feasibility of decarbonization goals and their compatibility with urban development. This persona also largely rejects technocratic approaches to addressing climate change, instead fully recognizing the need for individuals to alter their lifestyle and behavior to tackle this crisis. The Skeptical Activist, as the name also implies, is thus a climate action leader, recording the highest average climate action score amongst all three personas. Their motivation for action is rooted in a combination of social and ecological values. The Skeptical Activist reports the greatest number of horizontal linkages, indicating high levels of organizational

**Fig. 1** Cluster representation in a factor map



collaboration in their climate action efforts. This may explain why the Skeptical Activist records the highest self-perceived organizational capacity to work on climate change and organizational power to influence climate-related decisions.

## The Optimist Technocrat

The Optimist Technocrat is distinguished from the other personas by their stronger hierarchical worldviews, prioritization of social values and a much more positive attitude toward the work of the municipal government and the openness of urban planning processes. Satisfaction with climate action by the city government is also significantly higher for this persona (see Table 4). The Optimist Technocrat identifies economic barriers, namely economic interests and lack of finances, as the primary obstacles to climate action, whereas the other two personas both point to political barriers as the main hindrances.

In general, this persona acknowledges climate change as an important local issue but is not entirely convinced about their personal or local responsibility toward it. However, as

implied by the name, the Optimist Technocrat displays a highly optimistic attitude toward the possibility of reducing emissions while simultaneously pursuing urban development and addressing poverty and inequality. The second part of the name reflects their tendencies toward technocratic or business-as-usual attitudes. Approximately 64% agree that a free society can only exist by giving companies the opportunity to prosper and 27% rely on new technology to address climate change without lifestyle changes.

Government agencies are most commonly associated with the Optimist Technocrat, comprising 64% of the overall stakeholder distribution for this persona. This partly explains the notably favorable views regarding government-led climate action and their high perceived ability to influence others. This persona reports the highest level of interactions with researchers and possesses strong self-perceived knowledge about climate change.

## The Bystander with Mixed Feelings

The Bystander with Mixed Feelings exhibits diverse worldviews, which justifies their name. This persona shows the

**Table 4** Summary comparison of personas highlighting key mindset traits, trust levels, capacities, organizational network features and demographic characteristics

|  | The Skeptical Activist | The Optimist Technocrat | The Bystander with Mixed Feelings |
|---|---|---|---|
| **Mindsets** |  |  |  |
| *Beliefs* |  |  |  |
| Distant phenomenon | 12% | 8% | 29% |
| Responsibility | Personal (97%) | Personal (95%) | Personal (100%) |
|  | Local (100%) | Local (92%) | Local (97%) |
| *Emotions* |  |  |  |
| Denial | 2% | 0% | 27% |
| *Perceptions (goals)* |  |  |  |
| Feasibility of zero carbon goal | 63% | 67% | 70% |
| Compatibility between urban development goals and decarbonization | 89% | 98% | 90% |
| *Perceptions (barriers)* |  |  |  |
| Political | 38% | 30% | 41% |
| Economic | 36% | 39% | 26% |
| Technical | 13% | 12% | 20% |
| Social | 13% | 18% | 13% |
| *Attitudes* |  |  |  |
| Satisfaction with government-led climate action | 12% | 72% | 26% |
| Support for participation of local communities and researchers in decision-making processes | 100% | 100% | 93% |
| New technology will address climate change without lifestyle changes | 12% | 27% | 39% |
| *Values* |  |  |  |
| Social | 39% | 39% | 32% |
| Ecological | 38% | 38% | 41% |
| Economic | 23% | 22% | 28% |
| *Worldviews* |  |  |  |
| Communitarian | 94% | 98% | 94% |
| Hierarchical | 60% | 83% | 79% |
| Individualist | 36% | 49% | 57% |
| Fatalist | 12% | 3% | 23% |
| Growth mindset (i.e. openness to change) | 90% | 95% | 79% |
| *Behavior* |  |  |  |
| Climate action metric (average total) | 6.3 | 4.2 | 4.1 |
| **Trust** |  |  |  |
| In city administration | 53% | 70% | 76% |
| In NGOs | 34% | 92% | 67% |
| In community associations | 93% | 88% | 85% |
| In research institutes | 97% | 98% | 91% |
| **Capacity** |  |  |  |
| Ability to influence others | 64% | 74% | 73% |
| Knowledge to act | 75% | 75% | 52% |
| **Organizations and networks** |  |  |  |
| Horizontal linkages (mean) | 3.19 | 3.06 | 2.47 |
| Organizational capacity | 86% | 82% | 76% |
| Organizational power | 19% | 15% | 6% |
| **Demographics** |  |  |  |
| *Urban Lab representation* |  |  |  |
| UL Buenos Aires | 34% | 41% | 12% |

**Table 4** (continued)

| | The Skeptical Activist | The Optimist Technocrat | The Bystander with Mixed Feelings |
|---|---|---|---|
| UL Recife | 14% | 26% | 27% |
| UL Teresina | 5% | 10% | 39% |
| UL León | 27% | 16% | 6% |
| UL Naucalpan | 20% | 7% | 15% |
| *Main stakeholder types* | | | |
| Government agency | 19% | 64% | 30% |
| NGO | 27% | 8% | - |
| Community association | 24% | - | 30% |
| Research institute | 17% | 16% | - |
| Private sector | 10% | - | 24% |
| *Education* | | | |
| Bachelor's level or above | 95% | 83% | 67% |

lowest level of openness to change and displays a notable presence of fatalist worldviews (see Table 4). The uncertainty embodied in these fatalist worldviews is also reflected along the climate denial metric, with 27% feeling that the threat of climate change has been exaggerated. Additionally, beliefs about climate change being a distant problem, both temporally and geographically, are more prevalent among the Bystander with Mixed Feelings compared to the other personas. This persona also expresses some hesitation regarding the participation of researchers and local communities in urban planning processes and decisions.

Ecological values rank as the primary motivation for climate action among the Bystander with Mixed Feelings, but, as implied by the name, they score the lowest on the climate action indicator. This could be, at least partly, attributed to their limited knowledge about climate change, lower organizational capacity and power to act, lower levels of education and smaller organizational networks in comparison to the other personas. However, the Bystander with Mixed Feelings demonstrates the greatest acknowledgement of personal responsibility to do more regarding climate change, indicating the potential to empower this persona to adopt a more proactive role in addressing climate change.

Table 4 shows that the most common persona in our sample is the Optimist Technocrat, accounting for 40% of all survey participants. A large share of these individuals (26%) hold positions within government agencies. The majority of Optimist Technocrats are based in Buenos Aires (41%) or Recife (26%). Skeptical Activists constitute over 38% of survey respondents, with a high concentration in Buenos Aires (34%), León (27%) and Naucalpan (20%). The distribution of stakeholder types embodying this persona primarily consists of NGOs and community associations (51%), followed by government agencies (19%) and research institutes (17%). Finally, the Bystander with Mixed Feelings is the least frequent persona in our study, representing 22% of the participants. This persona is predominantly found in Brazilian Urban Labs, specifically in Teresina (39%) and Recife (27%). Representatives from community associations (30%), government agencies (30%) and the private sector (24%) make up the majority of Bystanders with Mixed Feelings.

## Discussion

The article aimed to identify and describe the mindsets of different stakeholders involved in sustainability transformations within Urban Labs, deepen our understanding of the dynamics of urban climate governance and evaluate the validity of claims found in literature regarding the need for mindset shifts. Part of the novelty is in our conceptualization and operationalization of 'mindsets' as a more holistic term covering emotions, beliefs, perceptions, attitudes, values and worldviews, and closely linked to behavior. The transdisciplinary nature of our study allowed us to bring together various fragmented understandings of the mindsets concept as well as associated theories and methods that were found scattered across disciplines. This article thus provides a robust and cohesive foundation to ensure that mindsets research is done more systematically in the future.

The personas resulting from the application of our multi-dimensional mindsets approach also represent an innovative heuristic device deriving from this study, highlighting unique characteristics as well as shared attributes. Differences and commonalities among these personas can guide targeted strategies for mindset shifts, climate action and sustainability transformations in Urban Labs.

All three personas, representing all individuals participating in five Urban Labs in Argentina, Brazil and Mexico, generally acknowledge the importance of climate change.

This seems to corroborate research by Steg (2023) who found increasingly generalized beliefs globally about climate change being an important issue. However, Urban Lab members do not consistently perceive climate change as a top priority in their cities, especially when compared to local challenges related to water provision, sanitation, mobility, education, inequality and insecurity (see "Mindsets across Urban Labs"). Additionally, some individuals, particularly the Bystanders with Mixed Feelings, still show inclinations toward climate denial, highlighting critical opportunities for mindset shifts ("The Bystander with Mixed Feelings"). These discoveries emphasize the need for further research in low- and middle-income countries, including in Brazil where the Bystander with Mixed Feelings is particularly prevalent, to assess the contextual factors at play. It also underscores the critical importance of the wording in survey questions, as asking directly 'how important is the problem of climate change in the city?' yielded slightly contrasting results to asking 'what are the three most important problems that the city is facing today?'.

Existing research also suggests that people worldwide generally endorse ecological values but the presence of these values is not always a predictor of climate action (Bouman et al. 2018; Steg 2023). Our findings, particularly regarding the Bystander with Mixed Feelings, confirm this argument. Despite having the highest endorsement for ecological values, this persona ranks the lowest on the climate action indicator. As Bouman et al. (2018, p. 103) explain, 'personal values are at the very start of a chain to climate action' and multiple variables in between can be influenced by external factors, leading individuals to not always act in alignment with their ecological values. We hypothesize that the Bystander with Mixed Feelings' limited knowledge about climate change may, at least partly, contribute to this misalignment (c.f. Bouman et al. 2018; Shi et al. 2016). Steg (2023) too emphasized the significance of knowledge in cases where individuals are uncertain about which actions would support or threaten their ecological values. However, she found that knowledge alone is insufficient to foster climate action if individuals lack the intrinsic motivation to engage. The Bystander with Mixed Feelings' acknowledgement of personal responsibility provides a solid foundation for devising and implementing a mindset shift strategy. This strategy could be centered on education and capacity building to address knowledge gaps and misconceptions and empower individuals to act on their ecological values and effectively engage in climate action (c.f. O'Brien and Sygna 2013; Wamsler et al. 2020; Woiwode et al. 2021).

Despite the large representation of government agencies in the Optimist Technocrat persona, this type of stakeholders is also represented in the other two personas, indicating high heterogeneity in mindsets within these agencies. Community associations, NGOs, research institutes and the private sector are distributed across two personas each, suggesting a moderate degree of variation in mindsets within these organizational types. This highlights variation both across and within different types of organizations. Likewise, despite the patterns identified previously, each persona exists in every Urban Lab to some extent.

Having the three personas working together in the Urban Labs holds great potential for facilitating mindset shifts too. For example, the Skeptical Activist is less sure than the Optimist Technocrat and the Bystander with Mixed Feelings about the feasibility of decarbonization goals and their compatibility with urban development. Collaboration with individuals with a more positive outlook could help alleviate skepticism and foster collective climate action (c.f. Wamsler et al. 2022). The Bystander with Mixed Feelings, who is less convinced about participatory governance, can experience firsthand the benefits of such approaches in terms of inclusivity and innovation (c.f. Ely et al. 2020). Both the Optimist Technocrat and the Bystander with Mixed Feelings display reservations toward lifestyle changes, when compared to the Skeptical Activist. Prior empirical research suggests that fostering collective agency or identity can effectively counteract individual resistances to changing the status quo (c.f. Charli-Joseph et al. 2023; Kok et al. 2023; Page et al. 2016). Moreover, collaboration could enable trust-building among the different personas, thereby contributing to expanding networks and boost collective power to address climate change in transformative ways (c.f. Kok et al. 2023).

Urban Labs lend themselves particularly well to testing the proposed mindset shift strategies given that they entail real-world experimentation by a diverse range of stakeholders and have shown to be effective for inter alia, building trust, co-developing innovative solutions, facilitating knowledge and capacity sharing, learning by doing and empowering marginalized and disadvantaged communities (Charli-Joseph et al. 2023; Kok et al. 2023; Nevens et al. 2013; Ziervogel et al. 2021). Furthermore, Urban Labs cater to the need for longitudinal research to track mindset shifts over time and evaluate the efficacy of these strategies (Dweck and Yeager 2019). This area represents a promising avenue for further research given the largely untapped potential of Urban Labs to trigger mindset shifts and scarce studies on their impact on mindsets.

Future research could also address the limitations of our study. The relatively low number of survey respondents and many variables investigated mean that this study should be seen as exploratory. HCPC is itself part of the exploratory data analysis branch in statistics. The relatively low level of variance explained by the identified factors underlying HCPC also warrants discussion. To address this issue and potentially improve HCPC performance, variable selection could be conducted prior to the application of MFA. However, it may be challenging to strike a balance between

explained variance and consistency with our multi-dimensional mindsets framework. We face a delicate trade-off when discarding mindset variables or dimensions through prior variable selection, potentially compromising the theoretical structure underlying the data analysis. Furthermore, the fact that we consider a non-randomized population may disguise different mindsets and personas, also affecting the study's explanatory potential. The resulting mindsets and personas may be influenced by several factors, including the specific contexts of the Urban Labs or cities under investigation, the selection of participants represented in each case, or a combination of these factors. We must also recognize the potential demographic bias in our sample, where the majority of Urban Lab members are highly educated and climate-conscious. Nevertheless, the fact that Urban Labs in different cities and countries are analyzed together bolsters the argument that the described mindsets and personas are likely to be present elsewhere. We do not claim the universal applicability of our results, but rather posit that the general coherence observed across diverse settings could be an indicator of regional mindset trends.

## Conclusions

Urban sustainability transformations are urgently needed to tackle intricate and interrelated challenges such as climate change and development. To accomplish this, many scholars advocate for fundamentally 'new' mindsets. Nevertheless, it is often unclear what the 'old' mindsets are, how they can be shifted to accelerate these transformations and under which conditions.

This article addressed the first gap by proposing a novel conceptual and analytical framework to identify mindsets for urban sustainability transformation. We applied this framework to five Urban Labs in Argentina, Brazil and Mexico to illustrate how urban sustainability transformation efforts can incorporate and benefit from assessments of individual mindsets and behavior. The resulting personas revealed both commonalities and variations in mindsets among Urban Lab participants in different cities, offering valuable insights into the complex dynamics of urban climate governance.

Our findings emphasized the need for developing tailored strategies to engage stakeholders in participatory governance spaces, trigger mindset shifts, foster climate action and accelerate transformations toward more just and sustainable cities. While we discussed a few of these strategies, further research is required to explore the specific conditions that enable mindset shifts in diverse local contexts, particularly in low- and middle-income countries.

As spaces where policymakers work alongside diverse community groups, Urban Labs offer a promising environment for testing, evaluating and scaling the proposed mindset shift strategies. In doing so, they can shed light on how changes in individuals' 'inner' dimensions interact with interventions in other leverage points, including governance reforms, to address the root causes of unsustainability and foster systemic transformations. Our findings pave the way for such investigations and can guide the design and implementation of climate policies and initiatives that are inclusive and responsive to the needs, concerns and priorities of local actors.

## Declarations

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