

Sustainability Design: Lessons from Designing a “Green Map”

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Abstract—The prevalence of urban agriculture groups mobilizing to create change in cities provides a rich opportunity to understand how these communities use and can design ICTs to support sustainability. In particular, organizations are using ‘green maps’ to make visible local projects, initiatives, and features, in order to reduce entrance barriers and increase participation. This paper reflects on the role of ICTs in these communities as well as the role of design in addressing sustainability concerns. It reports on a design project that developed a green mapping platform to ameliorate the challenges that individuals face in discovering and participating in community-based ‘green’ initiatives. In order to do so, the project adopted sustainability design principles and a participatory approach. While preliminary evaluation concluded the project did not achieve its original objectives, it provided a valuable exploration of practises to address and evaluate sustainability in design projects. It highlighted the value of participation in processes rather than creation of technology products and pointed to lacking support for sustainability in current methods and techniques for systems design. The paper ends with reflections on sustainability design opportunities for community mapping and identifies future areas for exploration.

Index Terms—Sustainability, participation, sustainability design, sustainable HCI.

I. INTRODUCTION

Urban agriculture and sustainability groups are looking to create change in their cities through green mapping, in order to increase participation in, and awareness of, local projects. The role and use of Information and Communications Technologies (ICTs) in these communities is double-edged: they can create powerful change or contribute additional obstacles to the challenges communities are already facing. This tension is compounded by the tendency toward solutionism inherent in many approaches to technology, the lack of a common approach toward addressing sustainability, as well as the nature of sustainability itself as a ‘contested concept’ or ‘wicked problem.’ What is beginning to emerge from multiple perspectives however, are principles of sustainability design rooted in participation and reflective practise.

This paper reports on a course-based green mapping design project undertaken to investigate these concerns in the city of Toronto and propose a technology-supported intervention. Through evaluation it appears the ambitious original objectives were not met, but valuable insights arose throughout the

process. Reflections on this experience and related findings reveal gaps and opportunities for sustainability design practise.

The paper is separated into six sections. The following section introduces green mapping and sustainability design and covers the role of ICTs in sustainability, technical solutionism, and potentials for reflective action. Next, green mapping in Toronto is examined through reviewing the design of a community mapping platform undertaken while considering sustainability design processes. An overview of findings arising from the design project follows, including a discussion of project takeaways, establishing evaluation criteria, key decisions, and possibilities for reflective action as an approach, addressing the need for carefully circumscribed interventions. Finally, reflections on lessons learned lead to preliminary opportunities for further exploration and research within sustainability design.

II. BACKGROUND

A. Green Mapping

Green mapping is a process through which groups reveal and map ‘green’ projects. The outcomes are “locally created environmentally themed maps...plot[ting] the locations of a community’s natural, cultural and sustainable resources” [1]. Belonging to a constellation of activities referred to as ‘community mapping’ [2], longstanding green mapping projects have covered a range of ‘green’ features and many have remained active over the last decade [1], [3]–[5]. Common to all is the aim to build local awareness and community membership through using the maps and, to some extent, through engaging in mapping activities.

These projects make use of a range of internet-accessible Geographic Information Systems (GIS) technologies and constitute one part of the growing geospatial web or ‘geoweb’. Other terms used to cover the combination of geocoded data, mapping, and analysis online are: neogeography, neocartography, and Volunteered Geographic Information (VGI), though none of these terms have widely-accepted meanings [6], [7]. Recent services and products these projects make use of include Google Maps, ArcGIS, CartoDB, and Mapbox, along with popular content management systems (CMS) like Wordpress and Drupal, common JavaScript libraries, and HTML frameworks.

Areas within geography, in particular subfields within GIS, have developed many critical approaches to understanding participation in, and longevity of, mapping projects. Public participation GIS, participatory GIS, community-integrated GIS, and critical GIS all help build reflective strategies for researchers investigating and designing maps, while also providing tools to analyze and understand outcomes [8]–[10].

B. Sustainability Design

An awareness of relevant perspectives provides an understanding of how researchers locate the concept of sustainability in designing for ICTs. Critical perspectives and theoretical frameworks, in addition to methods and tools, anchor any investigations within a disciplinary context. Broadly, sustainability is often understood as the capacity environments or systems have to endure over time. A frequently used framing comes from the Brundtland Commission, which in 1987 identified sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [11]. Another approach to understanding sustainability relies on ‘contested concepts,’ in order to argue that any definition of sustainability is inherently un-resolvable and ambiguous in nature [12].

Many researchers approach sustainability using Rittel and Webber’s concept of a ‘wicked problem’ [13]: articulating different degrees to which they see sustainability as difficult, if not impossible, to formulate as a problem and subsequently frame as solvable. This approach maps sustainability to ten identified characteristics of wicked problems.

The Karlskrona Manifesto builds out a conceptual framework for thinking about sustainability, approached using 5 interrelated dimensions: individual, social, economic, technical, and environmental [14], [15]. Acknowledging the lack of a clearly-established theoretical base across disciplines, as well as other limits stalling a trans-disciplinary understanding of sustainability design, *The Karlskrona Manifesto’s* authors reformulate the issue of sustainability design as one of: “[what] methods and tools are needed to explore inter-dependencies between these concerns, and to foster more integrated and long-term thinking?” [15].

Practitioner research including design thinking [16], participatory design [17], community and urban informatics [18], [19] and human computer interaction (HCI) [20], provide approaches for integrated thinking through emphasis on participation and user-centered design techniques. Participatory design’s moral and pragmatic design propositions—that users adopting the design outcome have a *right to be included* and *should be included*, in order to increase chances of success [17]—has led to a wealth of participant-centered approaches when designing for challenges simultaneously faced by individuals and communities.

Informatics’ emphasis on the informational nature of technology has also led to approaches to design heavily informed by community and user engagement. While some community informatics practitioners position the field as concerned with sustainable processes through self-actualisation in design

[17], urban informatics practitioners place their related field’s concern in the interleaving of place, technology, and people when designing experiences—exploring the possible role of community engagement in building urban sustainability [21].

HCI focuses on the intersection of humans and technologies, paying particular attention to interactions between the two through user-centred study and design techniques. Within the emerging subarea of sustainable HCI scholars have identified an orientation toward seeing user practises and attitudes as problems to be ‘solved’ rather than drawn upon [22]. Partially informed by models of persuasive computing, this approach has led to techniques that have minimized meaningful participation [22], [23]. However, recent scholarship in sustainable HCI focuses on new orientations, methods, and approaches—including participation-oriented engagement—in order to create more sustainable systems [23].

C. ICTs role in Environmental and Social Sustainability

The potential of sustainability design and green maps is relevant in an age of heightened concerns around climate change and increased community-based efforts tackling sustainability challenges. ICTs for sustainability (ICT4S), of which green maps are an example, occupy a uniquely doubled position [12]: on the one hand, ICTs can reinforce unsustainable cycles of consumption and production [24], [25] as well as unequal power dynamics [26]; on the other, ICTs can potentially serve as a transformational catalyst [27]. Perhaps most revealing, technologies are “full of assumptions about how we live” [28]—these assumptions can be driven by industry trends and motivations [24] but also harnessed to re-imagine our future.

Technology is positioned at the intersection of policy, industry, and civil society conversations. As a result, interventions intended to produce sustainable technologies come through all of these channels. Within the academy, sustainability questions are explored from a variety of disciplinary backgrounds, each with unique histories and approaches. In this moment, there are calls for scholars to draw from, and support work on, sustainability outside their historical domains [14], [29].

ICT-based research faces additional sustainability-specific challenges: for those working in the area, the question remains open how to best address urgent issues while also contributing to implemented outcomes. At the 2015 iConference *ICT for Sustainability* workshop, Laura Sheble’s *Transfer into Practice and Integrate the Public* session proposed a model of community-based participatory research in order to “develop multiple perspectives of the problem space” and generate research that can: “1) address urgent societal issues, 2) understand the impact of research on communities, and 3) develop research partners to frame, contribute to, and implement outcomes of research” [30].

D. Solutionism & “Yet Another Platform”

In many respects, ICT4S may still be prone to a solutionist orientation. The tendency in computational solutions is to focus on providing novel information, forms of control, or

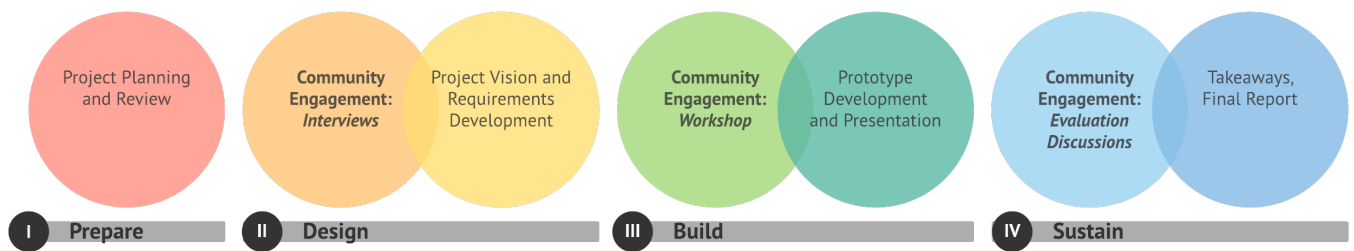


Fig. 1. Community Mapping Platform Project Roadmap.

sources [24]. Easterbrook argues that computational thinking often ignores social and environmental sustainability and worse, can actively undermine it. He points to the need for a shift in our approach toward systems thinking, drawing on critical theory, and understanding how technology has shaped our problem-solving infrastructure, in order to move into sustainability practise.

Systems thinking is also applicable when re-conceiving ‘techno-based’ concepts of ICT solutions as ICT practises, a technique to open up space and pose questions to traditional understandings of ICT use and its role in transitioning toward sustainability [12]. Both of these strategies—adopting systems thinking and working with a richer notion of practise around ICTs—would move design away from the tendency to create “yet another platform,” challenging the solutionist paradigm embodied in computational thinking-driven approaches [24].

E. Reflective Action

With this understanding of ICTs dual role and awareness of the perils of a product-oriented, solutionist mindset, a pressing question remains as to what opportunities there are for reflective action to improve sustainability-oriented design. Emphasizing reflection in process-oriented approaches could provide early opportunities to evaluate efficacy, find agreement, and contrast methodologies, which would be valuable given the absence of a common theoretical basis across disciplines researching and designing for ICTs. A recurring theme across these topics is the emphasis on participation and engagement at both an individual and community level. Acknowledging sustainability as a site of importance for ICT design has also led to recognizing the potential to adopt exploratory and adaptive approaches in early projects to build understandings that can be shared across disciplines [31].

III. COMMUNITY GREEN MAPPING IN TORONTO

A. Course-based Design Project

The city of Toronto features many different ‘green’ initiatives undertaken by local organizations as well as municipal departments. With over 5.5 million people in the Greater Toronto Area (GTA), the city’s active urban agriculture community has projects spread through many neighbourhoods. This includes groups like FoodShare [32], who work with

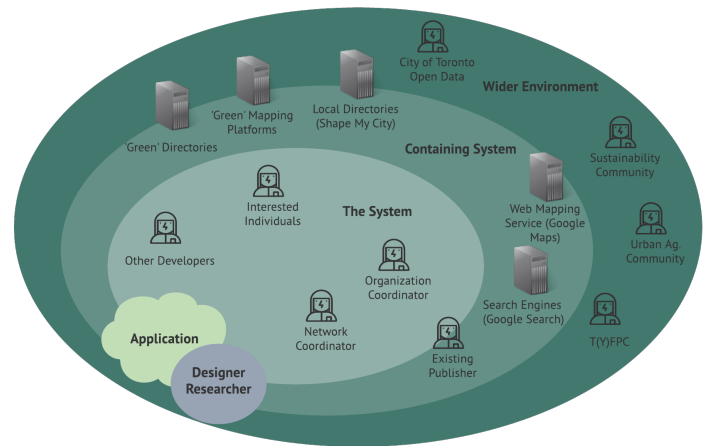


Fig. 2. Community Mapping Platform Stakeholder Onion Diagram.

communities and schools to grow food as well as build food literacy through education, and Not Far From the Tree [33], who match private trees with foragers to share in the urban fruit harvest.

Networks include organizations like Toronto Urban Growers (TUG) [34] who emerged to connect those working on similar issues, like the projects above. Further, there are strong policy connections to City Hall through the Toronto Food Policy Council (TFPC) [35], the community reference group for Toronto Public Health’s Food Strategy team, who helped develop the the GrowTO Urban Agriculture Action Plan [36].

As part of their activities, these groups and networks seek to create change in their urban communities. They achieve this by increasing their visibility to draw people together around these concerns and encourage participation. ‘Green’ maps, as well as ‘green’ directories and resources, are one way this has been accomplished [37]–[41]. As with other urban agriculture-focused organizations, in particular less-established ones, these mapping projects have been susceptible to fluctuations in vitality and longevity, given their reliance on volunteer engagement.

Within this context, the first author completed an 8-month Masters of Information System Design project to design a technology-supported intervention for green mapping urban agriculture groups in the city. The first author is an active

TABLE I
MILESTONES FOR DESIGN PROJECT

Design Phase	Milestones
Prepare	M0. Project Kickoff (Ethics Protocol, Literature Review, Project Plan) M1. Baseline Summary (Technology Review, Community Engagement Plan)
Design	M2. Project Vision M3. Requirements Document and Initial Design
Build	M4. Prototype Presentation
Sustain	M5. Final Report

member of the urban agriculture community in a leadership and organizational capacity in two local organizations. The design goals established for the project were:

- 1) Support the discovery of, and initial participation in, urban agriculture and sustainability initiatives by interested individuals.
- 2) Develop techniques for consistent, reusable platforms and tools.

From September 14, 2015 until April 30, 2016, the first author undertook a project, to design and prototype a community map and toolkit, taken together as a *community mapping platform* aimed at facilitating participation in urban agriculture initiatives in Toronto.

B. Design Framework and Methods

Table I lists the four phases of the design process established as part of the project framework: “prepare, design, build, and sustain,” influenced by Newman’s “plan, act and reflect” [16]. An initial iteration led to a prototype based on the design requirements elicited through interviews, activities from workshops, and technical research. The intent was to cycle through the phases more than once, however due to time constraints a second iteration did not happen. A project plan was developed in the *prepare* phase which included the roadmap in Figure 1 and established the milestones in Table I.

Throughout, a variety of methods were employed including:

- **Action Research** informed by approaches such as Soft Systems Methodology (SSM). Techniques used throughout all phases included three analyses (of the Intervention, Social, and Political) performed through ongoing field notes and reflection as well as rich picture diagramming and root definition development [42].
- Exploratory **semi-structured interviews** held during the *prepare* phase. Interviews covered participants background, awareness of local projects, information seeking behaviours, and use of technology to participate in initiatives.
- A **participatory** green mapping workshop (with twelve participants) and evaluation discussion (with four participants) held during the *build* and *sustain* phase. The workshop included three hands-on components: a green mapping website walk-through (seen in Figure 3), mapping green features, and creating a prototype online map. The evaluation discussion focused on a goal setting activity [43].

Activity: Green Map Website Walkthrough

Notes
With a partner and a laptop, we will walk through the green map project on the other side of this sheet, using the user tasks below and any additional tasks you identify.

Take turns recording and ‘driving’ on the site.

Think like a designer! You will be prototyping and making your own green map shortly so think about how you would design an alternative.

Document as you go! We will come back as a group and share our findings of each site.

User Tasks

- Please take a look at this site and explore it for a few minutes. As you familiarise yourself with it, say everything that comes to your mind, particularly:
 - What can you do on this site?
 - Who is this site intended for?
 - Have you ever used a site or service like this?
- Find a feature indicated on the map that is closest to where you live
- Search for all the features on the map with a local name (e.g. “Parkdale,” “Dufferin Grove,” “Malvern”)
- Show only certain types of features on the map

Potential Areas to Evaluate

- **Navigation and Search**
How much of the site is accessible from the home page?
How easy is it to find what you are looking for?
Is it clear where you are on the site (all of the time)?
- **Control**
How in control do you feel using the site?
Can you cancel or revert any changes?
- **Feedback**
Is it always clear what is happening on the site?
Are you able to provide feedback?
Is support available if you are unclear?
- **Clarity**
Is the language appropriate and consistently used?
Does the website conform to standards or look too familiar to other sites?
- **Error Prevention and Recovery**
Are you able to understand error messages?
Is there a clear way to exit or recover from an error?
Are ways to gain assistance clearly available?

Remember!

- This activity is about walking through and testing the site, not your abilities
- Try to “think aloud” with your partner: it is helpful to talk through what you are doing and thinking as you go

Fig. 3. Website Walk-through Activity Sheet from Workshop.

TABLE II
CRITERIA FOR DESIGN GOALS ACROSS FIVE DIMENSIONS OF SUSTAINABILITY

Sustainability Dimension	Criteria for Design Goals
Individual	Individuals who use the platform will increase their knowledge of sustainability and urban agriculture initiatives in Toronto.
Social	Individuals and organizers who use the platform will perceive the system as benefiting the sustainability and urban agriculture community.
Economic	Organizers who use the system will perceive the system as adding value to their organization’s outreach efforts.
Technical	Information generated by the platform will have enhanced longevity through standardization and use of open formats The platform will, as much as possible, minimize the necessity of its presence in how it operates.
Environmental	Through raising individual awareness, the platform will contribute to environmental protection.

A design document (M3 in Table I) formalized a design for a Green Map from the interviews, SSM techniques, and technical review. This design document identified a list of stakeholders, developed user personas, indicated constraints, risks, and limitations, created functional and non-functional requirements, and established the preliminary sustainability criteria in Table II.

C. Community Engagement

A community engagement plan created during the *prepare* phase detailed the engagement methods—including the interviews and workshops mentioned above—in part to ensure the experience was relevant and meaningful for participants.

Participants included individuals who were interested in urban agriculture or sustainability, or who were involved as an organizer in locally-based projects. Recruitment occurred through targeted outreach to stakeholder groups mapped in Figure 2, advertising on relevant topical mailing lists, a project

TABLE III
INTERVIEW PARTICIPANTS

Participant	Prior Involvement Level (Stakeholder Type)
Able	Medium (Interested Individual)
Bethnel	Low (Interested Individual)
Cadence	High (Organizer)
Devon	High (Organizer)
Eliot	Low (Interested Individual)

website, and referrals from individuals. Where possible, the same individuals were asked to participate throughout the various forms of community engagement. In total 16 participants contributed to the project, five through semi-structured interviews, twelve through the green mapping workshop, and four in the evaluation discussion. While no individuals participated in all three activities, five were involved in at least two.

Semi-structured interviews focused on participants involvement with and thoughts on sustainability and urban agriculture initiatives, their awareness and strategies to find out information around those initiatives, and how technology enabled or blocked participants as they sought to find projects (see the Appendix for interview questions).

During the interviews, cultural probe packages [44], as seen in Figure 4, were introduced to participants to take away with them as part of a strategy identified by Gaver, Dunne and Pacenti to “provoke inspirational responses” [44]. The probes contained a map of the local area created using fieldpapers.org [45], prompts to draw ‘green’ features on the map, and a card requesting a picture (either by text or email) of a place or event that made participants think about sustainability in Toronto. These were provided with a stamped envelope addressed to the first author. One interview was conducted remotely and did not involve providing a probe. The probes were not taken up by interviewees and only one was returned, perhaps sparing the first author from pitfalls around their use [46].

From the interviews, two critical barriers to participation became apparent: *a lack of time* by participants interested in becoming involved, and *too much information* making opportunities difficult to identify. As one interviewee, Bethnel stated, their key barrier was “my own time. Like I don’t get home from work until 5:00 most of the time, or 5:45. And then the day is gone, it’s devoted to getting ready for the next day and going to sleep.”

All the interviewees mentioned a pervasive challenge of disorganized, all over the place, information. Again, Bethnel stated: “I think there’s like a wealth of information that is almost intimidating, I don’t know where to start. I would almost rather something more structured. Maybe not a mentor situation but, I’d love to find something that I trust.” Another interviewee, Able acknowledged this redundancy: “[It’s] the same thing with listservs, there’s been plenty that I’ve cut out just [be]cause, it’s too much information or like repetitive information.” From an organization perspective, this information is seen as a failure of knowledge sharing and repeated labour, indicative of a lack of communication between projects. Able described their sense, after working with an organization to

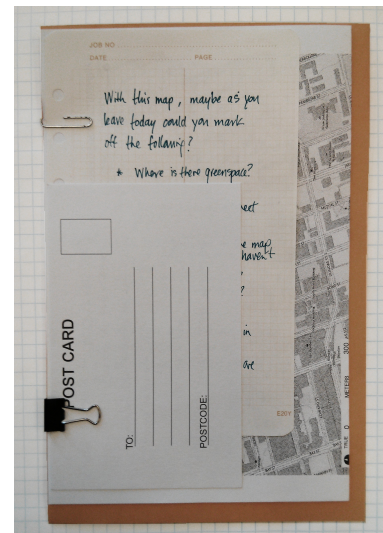


Fig. 4. Cultural Probe Package.

develop a strategy for the upcoming year, that: “Everybody is re-inventing the wheel over and over again. It’s like this really arduous process.”

D. Toronto Green Map: Community Mapping Platform

The community map and toolkit articulated in the design document were taken together as a *community mapping platform* for facilitating participation in urban agriculture initiatives in Toronto. The web-based community map, seen in Figure 5, features urban agriculture projects located throughout the city. The toolkit contains documentation and web-based scripts, making use of existing CMS plugins that integrate with collaborative applications being used to create online content.

Initial technical review and early proposals focused on concrete implementations and technologies for a community map. Features identified for inclusion included an interactive map with layers that could be toggled for various features, a search bar to display results for specific projects, and access to the data for download in a machine-readable format.

Prior to developing the prototype an imagined design was explored with SSM rich pictures seen in Figure 6, which led to a much more expansive view of what a “Toronto Green Map” could be. This included designing a mapping platform that could stay up to date with changes organizers were making on their websites through scraping, provide correct and structured data to search engines to improve search engine visibility, and allow organizers to embed maps on their website or in newsletters.

Based on interviews, these SSM diagrams and root definitions revealed a significant shift toward a platform emphasizing a toolkit approach to glue together, or ‘artfully integrate,’ the different tools and services already in use by organizations [47].

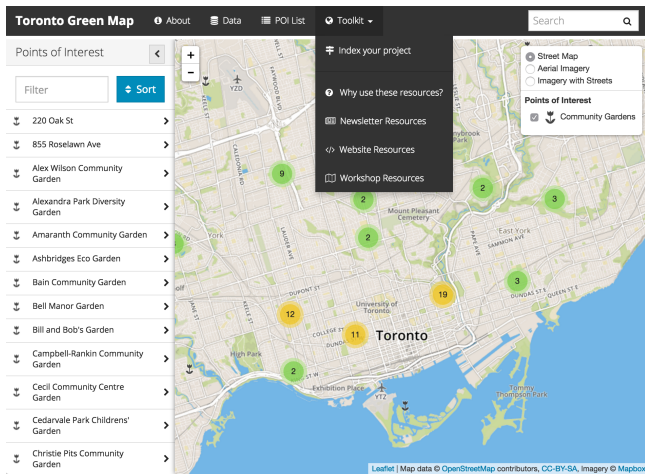


Fig. 5. Toronto Green Map Prototype Screenshot.

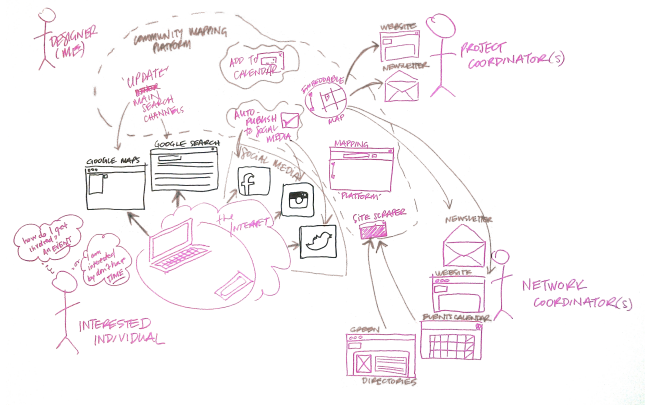


Fig. 6. Toronto Green Mapping Platform Rich Picture.

E. Design Evaluation

To assess the project, a three-step evaluation plan was created by the first author after the design document. Determination of project outcomes was made through assessing:

- 1) **Whether design goals were addressed across the five dimensions of sustainability** [14], determined from criteria established for the design goals in Table II.
- 2) **Whether the theory, frameworks, and methods adopted were appropriate**, determined through review of data and SSM analysis [42] as well as reflection.
- 3) **Whether the project was ‘successful’ and improved the situation**, aided by the evaluation discussion and architectural evaluation of the final versus proposed design.

Contributing to this evaluation plan, an evaluation discussion with organizers involved in a local urban agriculture project and an informal interview with an organizer involved in a mapping project were held during the *sustain* phase. Both conversations addressed the difficulty of identifying measures and understanding impact in a way that gets to the heart of project goals.

Evaluation was undertaken by the first author using the steps above. Through the architectural evaluation in the third step, the translation gap between the specified design and resulting prototype was revealed. Many of the imagined integration features were not prototyped due to time constraints. The evaluation process led the first author to the determination that the project did not meet its original objectives, despite the shift described in Section III-D from “yet another map” to a more holistic and integrated platform.

As part of evaluation, particularly the review of data collected through community engagement and SSM analysis, six takeaways on community maps emerged, discussed in Section IV-D.

F. Sustainable Design Processes

As part of considering a sustainability design process, the design document incorporated preliminary sustainability criteria. Determinations of what sustainability design looks like remain preliminary in research [31]. No established and accepted methods or techniques were found during review that could be incorporated into the project as milestones identified in Table I.

In spite of this, steps were taken throughout the four phases to further bring the project toward sustainable design practises:

- **Participation**-driven techniques augmented aspects of the design process that were conducted individually.
- **Reflection** of activities undertaken as well as the prototype result, through evaluation.
- **Documented and open development processes** which included version-controlled open source code and open license workshop materials.
- **Key decisions review** that drew on design practise tasks in *Requirements: The Key to Sustainability* [31], identified in Table V.

IV. DISCUSSION

A. Community Mapping as a Process over Product

A key insight identified during the project was that green mapping as a process proved more valuable than any resulting product for articulating concerns within communities. Although participants saw comprehensiveness (i.e., a full range of green features represented) as valuable to have represented on a map, many only had a narrow range of things, conceptual or geographical, that they felt were important to map.

This insight emerged from comments made by participants during the green mapping workshop and contributed to the shift in design discussed in Section III-D. As a result, the platform was designed to assist with individuals in urban agriculture and sustainability communities enacting processes of identifying concerns through the toolkit materials. While this insight may be over-emphasized given that workshop participants self-selected as interested in mapping processes, it aligns with research on the value of re-conceiving ICT solutions as ICT practises [12]. Regardless, this insight highlights the potential for exploration of practise-oriented ICT4S approaches within the context of community mapping.

TABLE IV
DESIGN PROCESS OUTCOMES ACROSS FIVE DIMENSIONS OF
SUSTAINABILITY

Sustainability Dimension	Criteria for Design Goals
Individual	Individuals participating in the project increased their knowledge of sustainability and urban agriculture initiatives in Toronto.
Social	Individuals and organizers who participated in the project perceived community mapping as benefiting the sustainability and urban agriculture community.
Economic	No costs or economic benefits identified.
Technical	The project led to conversations with other mapping projects about data standardization and use of open formats.
Environmental	Individuals participating in the project increased their awareness of sustainability and urban agriculture initiatives.

B. Evaluation Criteria

From an initial evaluation against the criteria for design goals established in Table II, the first author drew three conclusions:

- 1) Criteria established were difficult, and in some cases impossible, to measure within the time frame of the project.
- 2) Criteria did not address or account for timescales in any dimension, and not in a way that could account for variations in how time is relevant over the dimensions.
- 3) Criteria were not the most relevant or resonant with central themes of the project, in particular awareness ‘contributing to protection’ for the Environmental dimension.

These were subsequently discussed with participants during the evaluation discussion and the first and second conclusions were acknowledged by participants. One explanation for these conclusions is that the original design goals and criteria were developed by the first author prior to meeting with participants in the evaluation discussion during the *sustain* phase.

While the discussion about evaluation did not lead to clear, established evaluation measures, it emphasized goal-setting and the need to reflect on the viability and applicability of core goals when pursuing change through community-based projects. Decomposing those goals into easily measurable criteria across five dimensions may not always be easy or do justice to the core concerns of a project.

An evaluation of the design process across the dimensions of sustainability was performed by the first author after the evaluation discussion and based on comments by participants, seen in Table IV. This evaluation focused on the benefits to participants of the design project, rather than benefits to potential users of the system.

C. Reviewing Design Practises

Design practise tasks are moments or points where decisions are made about the future, or when the project is assessed. Key tasks undertaken as part of the project, seen in Table V, were reviewed in the *sustain* phase of the project.

TABLE V
DESIGN PRACTISE TASKS [31]

Task
<i>Mindsetting</i>
<i>Project objective, System purpose and boundary scoping</i>
<i>External constraints identification</i>
<i>Stakeholder identification</i>
<i>Success criteria definition</i>
<i>Requirements Elicitation</i>
<i>Risk identification</i>
<i>Trade-off analysis</i>
<i>Go/No-Go decision</i>
<i>Requirements validation</i>
<i>Project completion</i>
<i>Requirements documentation</i>

These established tasks [31] served as a valuable baseline, revealing how key decisions, in particular *project objective, system purpose and boundary scoping* as well as the *success criteria definition* wound up being less participatory than initially intended. Some of this resulted from constraints imposed by the course-based nature of the project, inflexible time line, and lack of financial support.

The review revealed gaps in support for sustainability design during the key tasks of *requirements documentation* and *success criteria definition*. Recent discussion has acknowledged these gaps and one model of a sustainable design process speaks to the potentials for requirements documents that “includes checklists for sustainability criteria and standards compliance in all five [interrelated] dimensions [of individual, social, economic, technical, and environmental]” [31].

Similar task evaluations have been used in co-created research projects around citizen science initiatives. These evaluations assess participation, community roles and benefits, as well as any challenges associated with each research step, allowing researchers to reflect and ensure the process aligns with the intended outcomes [48].

This research task evaluation model holds promise for conducting sustainability design research, particularly if connected to an identification of the tools and techniques lacking at key task junctures as well as in requirements documents.

D. Six Takeaways on Community Maps

A commitment made by the first author to participants was to distill the more valuable, interesting, and community-focused insights emerging from the design process into an accessible format. During evaluation of the project, discussed in Section III-E, six takeaways on community maps were developed:

- *People are overwhelmed with information, most do not need any more.* Participants described feeling intimidated by the volume and disorganized nature of information available to them. As a result, many sought trusted opinions, ideally from someone they knew.
- *Newcomers look for event-driven-over volunteer-driven or location-driven-involvement.* Not only are events seen

as a first step, they are seen as the most desirable opportunities by those looking to become more involved.

- *People use search to find projects (mostly Google).* There was no consistent pattern of online tools participants used to find out about opportunities to participate. All employed the online services and applications they already used, the most popular of which was search.
- *Maps are seen as more valuable as processes than products (arguably).* Participants in the mapping workshop identified wide-ranging positive outcomes from the process of making a map, more so than using a map.
- *There are more people interested in urban agriculture and sustainability than established organizations have the capacity to support.* Participants highlighted the excitement and energy around ‘green’ projects in Toronto. Those involved in organizations spoke about overwhelming levels of interest, a lack of capacity to work with every potential participant, and a desire to ensure participation was a fit for both volunteers and projects.
- *Even with desire to work together, it can remain beyond the capacity of groups to do so.* Participants involved with urban agriculture groups or who had completed mapping projects, spoke positively about the potentials of working with each other and sharing resources. Yet, many identified systemic barriers that lead to ‘reinventing the wheel’ while working on their respective projects.

E. Meaningfully Integrated Design

Suchman articulates that the design of technologies can be understood as: “a process of inscribing knowledges and activities into new material forms” [47]. Design understood in this way should be able to be convinced by strong arguments and techniques that provide better access to understanding the production of that knowledge. This view of design is informed by a feminist move to reframe objectivity as arising out of a plurality of knowledges in dynamic production with a decentralized and diffuse responsibility, not as emerging out of a body of knowledge or facts separated from people [47].

In this project, the initial impulse toward a design that did not acknowledge the existing practises, tools, and services that organizers were already using, could have gone unchecked were it not for the adoption of participation-focused engagement. Encountering the knowledge and activities already existing around the area of a proposed design caused a shift toward imagining a “Toronto Green Map” platform, described in Section III-D, which supported and tried to minimally disruption to existing practises.

Suchman identifies five possible transformations of understanding, of which the last one links her feminist argument to sustainability considerations discussed in this paper. Considering the array of ICTs and how they are put to use in the world, designers need to account for and: “value heterogeneity in technical systems, achieved through practises of artful homogeneity and integration, over domination” [47].

F. Reflective Action as an Alternative

Reflection was intentionally built into the project to move toward a sustainable design process and aid in evaluation. One outcome of this reflection was the six takeaways on community maps discussed in Section IV-D. Additional reflection identified the opportunity of focusing on community mapping as a process rather than emphasizing maps as products. This focus echos the move away from a solution-oriented computation perspective, and could be extended into thinking more broadly about design’s relevance as a process serving to educate and build critical engagement rather than create “yet another platform.”

Seeing how much participants valued the green mapping workshop gestures at the need to orient design projects toward building ICT and technical literacy for participants as part of a design process. Critical and participatory HCI has already identified opportunities for treating design as a site of critical engagement, to bring about “reflective analysis and interpretation of issues” [20], [49]. These serve to model important reflective techniques that ICT4S and sustainability design should seek to incorporate in the future.

V. CONCLUSIONS

This paper explored questions that have relevance to broader ICT4S discussions within the context of a green mapping design project. The findings highlighted the importance of reflective action, a perspective that moves beyond solutionism, and the opportunity of considering design projects as sites for critical engagement. While the paper provides only a modest investigation and reflection on possibilities for sustainability design processes due to the constrained nature of a course-based project, it revealed that key issues relevant to sustainability design are not yet well understood. For example, the representation of time when deploying community-developed evaluation strategies for sustainability, and the role that specific design process and practises play in sustainability.

Evaluating the design goal criteria for the design project highlighted two areas that require more attention:

- 1) Implementing evaluation processes that can investigate the implications of different timescales for sustainability.
- 2) Developing community-based criteria and indicators built on participatory approaches that can lead to capacity-building as part of a research project [22], [50].

Tactics to inform next steps in these areas could include:

- Investigating the role of participation by mobilizing the insights of scholars doing related work outside of familiar disciplinary backgrounds.
- Developing approaches to sustainability design action research that focus on literacy development and public scholarship.
- Exploring how embedding boundary critique [51] within an action research framework can be brought to bear on sustainability design problems in ICT.

APPENDIX
INTERVIEW QUESTIONS

Background

- Could you define what you view as sustainability or urban agriculture, if possible using examples from events, groups or activities in Toronto?
- How long have you been interested in sustainability or urban agriculture?
- Are you currently involved in any community groups or organizations working on these topics?
- *For participants not involved in a project:*
 - Have you previously been involved with a group or organization that deals with sustainability or urban agriculture?
What led you to become involved?
If you don't mind sharing, why are you no longer?
 - Are you interested in becoming involved with a group or organization that deals with sustainability or urban agriculture?
Are there barriers that you have identified that might prevent you from doing so?
 - What steps you have taken to learn more about these types of projects?
- *For participants already involved in a project:*
 - Could you describe your current role and organization?
 - What do you see as the most interesting or important part of that participation?
 - What is a recent example of an activity, event or outreach moment that you thought worked well?
What do you think made it successful?
 - Do you have an example of an activity, event or outreach moment that didn't work that you would be comfortable sharing?
What do you think made it unsuccessful?
 - What do you see as the biggest challenge facing the organization you are involved with?

Awareness and Information

- Would you consider yourself well-informed about sustainability and urban agriculture in Toronto?
- Can you think of a recent example when you've heard about a project and want to find out more information about it?
What was the first step you took?
- *For participants not involved in a project:*
 - Do you feel you are able to get the information you want or need using these strategies?
 - Do you find this information is accurate and complete?
 - Is it clear how you can contact or find out more?
 - Have you ever looked for information about sustainability or urban agriculture using an online directory or on a map?

- *For participants already involved in a project:*
 - How would you describe [Organization Name]'s efforts around outreach and getting new people involved?
 - What are ways that you currently attract people to [Organization Name]?
 - Have you listed [Organization Name] in an online directory or on a map?
 - How successful do you feel these strategies are?
 - Given your current resources and capacities what are one or two priorities you are focusing on next?

Technology as a Support

- *For participants not involved in a project:*
 - What are ways that you use technology to find out information about initiatives?
Technology could include anything from computers to phones and other devices, websites, applications, services and more.
 - Do you feel that [most used technology identified]...
 - * enhances your effectiveness when seeking information?
 - * makes it easier to learn more about initiatives?
 - * overall is useful for your goals?
- *For participants already involved in a project:*
 - What are ways that [Organization Name] uses technology for communication and to raise awareness of its initiatives?
Technology could include anything from computers to phones and other devices, websites, applications, services and more.
 - Do you feel that [most used technology identified]...
 - * enhances [Organization Name]'s effectiveness when raising awareness about initiatives?
 - * makes it easier for [Organization Name] to reach new individuals?
 - * overall is useful for [Organization Name]?
- Are there any additional technologies that you would like to try and use?
- Can you think of an example of when a technology you wanted to use did not work as well as intended?
- How do you imagine technology could enable you (or [Organization Name]) to be more meaningfully involved with sustainability and urban agriculture in the future?

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