

LIFE-CENTERED DESIGN AND INTERSECTIONALITY: CITIZEN SCIENCE AND DATA VISUALIZATION AS ENTRY POINTS

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Abstract

Europe is calling for an ecological transition (Dewberry, 2018; Boehnert, 2019) able to influence social groups and territories. Life-centered approach is an ethical framework in which life is the ultimate source of value (Orr, 2006) in a process that includes both digital and physical components, social justice and environmental outcomes. Life-centered design is considered by the authors as an approach related to posthuman design (Forlano, 2017) which investigates overcoming the centrality of “humanity” starting, mainly, from two points:

- The concept of the Anthropocene leads us to reconsider the nature/culture duality. Some theoretical frameworks, such as critical posthumanism (Braidotti, 2013), propose an alignment of those concepts in a cooperative perspective.
- Since the Enlightenment, *humanity* has referred to humans that often present the same characteristics (Western, white, male, etc.) (Braidotti, 2019). The progressive diffusion of inclusive development frameworks pushes us to rethink this model, assuming diversity as a key element.

On this pathway towards a just transition, design is a field that involves humans acting as aggregators of creative practices and facilitating the coevolution of socio-technical aspects of transition phenomena (Geels, 2005). This coevolution is supported by an impulse that comes from the use of data collection techniques for citizen science. Digital tools, such as cheap sensors, are considered non-human actors which can act as mediators (Latour, 2005), affording new ways of social mobilization around knowledge and feeding new epistemologies in citizen science. Life-centered design could integrate different forms of collaborative action with a focus on the design of the “possible” and with emphasis on the responsibility of design (Lotti, 1998; Thackara, 2005). In this process, technologies are at the service of the inclusive socio-economic components, with direct results in new

languages of ethical and free-of-bias relationships (Portugali et al., 2012). The aim of this paper is to outline life-centered design through data visualization and citizen science initiatives carried out by the research group in order to activate an intersectional perspective in relation to climate citizens. The objectives of this research are:

- To increase diversity and intensity of participation through an intersectional approach.
- To address socio-technical aspects of climate change problems through the co-design of accessible tools.
- To reduce distance between citizens and academia through tailored communication.

Research communication should clarify the implications for individuals who identify themselves in diversified socio-cultural categories (such as age, gender, sexual orientation, education, ethnicity, ability) in order to favor equal participation (Lakomý et al., 2020). Several gaps in this communication process must be considered: cognitive biases, especially in the social network society (Lauwereyns, 2011); data overexposure and "spectacularization"; data extractive approaches and behavioral economy; and the complex perception/reality relationship. Paradigms of this communication will be identified in order to understand which roles and responsibilities of the different target groups influence their ability to deal with climate change challenges.

Author Keywords

Citizen science; design; life-centered; just transition; data communication.

Citizen Science and Data Visualization: Processes in Coevolution

Europe is calling for an ecological transition (Dewberry, 2018; Boehnert, 2019) able to influence social groups and territories. Life-centered approach is an ethical framework in which life is the ultimate source of value (Orr, 2006) in a process that includes both digital and physical components, social justice and environmental outcomes. Contemporary global challenges (Gaziulusoy & Öztekin, 2019) are raising a design debate around the prototyping of new forms of collaboration for a systemic reaction to the climate crisis (Irwin, 2015; Tonkinwise, 2015; Fuad-Luke, 2009). Life-centered design is considered by the authors as an approach of design cultures and practice related to posthuman design (Forlano, 2017) which deals with global challenges and wicked problems by overcoming the concept of "human-centered" in favor of facilitating the construction of new relationships between multi-actor assemblages and the environment inhabited by them. Starting in the 1980s, design practices and studies have seen a change in their research objectives coinciding with the diffusion of user-centered and human-centered approaches. In that case, the main object became the individuation of "design problems" starting with user (then human) needs. Human-centered approaches, even if they may appear more "inclusive" than functionality-led processes, started becoming unable to deal with global crises as long as they are caused by "man" and "anthropo" centric ways of acting (Braidotti, 2019). The core of user or human-centered approaches of design is that a plurality of perspectives is included in the design process by using specific methodologies that have been developed in the disciplinary context (such as design thinking).

One of the critiques that may be made of this kind of approach is that including a plurality of (user) viewpoints does not necessarily lead to plurality (or diversity) as long as the people involved in the process present similar needs due to similar characteristics in the ways in which they live. In this paper, we are assuming that the humancentric (mancentric) vision that has been a pervasive perspective since the Enlightenment and the anthropocentric vision (i.e. considering humans supreme with regard to other species) have contributed to contemporary social and climate crises and since design cultures have seen an increasingly important role in facing systemic and wicked problems (Tonkinwise, 2015), this is a matter of design. The diffusion of the concept of the Anthropocene (and/or Capitalocene) leads us to reconsider the relationship of nature and culture no longer as a duality but as a continuum (from nature/culture to natureculture) (Braidotti, 2019). This has opened debate in various fields such as humanities around the necessity of reframing the relationship between humans (and human actions) and "natural" ecosystems. Concerning design cultures, this debate has seen a growing importance regarding three aspects:

- Some theoretical positions, such as critical posthumanism (Braidotti, 2013), propose an alignment of culture (humans) and nature (non-humans) in a cooperative perspective.
- Some theoretical frameworks invite us to consider artifacts (objects) as actors able to influence knowledge transfer processes (Latour, 2005).
- Feminist studies invite us to deal with global crises also by rethinking the concept of "humanity," assuming diversity as a key element and proposing more inclusive² development frameworks, both with regard to creating new relations between humans and machines (Haraway, 1991) and with regard to creating alliances with other species towards ecological justice for all (Balzano et al., 2022; Figueres & Rivett-Carnac, 2020; Escobar, 2018; Light et al., 2017).

On this pathway towards ecological transition, design is a field that involves humans acting as an aggregator of creative practices and facilitating the coevolution of socio-technical aspects of transition phenomena (Geels, 2005). This coevolution is supported by an impulse that comes from the use of data collection and data visualization techniques for citizen science.

The term citizen science (CS) refers to scientific research processes involving the participation of citizens and non-specialized actors in one or more stages (ECSA, 2015). The practice has seen growing popularity, both from an institutional point of view, i.e. becoming an element of interest within national and European funding programs and, from the point of view of participants, due to the spread of online platforms and tools – such as Zooniverse, which has more than 50 CS projects and 2.4 million users³ – that are able to create a link between the academy and non-specialized actors. Those platforms usually support participatory data collection by giving tools for sharing data with academia or the research group that organizes a CS project and providing resources or indications in order to favor the collection of reliable data from a scientific perspective. Among the main critiques that can be made of this model – which is relevant for the purposes of this paper – is the fact that these processes generally favor the participation of individuals with similar characteristics: generally male, highly educated or otherwise already interested

in scientific subjects (Khairunnisa et al., 2021; Lakomý et al., 2020; Raddick et al., 2013). In order to improve the participation of a more diversified public in those kinds of processes which enable participants to achieve new skills and knowledge, more accessible data collection devices should be used on the one hand, and, on the other, more inclusive scientific communication should be designed.

Regarding the devices to be used, they should be designed with attention to accessibility and the diversification of the public that will use them in order to favor a data collection process enabled by an intersectional perspective (D'Ignazio & Klein, 2020). Regarding communication between academia and citizens, data visualization (DV) practices may be used as a channel to favor the diffusion and the critical elaboration of collected data. Science and publishing have used data visualization as a communication tool for hundreds of years to enable the study of complex phenomena and make large streams of information accessible to different actors, from institutions to citizens. A selection of data-driven graphical elaborations, still used as models today as described below, has been diffused mainly driven by two needs: knowledge and emergency. The need for knowledge gave rise to visualizations with the aim of analyzing and understanding phenomena relating to large-scale problems, which often led to important discoveries such as Galton's weather charts in 1861 (Figure 1), which enabled the discovery of anti-cyclonic movement of wind around low-pressure areas. On the other hand, the use of data visualization as an enabler for understanding, and sometimes solving, urgent social, health and economic crisis and emergencies assumes the role of civic tool, as in the case of John Snow's cholera map or Florence Nightingale's coxcomb diagrams which allowed them to save lives during health emergencies.

Looking at the history of data visualization, there are also attempts at being a medium for dissemination to citizens as in 1913 in New York (Figure 2). For statistical exhibits in the municipal parade, the employees of the city of New York, and "the Health Department, in particular, made excellent use of graphic methods, showing in most convincing manner how the death rate is being reduced by modern methods of sanitation and nursing" (Brinton, 1914).

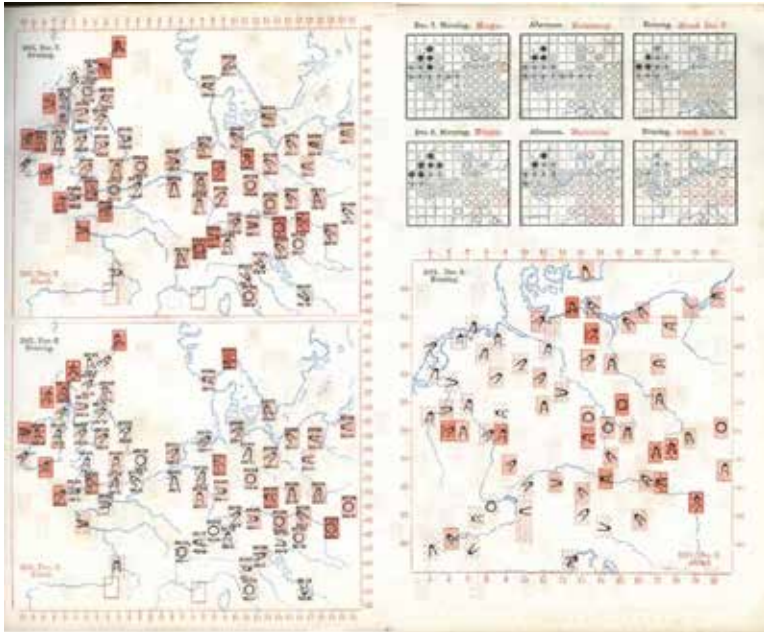


Figure 1. Early example of data visualization: weather maps by Francis Galton, 1861.



Figure 2. Photo from The Statistical Exhibits in the Municipal Parade by the Employees of the City of New York, May 17, 1913.

Although data visualization acquired more of an infotainment role (Holmes, 1984) in the 1970s in parallel with the information age – when it went from being an awareness-raising tool to purely aesthetic entertainment (Tufte, 1990) – with the recent Covid-19 pandemic, it may regain its function as an awareness-raising and emergency communication tool. Another phase regarding data visualization that gained relevance between the information age and the Covid-19 period is the so-called social network society, during which the advent of social media in the early 2000s completely revolutionized socio-economic structures. Digital devices such as smartphones have become an extension of the human world (McLuhan & Laphalm, 1967). Humans act on social networks about six hours per day (Starri, 2022), turning the digital social network environment into a place where we actually live as in real life.

All types of information today are influenced by social networks, which are nowadays a major channel for disseminating news and results and a medium of mass communication towards users and citizens. However, social networks are only a limited-explored field in the disciplinary history of data visualization.

In the area of data visualization for climate citizens, we report two examples:

- With the aim of increasing the effectiveness of communication to target communities, Will Media Italia⁴ is a news channel that uses social media to report on “the changing world,” often addressing major world issues such as climate change, with 1.3 million followers aged between 18 and 45.⁵ Will Media Italia does not make a copy/paste of data visualizations for print media, but builds user experiences tailored to the space and time of the social media, exploiting, for example, the carousel tool of Instagram to gradually unveil the information according to precise storytelling and graphic design values applied to the construction of the message and the accompanying data visualization.
- Considering social media as an awareness-raising tool, the famous data visualization gif/video *The Climate Spiral* (2016)⁶ (Figure 3) spread around the world and was nominated that same year for the prestigious *Kantar Information is Beautiful Awards*. Ed Hawkins, the British scientist who authored the visualization, posted his work on Twitter on 9 May, 2016 and it reached 3.4 million views in its first year. The animated DV shows the rise in temperatures from 1850 to 2017. The success of the visualization lies, as in the case of Will Media Italia, in finding the right way to exploit social network dynamics to spread a message while respecting the above-mentioned principles of user space and time and the principles of adaptability of the project according to the dynamics and characteristics of the selected social platform.

Intersectional Framework for Life-Centered and Responsible Design

Life-centered design could integrate different forms of collaborative action, with a focus on the design of the “possible” and with emphasis on the responsibility of design (Lotti, 1998; Thackara, 2005) through the improvement of the human-centered design approach considering the “life” centrality. The close relationship between design culture, studies and practices and research and responsible innovation (RRI)⁷ is increasingly acquiring

significance for science, technology, innovation policy and research and innovation practices (Succini et al., 2021). It offers forward-looking approaches and methods for reflecting on societal impacts, with a focus on participatory research and innovation aspects (Owen et al., 2012; Uyarra et al., 2019). The European Commission included sustainability as a key area for stakeholder dialog in the RRI agenda at a later stage, which has resulted in the underdevelopment of the operationalization of environmental concerns – and more particularly climate change – in the set of tools available for RRI. The six RRI key areas for dialog with stakeholders include: (i) public engagement; (ii) gender equality; (iii) science education; (iv) open access; (v) ethics; and (vi) governance. Lately, two more areas were added: sustainability (environmental) and social justice (Ligardo-Herrera, 2018; Carbajo & Cabeza, 2019).

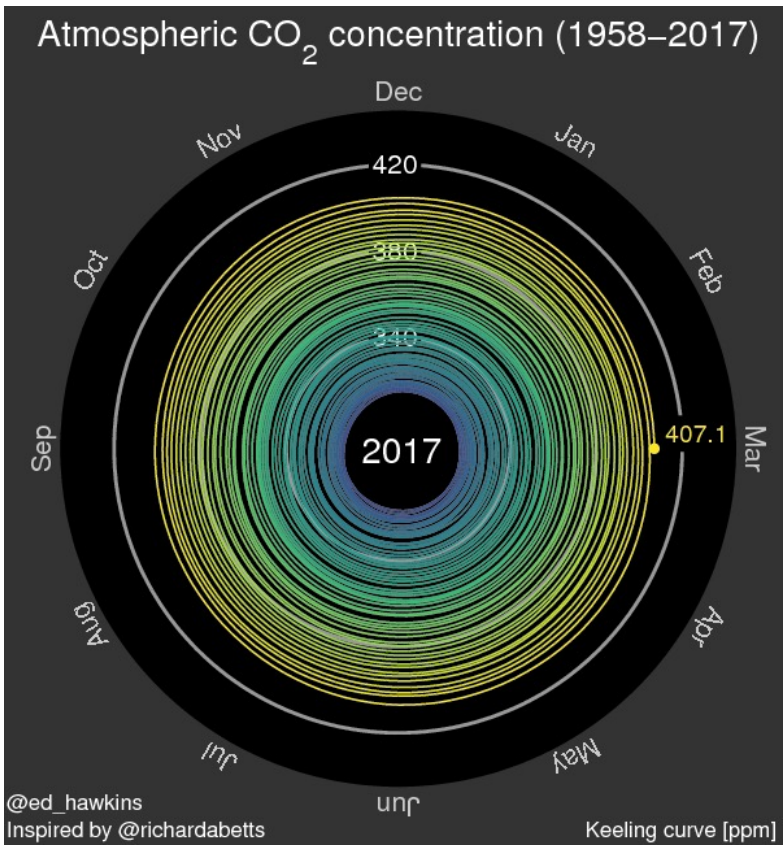


Figure 3. A frame extracted from the animated data visualization *The Climate Spiral* by Ed Hawkins (2016).

Natural hazards and the influence of climate change produce distinct exposures, sensitivities and adaptive capacities (Thompson-Hall et al., 2016) based on the intersection between existing inequalities determined, for example, by social dimensions of gender and identity

and the different ecological, economic and climate contexts, providing evidence that the greatest level of risk is often related to high inequality and barriers to accessing people's rights in their everyday life. This evidence is taken into account by climate and disaster risk reduction research, policy and programming with specific focus on vulnerable and marginalized groups (people with disabilities, women, children, older persons, minority and Indigenous groups, LGBTQIA+, people with chronic health conditions and others who are contextually marginalized), but they are usually considered as a collective category or separately as specific groups of people.

A paradigm shift is needed to let the value of intersectional approaches emerge and to recognize that groups of people who experience marginalization have different identities, needs and priorities. Moreover, to support vulnerability reduction, it is necessary to take complex contextual realities into account and understand intra-group differences and the existence of multiple axes of identity that govern an individual's or group's relationship to power (Osborne, 2015).

Intersectionality is assumed to be a theoretical framework to guide the participatory methodologies in citizen science processes and data collection, interpretation and visualization. Starting from this assumption, our research group is designing methods, tools and technologies that address challenges faced by underserved communities in a process of adaptation able to intercept the complexities (context conditions, power relations, resources) that impact participants' ability to be engaged as active partners in inclusive participatory design and citizen science process. Participatory design methods (workshops, do-it-yourself, crowdsensing and crowdsourcing, etc.) with a special focus on climate change seek to engage participants in the research and design process as co-researchers, but there are still challenges and gaps in fostering agency among members in underserved communities. The creation of situated knowledge and located accountabilities allows for the collection of alternative viewpoints, agency and questions of how knowledge is produced, by whom and under what conditions (Suchman, 2002).

Intersectionality supports a paradigm shift, moving from the description of the unique experiences of a singular master social group or subgroup (Hancock, 2007) to examine the fluidity, variability and temporality of interactive processes generated between and within multiple social groups, institutions and social practices (Few-Demo, 2014).

There is increasing recognition that the term "intersectionality" was popularized by law professor Kimberlé Crenshaw in her 1991 article "Mapping the Margins" (Mays & Ghavami, 2018), supported by Collins's (1999) strengthening of the concept throughout the 1990s. During that time, social sciences especially investigated the ways social categories combine at various developmental stages to shape outcomes directly influenced by the context of power, privilege and disadvantage (Del Toro & Yoshikawa, 2016; Ghavami et al., 2016). All these considerations provide important insights into the design and co-design processes for the development and experience of usable products, buildings and systems, assessing the role they play in people's lives.

Responsible design is nourished by the complexity that arises when the subject of analysis expands to include multiple dimensions of social and ecological life, improving the categories of analysis. In particular, reflexivity, one of the RRI pillars (Stilgoe & Guston, 2017)

revolves around the role of design, stimulating new reflections from a thematic point of view about tools, processes and methodologies (the convergence of design methods and future-focused thinking), of transformative value (the co-generation of futures and participation in the construction of collective futures) for a life-centered approach that encouraged negotiations of roles, goals, and technology.

In this process, technologies, especially the ones related to data gathering and visualization, are at the service of the inclusive socio-economic components, with direct results in new languages of ethical and bias-free relationships (Portugali et al., 2012).

Methods and Practices for Diversity and Inclusion

The aim of this paper is to outline life-centered responsible design through data visualization and citizen science initiatives carried out by the research group in order to activate an intersectional perspective in relation to climate citizens:

- To increase diversity and intensity in participation through an intersectional approach. The proposed research lines aim to extend beyond the gender-specific and empowering categories of social identity (youth, old age, disabilities, non-heteronormative sexualities, minority ethnicities, income, religion and more) an intersectional perspective with a focus on a variety of multi-level interacting social forces, narratives, norms, factors and power structures that shape and influence the life of climate citizens. To address the coevolution process mentioned above, the research unit is working on the update and cross-fertilization of participatory practices and methods, assuming intersectionality as an innovative design framework. This has the potential to advance understanding of, and action on, inequalities by highlighting processes of stigmatization, but mainly to encourage a critical reflection to move beyond singular categories, foregrounding issues of equity. Accordingly, and in line with the United Nations' Sustainable Development Goal #5 "gender equality"⁸ and MoRRI gender equality indicators,⁹ a reflection about socio-demographic (age, gender, migration background, ethnicity, etc.), economic (income, living conditions, etc.) and territorial (specific socio-economic contexts, percent of people with disabilities, local digital skills level, etc.) variables is adopted to maximize impacts through engagement strategies and specific intermediate bodies, adopting a language that reflects these complexities. This helps prevent the simplification of complex local realities and aids in selecting enabling tools (physical and digital) to promote the inclusive involvement of people.
- To address socio-technical aspects of climate change problems through the co-design of accessible tools, digital tools such as cheap sensors are considered non-human actors which can act as mediators (Latour, 2005), affording new ways of social mobilization around knowledge and feeding new epistemologies in citizen science. The proposed research aims to define a model for collective monitoring of natural and urban phenomena by gathering data through both using digital devices and involving humans through participatory methods. In order to achieve one of the objectives of citizen science's approach – to enable knowledge transfer

to the involved communities – digital tools involved in data gathering should be accessible to use from an intersectional perspective (e.g., accessible and usable by non-conforming bodies) and should be treated as an object for favoring the discussion around research's specific topic.

- To reduce distance between citizens and academia through tailored communication.

Research communication should clarify the implications for individuals who identify with diversified socio-cultural categories (such as age, gender, sexual orientation, education, ethnicity, ability), in order to favor equal participation (Lakomý et al., 2020). Several gaps in this communication process must be considered regarding the contemporary context of communication (also considering the social network) and cognitive and perceptive limits of people inside and outside social context, such as bias. Regarding the concept of bias, it is necessary to distinguish between the general concept of bias and the negative one. According to Lauwereyns (2011), the general concept of bias refers to the way in which the human brain makes choices in response to information or stimuli, being a natural process which is related to human living.

Meanwhile, the concept of negative bias has to do with subjective or collective stereotypes that are related to individual experience and context of living. Dealing with bias is necessary when working with data as long as they pretend to present "objective knowledge," even if they are collected and elaborated by machines, because they are influenced by human perspective (which designs or defines the way in which machines will collect data). The concept of negative data bias which may lead to a misuse of databases that may influence marginalized communities (D'Ignazio & Klein, 2020) must be taken into account when operating in a highly participated in and public environment such as social media.

On the Ground Investigations and Open Reflections

Since the middle of 2021, the research unit has been involved in experimental initiatives with a threefold aim:

1. To determine on the ground the critical aspects related to the adoption of an intersectional approach in public engagement connected to citizen science, with a particular focus on those related to climate change and communities.
2. To map out leading sociotechnical practices and tools that are useful at better understanding or interpreting climate change topics through an intensive and more aware use of data in the different phases of the citizen science processes.
3. To investigate the empathic and perceptual limits of data visualization about climate change in the social media environment to better address the communication and dissemination of projects.

These three objectives are mainly connected to the reflections that emerged due to direct participation in two Horizon 2020 (H2020) projects, GRETA and RESET. H2020 Green Energy Transition Actions (GRETA)¹⁰ was launched at the end of 2020 with the aim of paving the path to active energy citizenship and communities, starting from the condi-

tions and barriers for their creation and consolidation. The project intends also to apply a gendered perspective in the energy transition, to propose answers to the unequal access to resources in a system that still favors established voices, resulting in an unbalanced representation of the European population in both decision-making processes and policy outcomes. The research unit is working on the Bologna case study in a multicultural, socio-economically stratified district: an area with a high percentage of elderly and immigrant residents, but also teenagers and families. Its population is mostly unaware of questions related to energy, with a limited understanding of technical subjects. The first actions promoted were related to engagement strategies to enable better understanding, with tailored messages for the different inhabitants, using and sharing energy data in a user-friendly mode and co-designed, tailored, place-based solutions for the specific areas. A series of collaborative workshops around community topics of interest (reduction of energy expenditure, planet care, renewable energy installations) has been set up, with a multi-voice support (institutions, companies, associations, citizens, students) to combine different needs, resources and opportunities deriving from human and not-human elements.

Restarting Economy in Support of Environment through Technology (RESET)¹¹ is a project financed by the European Union's Horizon 2020 FET Proactive Programme which aims at improving green and environmental investments by proposing a process based on environmental intelligence (Mulligan et al., 2020). In the urban case study of Bologna, a mixed data collecting approach based on ground-based weather stations and citizen science will deal with thermal extremes and how urban green areas can act as a heat mitigator. The research process is aimed at combining machine-sourced data with crowd-sourced data collected by the citizens through a process of continuous exchange and communication based on data visualization methods (Figure 4).

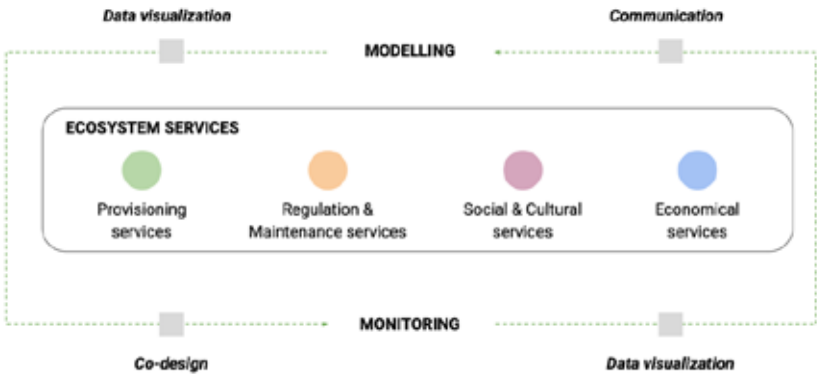


Figure 4. Methodological process of RESET in Bologna.

During 2022, preparatory activities have been carried out in order to:

- Define the experimental design for the ground-based monitoring in Bologna. Along with the municipality, a group of green areas has been selected for weather stations that will collect data about thermal extremes

in areas near the city center (highly built environment), former industrial areas (open air environment) and areas further from the city center (less built environment).

- Constitute a network of stakeholders that will act as intermediate bodies to involve citizens and communities. Other than the university, municipal institutions and local associations, representatives of people with disabilities, LGBTQIA+ communities and elderly people have been involved in directly hosting weather stations and in facilitating the situational citizen engagement.
- Test a digital open platform for citizen science. Over 80 university students have been involved in data gathering in order to map the existing green areas in terms of public services and thermal extremes mitigation perception. During this activity, students monitored existing services and barriers using a Spotteron-based smartphone application that was selected for its usability. During the activity, the participants registered over 200 spots that are now available on an online open map provided by the application.¹²

All these preliminary activities are preparing the ground to open RESET citizen science initiatives to a larger community of participants. To couple the co-creation initiatives of these two projects, the research unit is investigating new communication pathways, especially through social media, to test impacts in terms of perception and empathy of data visualization about climate change and intersectionality, starting from the results of the experiment "From Data to Stories" (Licaj & Raffo, 2018) about the phenomenon of migration on Mediterranean Sea routes using data and information collected on the UNHCR platform, and adapting the emerged model to these new initiatives. The model was tested in two ways: through the tools provided by the social network (sponsorship, engagement rate measurements, views, clicks, etc.) and through a series of live tests with users (Figure 5).

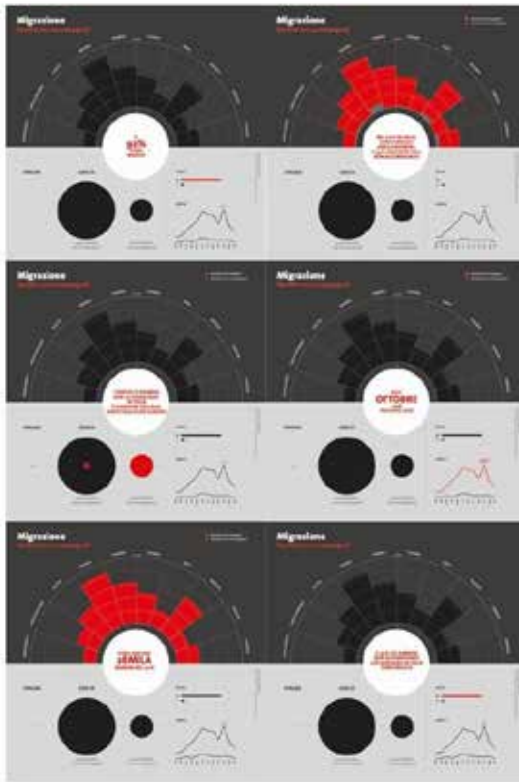


Figure 5. Data visualizations used for the test sessions with users during the experiment “From Data to Stories.”

The results from the various tests defined three areas of focus:

- The perception of data reliability not only in relation to the official source – in that case UNHCR – but also the person or the page that shared the information.
- The increased capacity of people to understand data and the explicit and implicit message beyond visualization. For example, in the 2018 experiment, within the first three seconds, the testers immediately understood the first level of information and within the next five seconds they had all understood the second level of reading.

The digital medium – and specifically the context of social networks – determines a basically limited time of fruition and defines the need to capture the user’s interest in the first seconds of interaction. The aim of the further experiments combined with the GRETA and RESET projects is to maintain the balance between complexity and level of entertainment, trying on the one hand to avoid information and message overload and on the other hand, pushing too far towards the threshold of so-called infotainment.

The use of data visualization in this communication pathway should not turn into a merely superficial fruition but, thanks to explicit messaging, a balanced distribution between primary and secondary data and balance between complexity and simplification, it becomes an effective experience for different users according to their digitalization comfort level.

All research activities will continue during the coming months, nurturing citizen science processes related to specific initiatives and experimenting with inclusive public engagement practices that see diversity as a key value. Moreover, the common view of research focuses on the concept of "data as a medium" where data, its collection, processing and representation are considered as an element of ecosystemic and inclusive mediation.

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¹ In this context, the term “inclusive” is considered to mean “broad in orientation of scope.”

² In this case, the term “inclusive” has to be understood as meaning “aiming to involve and integrate everyone into an activity or process.”

³ <https://www.zooniverse.org>

⁴ <https://willmedia.it/>

⁵ <https://masterx.iulm.it/news/interni/will-start-up-under-31-fondata-imen-jane/>

⁶ <https://web.archive.org/web/20190816215511/http://www.climate-lab-book.ac.uk/2016/spiralling-global-temperatures/>

⁷ <https://www.rri-practice.eu/about-rri-practice/what-is-rri/>

⁸ <https://sdgs.un.org/goals/goal5>

⁹ <https://morri.netlify.app/>

¹⁰ <https://cordis.europa.eu/project/id/101022317>

¹¹ <https://cordis.europa.eu/project/id/101017857>

¹² <https://www.naturespots.net/map>