

Map Making: Mobilizing Local Knowledge and Fostering Collaboration

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Participatory mapping – the production of maps in a collective way – is a common activity used for planning and decision making in urban studies. It started as a way to empower men and women, usually from rural vulnerable communities threatened by climate change, degradation of their landfills or any other conflict related to access to their land. It has been considered a fundamental instrument to help marginal groups represent and communicate their needs within the territory and augment their capacity to protect their rights. (FIDA, 2011). Why is it that in some cases participatory mapping works and in others fails? Why do these initiatives not trigger local action? Or even end up being counterproductive, when authorities use the map made by locals, to validate their points, causing conflict instead of negotiation?

As a research team of designers and social scientists involved in the creation of participatory mapping workshops, our goal was to analyze the process and resources and different outcomes of some participatory cartographic projects, including one developed by us for three small communities of the original settlements of the West Mountain Region of Mexico City.

Our findings outline three main principles to consider when pursuing a community mapping project whether using low-end or state of the art technology, in order to involve a community, validate their knowledge acquired from the mapping practice, and foster collaboration and organized action.

MAPS AS PRACTICE INSTEAD OF A REPRESENTATION

In the western world, we are very used to maps. We use them all the time: they help us get from one place to another; they help us find our way through unfamiliar terrain, locate people, objects and events. They have helped us plan, predict and understand our world. What if maps are more than what cartography has been telling us they are?

Historically we think of maps from a certain perspective. This maintains the hierarchical attitude about who makes the map, who owns it, and the power that comes with. This attitude delegates the power of the map to an elite group of experts, who are in charge to capture and portray spatial data accurately. By default, these structures reinforce the power of hegemonic institutions over local people, lands and other resources.

We often forget that the conventional appearance of maps mirrors social and political decisions and contain a bias: they express a point of view and indicate property lines, postal districts and enterprise zones. They are always biased in the sense that “*they project the interests of their creators,*” as Wood states in “The Power of Maps” (Wood and Fels 1992). Maps are not ontologically secure representations nor neutral products of science, they carry a long tradition of conventions and principles that reinforces the dichotomy of the cartographer as a skilled professional who make judgments that privileged discourses and

relies on the map as a container of the “truth”, subjugating other kinds of knowledge. And then we have the user or interpreter of the map who is responsible for its depiction by his limited skills and knowledge.

If you think about it, maps are never fully formed, nor complete. They are more like living documents, transitory and fleeting. They are contingent, relational and highly context-dependent. A map is about spatial practices enacted to solve relational problems.

Take for instance this hypothetical example:

Imagine a group of social scientists that have been given the task by a government agency of reporting on the distribution of population in informal settlements in Mexico City between 2010 and 2018. Given the spatial nature of the problem, producing what is commonly understood to be a map provides one viable solution over a variety of potential solutions to this problem. They have to construct a spatial representation using available data that conform to the agreed standards and conventions and which effectively communicates the pattern of population change.

Starting from a position of having specialized tools and resources, and certain degree of knowledge, experience and skills, they work toward the process of mapping. The map *emerges* through a set of iterative practices of employing certain techniques that built on other’s previous works or standardized forms of representation. This process is choreographed to a certain degree, shaped by the scientific culture of conventions, standards, rules, techniques and philosophies but is not determined and essential. The map is contingent and relational in its production through the decisions made by the team with respect to what attributes are mapped, their classification, the scale, the orientation, the colour scheme, labelling, intended message, and so on. The fact that the construction is enacted through affective, reflexive, habitual practices that remains outside cognitive reflection. The team “plays” with the possibilities of how the map will become, they experiment with different colour schemes, different forms of classification, and differing scales to map the same data. Making maps then is inherently creative and maps emerge in process.

While all this decisions and actions might seem trivial, this culmination of a set of practices— creates a spatial representation that they understand as a map and believe that others will accept as a workable map based upon their knowledge and experience of what constitutes a map. Finally, when this spatial representation that the group understands as a map is printed to show to the government agency required, we would argue that their creation is not complete, although it has the appearance of what Bruno Latour (1986) calls an “immutable mobile” with its knowledge and message fixed and portable, and it can be read by anyone understanding maps language, it remains mutable, remade every time it is employed. Their creation is not ontologically secure as a map because it is being transformed by the inhabitants living those places that continue to grow in those settlements, or the state worker that would take a decision regarding a new policy based on that data. Individuals transform the spatial representation created by the team, into a map. Each person engaging with a spatial representation brings a different map into being, framed by their individual’s knowledge, skills and spatial experience. For someone who does not understand the concept of thematic mapping or classification schemes, again the map will be brought into being differently to people who do, who will ask different questions of the data and how it is displayed. There is variability in the ability of people to mobilize the representation and to solve particular problems. Moreover, the recognition of the map generates a new, imaginative geography for each person.

In this paper we share how embracing this point of view of maps as processual instead of representational devices and reimagined them more like unfolding activities brought into practice in an embodied, social and technical way. Kitchin, Perkins and Dodge, (2011), provide a mix of creative, playful and tactile tools to support a participatory mapping

initiative, considering the experience knowledge and skills of local inhabitants of three communities in the West Mountain Region of Mexico City. The experience of creating a map as a collective, made them conscious of their memories and heritage, linked to their natural resources, made them reflect on their own identity and knowledge and mobilized toward more organized and purposeful actions.

The West Mountain Range of “Las Cruces” comprises one of the last forest areas surrounding the Mexico City megalopolis. Five original indigenous¹ towns settled formally in 1860 as the District County of *Cuajimalpa* and have been living in a direct relationship with their environment and close to their traditional knowledge and religious rituals. Their main activities were agriculture (collected mushrooms and wood from the forests surrounding them), a locally cultivated “pulque”² alcohol, and coal production. Unfortunately, various modern pressures on their environment including real estate development, different agrarian regimens, forest closures and corruption has resulted in significant deforestation and river pollution.

The government has attempted partial solutions but have not gained much traction. There is a long history of negligence, inefficient water collection systems and unsustainable programs for river and forest protection. A lot of these settlements are informal and do not have sufficient drainage channels, and the ones that do, are poorly maintained, causing redundant water leaks that bring untreated waste to the underground soil and rivers. There is a partial conservation plan that very few know about or respect. There are also different levels of land tenure, meaning that ownership issues have forced inhabitants to sell their lands to private property, or even relocation to more dangerous areas.

This is the common context that these original towns find themselves in today that constitute the “peri-urban forest belt”. The reality is that they are slowly being consumed by urban expansion. The natural resources from these forests are diminishing, yet are still essential livelihood for many, though cared for only by a few, causing many disturbances and conflicts between these communities.

In this context, our academic research team of designers and social scientists worked in collaboration with the Environmental and Territorial Ordinance Procurator's Office (PAOT). We decided to co-create a Natural Resources Catalogue within three of these communities considered original towns in the city: *San Pablo Chimalpa* with 151,127 inhabitants; *San Mateo Tlaltenago* a communal agrarian organization with 14,168 inhabitants (80% of their territory is part of “*Desierto the Los Leones*” National Park); and *Santa Fe Town*, (one of the original hospital-towns founded by missionary Vasco de Quiroga in 1583, it is actually a collection of neighbourhoods belonging to Alvaro Obregon’s district). All these original towns preserve a strong traditional representation of the people in front of the governmental structures we call “Delegations”, which responds to the urban logic of the city and its government nowadays. The relationship between the socio-religious-parental structure and traditional forms of community governance groups called “*comunas*” had been historically very strong and opposes new ways of government planning and authority which has generated slow processes of transformation in these towns (Portal and Sanchez Mejorada 2010). Since there are very few formal land planning records of the territory from the authorities, and the sources of existing spatial information have many discrepancies and are not public, we decided to pursue a participatory cartographic approach with the purpose of starting to develop a common planning and decision-making activity in the city.

Participatory cartography has been considered a fundamental instrument to help marginal groups represent and communicate their needs within the territory and augment their capacity to protect their rights. (IFAD, 2009). We decided to carry out this initiative as an alternative to empower the community, who have vulnerable backgrounds, are threatened by landfills and other conflicts related to land access and ownership. We also realized that community mapping initiatives can easily fail or even end up being counterproductive, especially when government agencies use the map made by locals, as evidence to favor their points without really considering community needs or voices, causing even more conflict rather than using them to pursue intelligent and balanced negotiation and planning.

Our goal was to include as many stakeholders as possible to better integrate local knowledge and direct experiences from the lived community environments. For this we needed to engage relevant stake-holders, like the community leaders or the women in charge of managing the rural laundries or “*lavaderos*” who have lasted from the colonial period and still represent a traditional way to use natural resources for the community. If we had only relied on tools like geographic information systems technology (GIS), we might be limiting the ratio of engagement to just a few people besides our research team and some specialists (Canevari-Luzardo et al. 2017). We needed to pursue a novel way to target and co-produce local knowledge, so we undertook a study about walking trails that incorporated interviews with the community leaders and developed a generative toolkit (Sanders and Stappers 2012) that supported map making through workshop sessions with a variety of participants and a followed them up with an observational guidebook to be distributed among other neighbours that could not attend the workshops. The design and planning of these generative methods are based on a relational design approach to human agency, called Agency Sensitive Design (ASD) which is based on Actor-Network Theory (ANT) and Activity Theory (AT) framework to develop a relational understanding of built environments. ASD approach suggest a new pragmatic design practice where a more inclusive mind set prevails in favour of more emergent and fluid actions over the prescriptive and controlled control attempt to predict actions. (Kocaballi et al. 2011). Baki Kocaballi and colleagues (2011) suggest six qualities that characterize this relational design approach, built on their analysis of recent developments with situated and embodied perspectives in interaction design field, which we considered to develop the tools for participatory mapping toolkit. We were also inspired by the Argentinian collective *Iconoclastas*, which have achieved great activists results for Latin American communities. (Ares and Risel, 2015). Within their own style, they have approached mapmaking as a practice, adapted a set of tools to organize mapping workshops, concentrating their efforts in the creation of a set of questions, and icon templates to easily identify major problems.

The study offered an opportunity to test how a processual approach to mapping using generative tools designed with consideration of relational aspects of agency, could trigger different levels of collaborative action in the context of participatory cartography. This new approach helped the three communities to increase legitimacy of the mapping process and led to incorporation of local actions. Interestingly, for two of the communities in the study, those with a more cohesive social and land organization with strong hierarchical and patriarchal distribution of labour, this approach gave women more voice and recognition in the decision-making process within the working groups.

The information generated by the community supported the decision-making process grounded in participation as well as encouraged better cooperation in knowledge co-

production between scientists, societal actors and decision-makers. It also informed the designers with a more inclusive way to understand and categorize natural resources and was a key aspect for the interface design of the platform, which is being worked on with some younger members of the community.

Approaching participatory mapping for the West Region communities

Participatory mapping also known as community-based or cultural mapping had its origins around the late 1970's and the beginning of the 1980's, and at its broadest definition involves the creation of maps by local communities often with the involvement of supporting organizations, either governments or non-governments organizations (NGOs). It emerged from participatory rural appraisal (PRA) methodologies, created by Robert Chambers, in 1983 a fellow at the Institute of Development Studies (United Kingdom), and spread widely throughout the development community, emphasizing transparency and inclusiveness of all community members in an event, most often related to a development initiative or some form of community-based decision-making process.

Participatory maps provide a valuable visual representation of what a community perceives as its place and the significant features contained within it. They could include a depiction of natural physical features and resources as well as socio cultural ones. It is significantly different from traditional cartography map-making through the process by which the map is created and the uses to which they are put. They focus on providing skills and expertise for community members to create the maps themselves, to represent the spatial knowledge of community members. (Corbett, et. al. IFAD 2009). The process attempts to make visible the association between land and local communities by using the commonly understood language of cartography, we could argue that, “the power of the map” is assumed as a given, a sentiment first broadly articulated in the by Denis Wood and other participatory mapping pioneers in the 1990s.

Making people collaborate in the construction of a map assumes that the representation has to present some spatial information at various scales, it can depict detailed information of the village infrastructure (rivers, road transport, or individual houses) or a large area (extent of the common natural resources, the distribution of territory and its boundaries) but it could also illustrate intangible things, like important and cultural aspects of their historical and local knowledge. Participatory maps differ from mainstream maps in content, appearance and methodology because they usually represent a socially and culturally distinct understanding of the landscape and include information that is excluded from mainstream maps, which usually represent the views of dominant sectors of society.

West Region Mountain communities and selection of mapping methodology

Our University established in The Santa Fe district in 2004, as part of the West Mountain Region. This area had a long history of controversies, starting from being one of the big garbage dumps for Mexico City in the 1950s when it had a population of 2000 inhabitants. Due to a “modernization” project run by Mayor Carlos Hank Gonzalez from the early 1980s to the mid 1990s has been transformed into a large-scale urban corporate and commercial zone (Moreno-Carranco 2013). The area has surpassed its growth capacity and now land prices have been increasing, forcing local communities, especially the original towns which,

use a different organizational structure and land ownership, regulated and recognized by their traditional knowledge and their agrarian origins as ‘commons’ by the government of the City. They have been forced to sell these lands and move towards other areas currently within conservation districts.

The story of the original towns (settled before the Mexican colonial age) have many tensions and conflicts between communal leaders who had been losing political representation, and the change of their common status due to changes with land use. Many disturbances begin with uncertain property boundaries and excessive urban growth, which places critical pressures over critical natural resources, mainly forests and water. An additional mass migration of outsiders in part due to the earthquake of 1985, poverty from other states like Tlaxcala, Puebla, Veracruz, Chiapas, Michoacán and those displaced from other landfills have initiated informal settlements to take root in the region, threatening one of the most emblematic Natural Resources like “*Desierto de los Leones*” National Park and hundreds of acres of forested preserved areas in the region.

Besides a few isolated efforts there is no Natural Resource Management plan implemented in the region. Communities are fragmented, and usually isolated due to border or land conflicts and corruption. In terms of their hydrology the main rivers like *Río Borracho* and *Río Atitla* are highly polluted despite the natural occurrence of springs, which inhabitants hide from authorities out of fear of being displaced. Inappropriate agricultural practices and rapid growth of informal settlements have led to water pollution; decline in river flows, and accelerated soil erosion. Combinations of these factors, along with deforestation, are principal the main causes of local environmental degradation.

Part of our mission as a public university in the region is to facilitate the transfer and propagation of knowledge and promote connections between the inhabitants of the original towns with their neighbours, corporate and government agencies. The university is also interested in developing a long-term mind set of sustainable management for natural resources in the area.

We co-created a current catalogue of natural resources that is meant to be a continuously evolving mapping activity reflecting the interests of the community. These artefacts are designed to help reflect the interests of the community, and function as a container that documents and protects local knowledge and communal experience. We saw the co-creation of a Natural Resource Catalogue with the community as an opportunity to facilitate the gathering of information about natural resources in the region. We hypothesized these living documents could increase the ability of the original towns to express their own traditional knowledge and land-related rights. It has helped them share their collective experience through partnership with scholars and reinforces social networks to other nearby towns.

We can recommend participatory mapping as highly effective for indigenous or marginal communities, in particular, where elders share traditional place names and stories with other members of the community. It can also generate interest in the local knowledge, especially among the youth.

One of the functional advantages of GIS technologies is that they convey a sense of unbiased authority making them a valuable tool for advocacy and for influencing land-related decision-making with other stakeholders. From our scientific perspective we needed to use these technologies to store, retrieve, map and analyse geographic data but we also needed to integrate, and layer local knowledge and data generated for the community to use. So, we decided to assume an intermediary or facilitator role for technology and assumed a “partial

participatory GIS approach” a process where all the computerized aspects of GIS are undertaken by a technical expert (Canevari-Luzardo et al. 2017); in our case, the main designer and geographer of the research team.

Our process consisted of 4 stages:

Stage 1. Diagnosis and delimitation of the area of study and community approach – Our University arrived and delimited their area of influence. We established preliminary contact with community leaders. In this stage we germinate the concept of a co-production of a Natural Resources Catalogue with the communities would help strengthen the relationship between the University and the communities. We also detected that in order to support their traditional knowledge and legitimize their decision-making processes it was crucial to involve them in participatory mapping initiative, since there was no spatial information generated from the community perspective and their memories and practices linked to their local natural resources were being lost.

Stage 2. Fieldwork and information gathering with the community – We conducted some trials and interviews with people from the community using Geographic Positioning Systems (GPS) and recorded photographic and video material of salient resources of their environment like springs, plants and trees, and settlements. The material generated in this stage was crucial for planning the participatory mapping workshop in later phases. We designed a fieldwork guide for the research team, to conduct a natural resources audit, document natural resources specimens, their location and the stories and popular uses to the inhabitants. In this stage we developed the materials for the workshops and prepared the communities for the mapping activity in the next phase.

Stage 3 Community Mapping Sessions – In this stage we facilitated and implemented the workshops with each community using the generative toolkit. We introduced the communities to a short explanation of the purpose of mapping, and the range of tools available to them. We also explored the potential use of the map as part of the catalogue with participants. Participants developed 11 maps. Following the workshop, we provided an observational guide for other members of the community that couldn't attend the mapping exercise or that thought they could complement the information later from their homes. After this stage we collected 10 guidebooks from the communities and integrated this content into the maps.

Stage 4 Evaluation monitor and map use phase – We analysed and evaluated all the community developed maps and integrated the data into general themed maps for each community including three categories: natural resources (water, flora and fauna and forestry), land-use regimen boundaries, and environment impacts. We integrated these into a natural resource platform proposal. As a mechanism of feedback, we took the maps and the proposal for the platform and arranged for feedback questions and interview sessions with the community. All the suggestions and changes were integrated as the platform was designed.

Materiality and the activity of mapping

The notion of co-production of a natural resource catalogue involves a collective activity applied across the process of map making and the interaction of the participants with material-based agency.

In our experience as researchers and practitioners we have seen that co-creation practices requires to use the design process as a means to enable a wide range of activities for different stakeholders in order to collaborate (Burns et al. 2006). We needed to change our researcher's perspective of the participant roles in the map-making exercise. We transformed the people from the community from passive objects of study to active and willing collaborators that need to acquire certain spatial skills for knowledge production working with an expert group of researchers. Our end goal was to bring knowledge from theory into practice in a way that understands the technology of mapping as well as respecting local knowledge.

Mapping is a collective activity where participant's roles get mixed. The person who eventually is going to use the map is given the position of being the "expert of his/her experience" and plays a larger role in overall knowledge development. Evidence for this statement happened during a particular trial in *Desierto de los Leones* National Park with Mr. Juan Esparza, one of the community leaders of San Mateo Tlaltenago. At one point of the trial Mr. Esparza stopped in an open valley to explain our location and other important issues in the territory, he grabbed a stick and started eloquently to explain by drawing with it in the ground. That moment was crucial evidence that Mr. Esparza had vast and critical spatial knowledge of the landscape and location of natural resources in his territory.

Mr. Esparza's explanation reminded me of a story Bruno Latour (2003) uses in his book "Science in Action" to analyse how specific inventions like cartography, helped people to construct facts for an argument. Latour's focuses specifically on how someone persuades someone else to take a statement. To illustrate his point, he refers to La Pérouse travels through the Pacific, for Louis XVI in 1788, with the specific mission of bringing new knowledge to their civilization. Landing in a particular place he encounters aborigines, to his surprise they show him they understood geography quite well, by answering La Pérouse question of where they are, they draw a map of the island on the sand with the scale and details needed by Pérouse to understand. Another, who is younger, sees that the rising tide will soon erase the map and picks one of the explorer's notebooks and draw the map again in pencil.

Latour questions the difference between the 'savage geography' and the 'civilized' or 'scientific mind.' Both actors in this encounter are able to think in terms of a map and navigation, strictly speaking they both have the ability to draw and visualize based on the same principle of projection, first on the sand and then on paper. What he tries to explain in his example is that knowledge is relative, if we analyse the situation closely, the purpose of that drawing changes for each of the persons that generates it. From the side of the aborigine, and in our case from Mr. Esparza, there is no doubt that he and his team know their territory quite well, there is no problem if the drawing fades away, it can be redrawn at any time. In the contrary for La Pérouse or our research team's perspective: the drawing represents a core part of the mission, we need to be able to establish document and pass the location of those places and species and bring them back to people who expect certain documentation. These people expect 'a map' as evidence to determine the contents and

locations of this part of the world and if it is worth another visit for claiming new natural resources for their future interests and exploitation. La Pérouse and our team's exclusive interest in this representation relies on some specific attributes that let us incorporate it as projection, writing, archiving and or computing. This capacity somehow needs to hold and endure the journey back to the place where people await that information. The critical information needs to be stored for later use and discourse. Our team and La Pérouse interests "hold on" to a long tradition of knowledge and practice that has been constructed through manipulation of paper, prints and images accumulated through our own culture.

According to Latour the difference between us as researchers and Mr. Esparza's team as actors in this situation is in the strategy, in the power provided by the semiotic material which is inscribed in the object we call a map, how is it that this particular inscription results in something convincing. In other words, Latour focuses on the mechanism used by the artefact to sum up "groups of allies".

Thinking about our project aim, we needed to come up with useful tools for the community in the process of mapping and understand their familiar inscriptions and materials that would facilitate their creative activity. In sum, we needed to invent objects, which have the properties of being mobile, but also immutable, presentable, readable and combinable with one another. (Latour, 1986 p. 21) From our participant's perspective, we needed them to be able to translate their local knowledge and memories related to their natural resources through conversation and pour them directly onto a collective map, we needed to think maps as "immutable mobiles".

Concept of inscription in Design

The concept of inscription is crucial for the design activity because any designer aims to create, modify, enable and or constrain some capacities of action through the designed artefact. Akrich (1991) explains the notion of inscription as: a vision, value, program of action, or prediction about the world that the designer ascribes in the technical content of a new object.

The strength of an inscription may vary from being very strong, that is, imposing on a particular inflexible program of action, to the very weak, offering many flexible programs of action, according to Kocaballi. Strong inscriptions belong to a design perspective of design that aims to predict, prescribe and control the kind of relations between humans and technologies and the ways in which their interaction unfolds.

By letting a few groups of specialists control the technology and resources in the process of map-making of a community instead of facilitating it, we are characterizing the human-technology interaction shaped by strong inscriptions in that situation. This is not suitable in situations where we need appropriation, personalization and adaptation or when exploration is needed. Participatory mapping is a process that does not benefit from the assumptions of agency as predictable and fully controllable phenomenon. On the contrary, to acknowledge and develop sensitivities to manage relationally for designing new technologies of mapping we must formulate design solutions that can deal with the unexpected situations in the various cases of participatory mapping that inevitably arise.

Co-creative approach and generative tools for the mapping activity – The generative tool kit to support the participatory mapping workshops with the communities had the following components:

- A visual presentation explaining the objective of the catalogue, maps and activities involved in the workshop
- A base map that could be a satellite image or a topographic layout of the community
- Translucent or clear paper to overlay the base map, Post-it notes and colour labels with different shapes.
- Photographic images of relevant species and places that we found during the trials (plants, trees, springs, places, animals and short video recordings).
- Glue and Velcro tape, small wood cubes, color markers and cards
- The observational guidebook was a follow-up activity for potential participants after the workshop.

For the purpose of explaining our methodology, we are considering all the components of the toolkit mentioned above as mediating devices that influence the individual experience of the participants in the mapping activity. This focus on artefacts is borrowed from activity theorist Wartofsky, who describes an artefact as being useful for creative thinking. He emphasizes the activity of representing with a purpose, that human beings create their own means cognition, signalling the existence of tertiary artefacts which “transcends the more immediate necessities of productive praxis,” giving freer rein to imagining “possible worlds” (Wartofsky 1979). And such possible worlds function as models, embodiments of purpose and at the same time instruments for carrying out such purposes. Based on this, we argue that all the maps generated by each of the collectives in the workshops, specify future object-oriented activities. They serve far beyond their immediate environment, propelled by the creative activity of the collective group.

Co-creative approaches to solve complex problems and identified future opportunities do not belong to a particularly discipline or domain. In fact, very similar approaches exist under the umbrella of Participatory Design that combine the expertise of designers and researchers and the situated expertise of the people whose work is to be impacted by a change. All these approaches are currently in use by academics, designers, international development and social the sciences. (Sanders and Stappers 2012)

Generative design approaches empower everyday people to generate and promote alternatives to their current situation and is based on the motto: “all people are creative”. The name “generative tools” refers to the creation of a shared language that researchers and other stakeholders use to communicate visually and directly with each other. The design language is generative in the sense that with it, people can express an infinite number of ideas through a limited set of stimuli. The generative tools approach in our case aims to provide simple and tangible materials to help participants communicate knowledge and memories linked to their natural resources through the exercise of mapping. We looked for inexpensive materials that required no professional or special verbal skills, low spatial expertise, and low effort to construct a tangible artefact.

The selection of the materials, colours and icons should encourage the expression and reflection of past memories and previous experiences. They should be designed to facilitate the process of participation of people unfamiliar with your goals. Participants select

materials, point, draw colour and build artefacts and explain to others what relevant information they are aware of. These individual artefact creating activities are a way of harvesting a collective wisdom into a layered and integrated whole.

The Generative Design (GD) approach as well as Agency Sensitive Design (ASD), are two approaches that helped us to develop and design the tools in our sessions. We see many parallel principles between the two approaches for ideation and expression for the mapping exercise. GD sees generative tools as a methodology within design research, focusing on materials or objects of creation for non-designers, through a shared design language that researchers use to visually communicate between the parties involved in a project. With these material objects, people generate and promote alternatives to their current situation and allow people to express their visions, wishes and expectations about the future.

ASD, in comparison, supports a relational nature of human agency (Kocaballi *et al.* 2011) where agency is neither an attribute of the subjects nor the objects, but an ongoing reconfiguration of the world and ultimately an effect of a heterogeneous network of human and non-human actors. (Latour 2005). These new approach to the concepts of agency has been very helpful for projects that need to rethink how technology (e.g. artefacts, tools, objects or things in general) interacts with human intentions and social structures. We argue that this approach is complementary to the participatory perspective. Instead of trying to control, predict or design actions and relations for the user, designers may look for more emergent and fluid relations in the situation they envision. Kocaballi (2012) sets out six different qualities: *Relationality, Visibility, Multiplicity, Accountability, Duality and Configurability*. The majority of these qualities are relevant in creating conceptual lenses for designers to gain a relational understanding of a situation and increase their awareness to accommodate the diversity and richness of human agency and to perform a more responsible and ethical design practice.

Both approaches need to promote alternatives to a specific current situation based on the notion that all people are creative and have knowledge, they become “experts of the experience”. They value the local expertise of the people who inhabit the environment and challenge the existing power structures that exist between dominant organizations.

One mapping session was held for each community through the period of March until May of 2017. The collection of tools the participants used were planned as a common language to lead the participants through conversations where they could communicate their stories, feelings and ideas while constructing the map of their territory. One of the greatest strengths of this initiative relied on the ability to bring mapping process to community members and share together ideas and visions, which can contribute to building community cohesion (Alcorn, 2000). We will use GD and ASD framework to explain some components of the mapping exercise.

Relationally – The quality of relationally refers to the connectedness and relatedness of human and non-human actors or socio-material arrangements where they co-constitute each other through their interactions.

To reconcile the relational character of our capacities for actions, the constructed nature of subjects and objects and the corporeal grounds of knowing an action, we designed the activities and materials for the sessions considering three sensitivities:

1. Understanding of mutual influence, shaping and co-constitution of actors and artefacts.

2. Embracing and supporting emergent and improvised actions.
3. Consider the mapping activity as an assemblage of actors, artefacts and collective hybrids.

For example, the images used for each session were collected from the trials with each community and they represented local places familiar for them, each session was conducted with the same structure but with small differences. In the Santa Fe's session, participants were more used to mobile technology and wanted to incorporate their own images for their maps, so we marked that with posit it notes, and then asked them to send them so we could incorporate them in final maps. We did not make a specific sample criterion for participants but encouraged elders as well as women. In one of the workshops, children were brought to the sessions and we were happy to work with all of them.

From all the generative materials for mapping we should like to stress that the printed photographs and iconography taken from their own environment, helped the flow of actions for all the participants by supporting emergent and improvised actions (Figure 1). The easy manipulation inscribed in simple objects enabled each participant to pick an image and attach it to the map, by doing so they could easily describe memories and stories related to their natural resources or express their concerns that threaten their environment.



Figure 1. A group of participants working with materials to build their map at Chimalpa's Workshop. Nora Morales. Photograph © Nora Morales.

Visibility – The quality of visibility is closely related to qualities like multiplicity and accountability. It involves making visible invisible work, human and non-human actors, infrastructure and interaction during the mapping activity. Visibility not only facilitates the

overall awareness of human actors of themselves and others, but also helps the performance of more responsible practices.

This quality was very important to support user appropriation by making resources publicly available. The observation guidebook (Figure 2) given to some participants after the mapping activity is a great example of the quality of visibility, it allowed the people that participated in the workshops to continue collecting information related to their memories and activities linked to natural resources. In some cases, it was given to some neighbours and allowed us to combine more information and integrate more participant knowledge into the project. The layout was designed following a rough sketch style, with a lot of white space encouraging the participants to fill in the space in a more creative way, by pasting their own personal images. In one of the cases a woman showed her family tradition of recollecting mushrooms “*bongeros*” by placing pictures from their family album and imprinting a detail inscription regarding each mushroom type and classification.

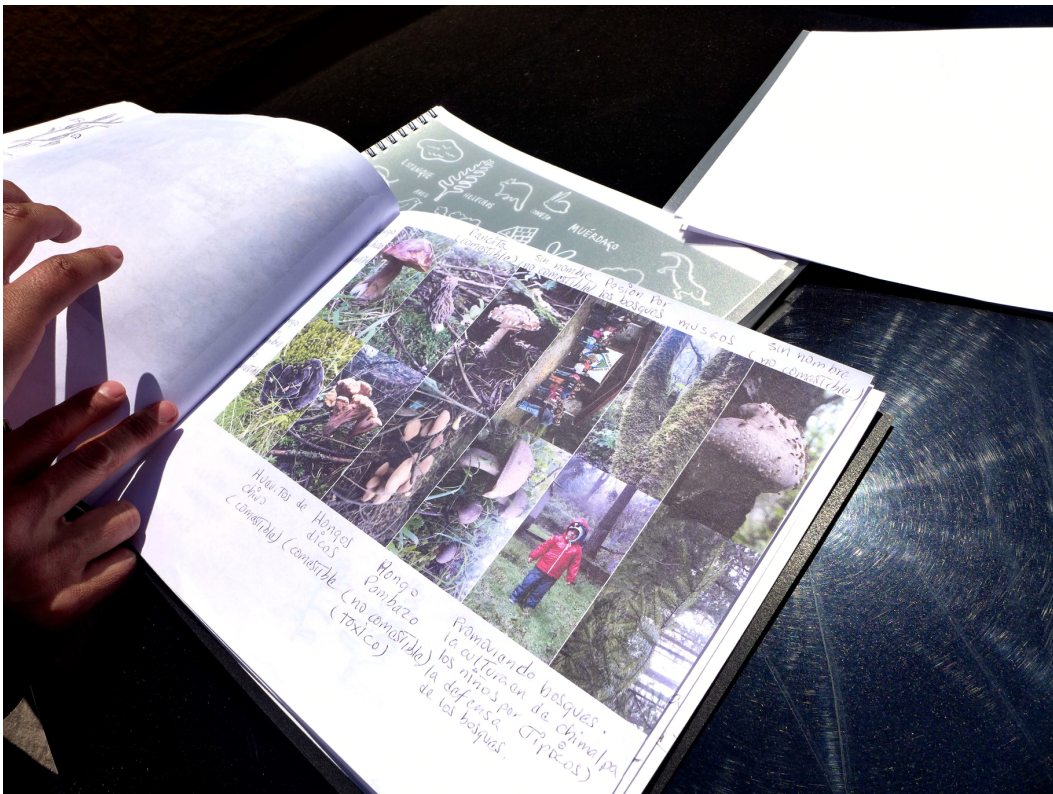


Figure 2. Observational guidebook from a participant from *Chimulpa* using family pictures to describe different types of mushroom and activities related to their recollection. Photograph © Nora Morales.

Multiplicity – This quality refers to multiplicity in ways of knowing and representing, which entail participation and heterogeneous sources of influence in the mapping process. In the workshop we had to overcome the traditional dichotomy of scientific/indigenous, expert/layman, men/women embrace knowledge diversity rather than our own traditions focusing on hierarchies.

We established mixed teams of participants and some of the elders couldn't write or read, so each team freely developed roles some of the participants acted as tellers, and others as writers. We also distributed a set of categories that we encouraged to be broken into different classification systems of their resources. There was an instance initiated by a female participant in one of the teams in *Chimalpa*, who tried to explain what she thought were root causes regarding their natural resource's issues using the "4 element classification of nature" (Water, Air, Fire and Earth) from ancient Greece. For example, she ascribed the problem of air pollution under the element of Air, and linked to various causes: burning trash, automobile pollution, lack of ecological culture, garbage in the streets, and animal waste. Those were common practices and situations from the inhabitants of the community. This enunciation later provided fertile ground to develop solutions they could implement.

This example is evidence of how the quality of the mapping activity was able to engage the group in the making of a *rich* map, describing themselves and their particular forms of practice. It also helped them explain to us the complex relations and incorporated multiple points of view of how they see their natural resources.

Accountability – Organized action can be observable and reportable. The materials and activities of the mapping session provided the participants with information about their own activities by dividing them in four or five groups (depending on the number of assistants). When finished, we asked them to explain their work to other groups in a plenary session. The participants were required to relate their position and perspective from other actors taking responsibility for their own perspective and partial knowledge.

Duality – Our designs invite particular kinds of actions, while inhibiting certain others (Latour 2005). This quality is strongly related to the idea of inscription of values into an object or technology. By using the kind of iconography with a "sketchy look" for the maps and the guidebook and the use of paper and tactile materials for the workshops we engaged regular people like woman and children who are more familiar with crafting activities. An important gender note: by prioritizing crafting technics, we de-prioritized the formality around written and oral speech that is usually ascribed to male dominant formats. Men in these contexts are usually the ones acting as local leaders, acting as "commissioners of the commons," especially when they negotiate with government delegations.

Configurability – The design process does not stop after the map production phase but the actual use of the map for the community, so our research team also developed a continuous organization of activities with the community to continue the integration process of information between technology and human actors transforming the data we collected into useful knowledge they could use. That is why the observational guidebook was key to the interaction with participants for the community from which we had very good results. We also are planning an open structure for the platform that will let participants continue adding information from their terrain of natural resources on an on-going basis, just like the mapping project.

After the workshop with each community each team generated a collage-map with the type of evidence that we were interested to connect with spatial data, which relates more to community memories and their shared understanding of the problems as well as local

knowledge linked to their natural resources. This type of information is usually avoided in formal cartographic scientific maps.

MAPS AS SOCIAL CONSTRUCTS OF KNOWLEDGE

After long sessions of analysis of all the materials, we were able to identify some tangible indicators as result of the mapping activity within the three communities at different scales:

Generation of thematic maps for the platform and validation.

The exercise let us identify which natural resources were more important to the community, San Pablo *Chimalpa* and *San Mateo Tlaltenago* showed a particular interest in their springs and trees, while in Santa Fe's town they were worried about natural landscape and trees as supports if their home's infrastructures since they are settled in the hillside near *Rio Tacubaya*. In the first two communities we noticed interest of recovering old pre-hispanic practices and language, they even refer to some places by referring to pre-hispanic names, they are also proud of speaking native languages and some individuals are keen on excavating their lands looking for archaeological object. With this information we developed thematic maps that will be part of the catalogue digital platform and had a preliminary session of feedback with the communities. As a result of the sessions we need to adjust some boundaries depicted on the collage maps and validate it with other neighbouring communities we are also thinking on generating a map with ancestral boundaries and pre-hispanic names.

The mapping activity trigger local action from the *individual scale to collective actions*.

Some examples referred to the individual level: In one session some men from Chimalpa said they were willing to start their own pulque production after they socialized to their team members. There was a group that recovered traditional knowledge from an elderly woman that used to be a "*leñera*" women that carried in their backs (in absence of animal ownership), logs and wood chips from the sawmill in the forest to their towns to make a living. That woman couldn't read or write, but orally accounted for the way she and her co-workers managed to transport the logs, she even remembered some prehispanic names the trees and places in the forest that were called "*parajes*" and corresponded to natural boundaries, she even remembered the names of the tools they use for carrying that they made with their own hands. Stories like these are evidence of how knowledge could be transferred from the elders to the youth within the community through the mapping process. The information generated at the workshop enabled participants to assume different roles while they communicate their ideas to others and supported equality in the decision-making processes,

The use of tactile and picture-based materials for map making was especially helpful for women of two communities in particular. These communities have a more cohesive social organization based on a 'communal commissioner' of the land, who holds a more traditional hierarchical and patriarchal division of labor within it. The objects used for the activity were made familiar to them through their materiality and encouraged them to speak their voice, especially for the elders in their group. In these situations, dominant men are the ones who usually tend to speak while others remain quiet, respecting their leader position for their group.

From individual to a collective activity

The processes of communication and coordination between individuals engaged in the collective activity of mapping has evolved between the participants and created some relationships binding them one to another, while we were doing follow up interviews with some of the participants we learned that some actions and initiatives have started from some of the groups, like women from the community of San Pablo, started a plant and herb recipe book which now is being worked with collaboration from students from our university.

From an interview to a community leader from *Chimalpa*, we learned that the community is meeting during the weekends to clean their rivers and also have initiated some consensus-based management that asks for the owners of private lands to tell the community leaders first, if he or she is planning to sell their land, so the land could stay within the community first.

In San Mateo, there has been some changes in the role of the community leaders and the politics of representing land tenure, that might have influence within their broader regions, some participants of the workshop are thinking about producing conservational areas maps to influence government land decision making in the construction of the inter-urban train coming from Toluca-Mexico.

CONCLUSIONS

The approach of mapping as a practice helped our academic team to overcome the high level of complexity that can marginalize poor communities from sharing their knowledge and beliefs of their territory. Our method provided the three groups with tangible information artefacts that let each person be aware of the spatial knowledge they possessed and how he or she can make immediate use of it. But more importantly it led beyond a common knowledge situation, where one or more people not only know something, but also all the others know, that they know. In other words, led to evidence their local knowledge among them.

By offering different ways to communicate their ideas, we also mobilized the information flow from one person to another and touch the community to a certain level, where the data endowed provided them with relevance and purpose regarding their natural resources. Specially by giving voice to women, an let them express their organizational routines, processes and practices in regard to their natural resources led men to recognize their primordial role in local knowledge.

All the memories evoked through the process of map making and embedded in the maps, made them reconnect with their personal and family history and understand their heritage regarded their natural resources. It empowered them by making them aware of their main risks and threats in their territory and established a hierarchy of resources that they needed to respond through collaborative and coordinated activities towards a positive change, instead of waiting for the government to do something.

Each community started actions according to their situation; in *Chimalpa* they are organizing weekend activities to clean the rivers, and a catalogue of traditional medicine and mushrooms in collaboration with students, In *Tlaltenango* they are looking for new

alternatives to communicate their boundaries to the government, and in the Town of Santa Fe they are starting to communicate among neighbours.

The emergent voice of the community was pronounced and ascribed to different forms of acknowledgement regarding natural resources management.

There are still strong barriers to overcome when applying GIS technologies to participatory mapping with rural or indigenous communities in developing countries, mainly to limited financial resources and lack of technical skills that automatically sets an unbalanced situation, from the community to the few experts, that automatically positions local inhabitants at a disadvantage within a power position.

There are major problems to attend to regarding the map authorship of these initiatives and the unintended negative consequences of exposing the information generated by the community. Either purposefully or inadvertently we will end up with private or otherwise valuable community knowledge. In our case it took the form of the location of informal settlements. Depending on how we showed it, or to whom, and how it will be managed could mean further harm and/or marginalization of exploitation of the land to the disadvantage of these people.

Perhaps these kinds of initiatives can help apply more pressure and inform official decision-making processes, and location-based technologies will one day be more accessible to everyone, or maybe we might settle down into something more widely useful, but for now it is still essentially a well-intentioned technological mess and remains unclear how this technology will actually help address these issues.

The absence of best practices and standard methodologies it becomes crucial to assess the validity and credibility of mapping processes within the context of the purpose and its use. If we believe that the ultimate purpose of maps is to support the general prioritization of actions or to increase the adaptive capacity within a community, we need to come up with new methods that help communicate or narrow the gap between local people and government.

We might not have one unique answer for achieving a successful participatory mapping project, but we believe we have revealed a methodology to balance the intended purpose of a map, the available resources, capacity within the community, the duration of the commitment to the project, and finally a way to trigger action and reflection through the process of map making. We might not yet be able to free the power of maps to just a few groups, but we might be pushing to keep all the voices of the stakeholders in a territorial project within the same level. Perhaps even these are merely the preliminary stepping stones to help us rethink new technologies from a different perspective and a step forward to achieve a successful participatory mapping initiative.

We can agree with Kitchin's statement that maps are never fully formed, and their work is never complete: they are transitory and fleeting, relational and context-dependent. My question to you would be how we would to establish a monitoring mechanism, and strategies to adapt to these constantly changing activities? The experience of this project is evidence of the truly fragile status of a place and these inhabitants. They face enormous pressures. At the moment I am narrating this story, these lands and natural resources of the three communities are being threatened and transformed by a giant infrastructural issue the construction of the Inter-urban train *Toluca-Mexico* which has caused the felling of many trees and species, as well as destruction of natural habitats near water springs land. It is doubtful to us that these projects used anything like a participatory map-making process as depicted in

this paper. With this transformation the human activities and practices of people in this territory is being transformed too.

NOTES

1. These communities have pre-hispanic origins, some of the regions are even mentioned in pre-hispanic codex as part of the villages in the outskirts of the mountains, there are still residents that remember their parents speaking indigenous tongues like: Nahuatl and Otomi.
2. A Mexican alcoholic beverage made by fermenting sap from the “maguey” a variety of fleshy-leaved agave plant known as “Century plant”.

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