The Hidden Politics of ICT innovation in development

Uncovering the politics at play during digital innovation processes and understanding how they relate to inclusion and exclusion in forest conservation and environmental justice

Author: R. van der Maas
Council: prof. dr. ir. C. Leeuwis
Date: 20-08-2020

Index

1. Introduction

In April 2018 a Dutch startup was founded with the aim to turn raw satellite data into an information utility by leveraging computer vision methods and cloud computing in a dedicated analysis cluster. It envisioned to make the terabytes of satellite data that are generated every day, useful for non-remote sensing experts. Helping them to monitor land cover conditions and dynamics anywhere on earth. As Non Governmental Organizations (NGOs) with an environmental focus were considered to be part of their potential market, validation interviews were conducted with various NGOs headquartered in Netherlands. One of these interviews turned into a project, where their ICT infrastructure would be used to help the the NGO's local partner track illegal deforestation in Latin America. Over a year later, the entire Gran Chaco forest, spanning Bolivia, Brazil, Paraguay, and Argentina, is being monitored for forest resources and other natural vegetation. Every detectable change in forest cover from 2016 onward is continuously recorded and published on a digital map. This data is fused with information about concession areas and land ownership, thus providing the necessary grounds to start distinguishing legal deforestation from illegal deforestation from behind a desk at low threshold.

ICT systems in forest conservation and environmental justice

While the innovation described above, in terms of its technical specifics and approach, is quite unique, the general narrative is not. Global Forest Watch (2.0), powered by the World Resources Institute, started out in 2014 and is a well established entity that monitors deforestation on a global scale. Its definition of forest is an FAO standard and its data is used by many organizations and researchers in the field of conservation, development, and environmental justice world wide. MapBiomas is a Brazil based initiative that has facilitated the mapping and sharing of data on forest and other land cover since 2015 and seeks to expand operations to other tropical areas. Newer initiatives, like the one described at the opening, are still sprouting. These also include the Starling mission launched by Airbus Defence and Space in 2018, Terra-i powered by International Centre for Tropical Agriculture (CIAT), FLEGT Watch by VisioTerra, and the World Wildlife Fund's Early Warning System that started development beyond its initial pilot phase in 2019. While each initiative is different in terms of its socio-economic and technical framework, they are all Information and Communications Technology systems (ICT systems) that are geared toward monitoring and operating in the realm of conservation, environmental justice, and development.

The challenges of forest conservation and environmental justice

These digital monitoring initiatives directly link into a broad effort to resolve the challenge posed by large scale (illegal) deforestation in tropical regions of developing and emerging economies. It is an issue that many academics from fields such as anthropology, forestry, biology, and geography have published about and that governments, companies, and NGOs have grappled with for decades (Boekhout 2014, 3). Deforestation, both legal and illegal, form a complex problem in tropical forests world wide. By many local actors deforestation and forest exploitation is considered a necessity for the development of their countries (Monteiro, 2018). Removing and exploiting forests for large scale cattle ranching, industrial agriculture, and export of tropical hardwood is a lucrative and international business (Arnold & Brown 2018). But it is not without its casualties, which fall disproportionately within local groups. Tropical deforestation is closely related to the use of violence against environmentalists, human rights activists, and indigenous forest inhabitants. Victims are not

exclusively human either. Tropical rainforests are the Earth's most biodiverse places, hosting over 50% of known species and organisms. Tropical deforestation leads directly to the extinction of these species, thus being a strong contributor to the extinction crisis and related environmental health challenges (Wilson 2002, p. 59, Caballero et al. 2014, Arnold & Brown 2018).

In aiming to control the problem of deforestation (legal, illegal, and everything in between), policy makers, law enforcement officers, development practitioners, and environmental advocates largely aim to do two things:

1) Establish who has rights to the land. This includes solving conflicting claims with indigenous peoples and touching upon various human rights violations, corruption, problematic land use, land ownership, and concession registration.
2) Monitor deforestation. This includes monitoring changes in forest cover, determining its causes, and determining its legality based on land rights.

As such, monitoring is a key activity in trying to control land use change and enforce laws. However, it is difficult for governments, departments of justice, NGOs, and private companies to trace and monitor (their own) impact and enforce laws and commitments (van Boekhout 2014, IUCN Netherlands Committee, 2018; Guyra Paraguay, 2018). This difficulty is also related to issues of corruption, intimidation, and (organized) crime that tends to (purposefully) confuse the how, when, and where of land use change, as well as its legality. It also keeps local people and activists from speaking out (van Boekhout 2014, 4).

The role of ICT in tackling monitoring challenges in forest conservation and environmental justice

It is currently mainly the second focus point (monitoring) that a portion of stakeholders is aiming to improve with the introduction of ICT systems that leverage AI, remote sensing, and/or cloud capabilities such as the ones introduced at the opening of this thesis. While satellite data has been around since the '80s, the use of remote sensing techniques to successfully monitor forests is relatively new. Until just recently, forest monitoring was an inherently costly, labor intensive, and, in many cases, dangerous undertaking (van Boekhout, 2014). Foresters use randomized field and aerial surveys to collect forest stock data and aerial photographs are used for plot-based analysis of forest cover (Crowther, Glick, Covey, Bettigole, Maynard, Thomas, & Bradford, 2015). Deforestation is still often tracked by manually comparing satellite footage, and logging clear cut with pictures and gps coordinates (van Boekhout 2014, 4; Guyra Paraguay, 2018). New ICT technologies have made it possible to monitor forest resources automatically and in near-real-time, yielding a complete inventory of natural vegetation as often as every month (Crowther et al., 2015). Thus allowing users of the monitoring systems to locate changes automatically, share their findings, and, in some cases, also determine their legality, from behind a computer screen. Without the interference and dangers of any natural and human obstacles that can be encountered in the field.

Researching ICT systems in development, conservation, and environmental justice

The advent of using Remote Sensing data to automate forest monitoring is just one of many examples of how ICT systems have come to play an important part in development, conservation, and environmental justice. Studies have examined the role of ICT systems in catalyzing initiatives towards democratic decentralization and empowerment of citizens, in reducing inequality, in providing new economic and industrial opportunities, and in assisting small ethnic groups to

overcome disadvantages of physical distance (e.g. Sein & Harindranath, 2004; Foster & Heeks, 2016; Madon & Krishna, 2018; Asongu & Odhiambo, 2019).

When looking at ICT innovations critically, scholars and development practitioners tend to speak of 'missed opportunities' and having to 'balance priorities' in using ICT. They call for the need to keep track of the broad development potential of Information and Communications Technology as well as a conscious prioritization of developments that are most important or impactful in specific situations. A critical academic stance can also be focused on unintended or unexpected negative consequences of the introduction of new ICT systems and, related to this, the need for more engagement between ICT practitioners and the development community (Sein & Harindranath, 2004; Parkinson & Ramirez, 2006; Thompson, 2008).

As such, whether the literature is hopeful or critical (or both), attention is primarily focused on the application and the consequences of ICT systems in the context of developing countries aiming to secure certain economic, social, and environmental goals, and not on the transformative nature and characteristics of the development process of the ICT systems in question (Walsham, 2012). This means that ICT artifacts and their consequences have been the subject of study, rather than the development process preceding them, where technology and society mutually shape each other and the observed consequences are enacted or may originate.

Zheng, Hatakka, Sahay, & Andersson (2018) argue that ICT for development (ICT4D) research requires a better understanding of the mechanisms through which ICT systems may be embedded in and shape development processes, their ideological nature, and their power structures. So while it is a common point of departure that technology and society mutually shape each other (Bijker, 1992; Latour, 1990), the ways in which this happens in ICT innovation processes, are still poorly understood and often go unnoticed (Zheng et al., 2018).

The politics of ICT systems in forest conservation and environmental justice

At first glance the ICT systems central to this thesis (automated deforestation monitors) appear to be quite empowering. They seek to make critical information easily available and actionable to everyone with internet access and an understanding of data analysis. By making deforestation patterns, land use restrictions, land use change, and land ownership visually insightful, communities and local organizations can be empowered with evidence to advocate and to hold landowners, law enforcers, and governments accountable to their commitments and legal obligations.

But while the output of these ICT artifacts may appear to be a democratizing force at the surface, the ability to benefit from them is not evenly distributed amongst stakeholders (Ribot and Peluso, 2003: 153). The process of building monitoring systems, as well as any other ICT system, consists of ample choices that influence the nature of the information that is being created, the workflow in which this happens, and the way it can be distributed and accessed. As such, these choices during the development process, while they may seem only technical in nature, are political and will shape society around them by empowering some stakeholders more than others, depending on their ability to leverage the type of information or knowledge that is created and the technology or protocol used for its distribution. As scholars tend to primarily look at the consequences of ICT artefacts, and do not seek a deeper understanding of their development process (Zheng et al., 2018), little attention is paid to the politics and strategic communication at play during early development

where these impactful choices are made. As such, we are missing out on how the groundwork is laid for the knowledge and technology based mechanisms of inclusion and exclusion that we observe as an outcome later on (Milgroom, 2012: 128).

The ICT shaped blind spot of Responsible Research and Innovation

Responsible Research and Innovation (RRI) is a common point of departure for development, innovation, and conservation practitioners, as well as for researchers in these fields. Inclusion and responsiveness are central to the concept of RRI and adhering to this school of thought means that uncertainties and ignorance about possible consequences of new technologies should be brought into the public realm of discussion (Groves, 2009; Di Giulio, Groves, Monteiro, & Taddei, 2016, 93). However, in innovation processes where ICT systems take center stage a lacking understanding of the underlying technology is putting many researchers and practitioners at a disadvantage when seeking to anticipate risk and uncertainty. The knowledge discrepancy between IT professionals on the one hand and development and conservation researchers and practitioners on the other, is currently proving to be too large to effectively discuss the ways in which mutual shaping takes place and understand how mechanisms of inclusion and exclusion may come into play during the innovation process (Hickey, Sen, Bukenya, 2015; Zheng et al., 2018).

The hidden politics of ICT system development in forest conservation and environmental justice

Considering 1) the persistent, destructive, and complex nature of challenges related to tropical deforestation, 2) the growing role of ICT systems in development and nature conservation, 3) the underexposure of the politics at play during ICT development processes in the existing body of literature, and 4) the ICT shaped knowledge gap of many social scientists and development practitioners, this thesis seeks to identify the hidden politics of ICT system development for forest monitoring. We do so through an innovation history analysis of the new automated forest monitoring system as introduced at the opening of this thesis, and tracing back how these politics take part in the mechanisms of inclusion and exclusion that we see emerge. As such, this thesis helps us to become more aware of power dynamics, potential mechanisms of exclusion, and patterns of strategic communication that may occur throughout the development process. This awareness supports scholars and practitioners to better conduct Responsible Research and Innovation.

Our thesis continues by building out its theoretical framework and introducing its research design. Then the context of our single case study is mapped out. Results of our research are presented and discussed next. Here we find that the politics at play are mainly knowledge based, resulting in various knowledge based mechanisms of inclusion and exclusion. We also find that these knowledge politics remain purposefully hidden due to a common interest of all parties directly involved, to remove from the narrative the exclusion of non-technical stakeholders from key decisions at the early stages of development. Where the nature of the information that is created, the workflow in which this happens, and the way in which it can be accessed is largely defined and greatly influences innovations outcomes and world-making. When looking at other ICT innovations as introduced above, a similar dynamic of hidden knowledge politics and knowledge based exclusion can be identified, suggesting that this pattern is not limited to the current case study. This thesis concludes with our main argument and recommendations for future research, where the identified dynamic should be thoroughly validated across multiple case studies to test its generalizability.

2. Theoretical framework

In the theoretical framework we introduce theories and concepts that are central to our research on the politics at play in ICT system development for forest monitoring, and how they are part of the mechanisms of inclusion and exclusion that we see emerge. We discuss theories that frame our thinking on the politics of knowledge, strategic communication, and mechanisms of inclusion and exclusion within the meta perspective of mutual shaping between technology and society as introduced in our introduction.

2.1 Inclusion and exclusion

Within the introduced RRI school of thought, inclusion is regarded as a key enabler of responsive innovation (Stilgoe, Owen, and Macnaghten, 2013). Being inclusive implies 'bringing into the processes that shape how innovation is guided and governed, publics whose interests may be affected by the outcomes of innovation' (Di Giulio,Groves,Monteiro, & Taddei; 2016; 92). In this study, inclusion is thus understood as a process in which groups who may be affected by an innovation are being brought in to discuss how it should be guided and governed. Being 'brought in' explicitly goes beyond having a seat at the table, and also implies that participants are also made aware of all possible risks, consequences and uncertainties involved, and that their views and knowledge, not just their person, are included (Groves 2009). By contrast, exclusion is understood as a process in which stakeholders are being obstructed from shaping how innovation is guided and governed. Exclusion on the basis of language barriers, knowledge, or knowledge inequality (such as being kept out of the loop on the possible risks, consequences and uncertainties of an innovation), is also a form of exclusion (idem).

Knowing which stakeholders, defined as those whose interests may be affected by the outcomes of the innovation, are out there and who among them are included in the development process is a point of interest for our research.

2.1.2 Mutual shaping and responsiveness

Within the introduced RRI school of thought, another key element that is seen as necessary to innovate responsibly, is responsiveness (Stilgoe, Owen, and Macnaghten, 2013). Responsiveness implies 'acknowledging and responding effectively and transparently to the perspectives of all those with a stake in the outcomes of innovation.' (idem). Responsiveness implies that the focus is not limited to the risks and possible (unintended) consequences of technologies, but also includes the way in which the innovation process itself is guided and shaped (Felt and Wynne 2007). This relates to the concept of mutual shaping between technology and society (Groves, 2009), as it recognizes this dynamic and also implies that this is something agents of development can, to an extent, steer and control. The extent to which the parts of society (individuals and groups) that are recognized as stakeholders are also enabled to exert influence, thus reflects the extent to which an innovation process is responsive.

As such, in addition to knowing which stakeholders were included in the development process, understanding how they were able to influence the way that ICT systems have taken shape is also a point of interest. This allows us to reflect on the extent to which the innovation process is responsive and to whom.

2.1.3 Mechanisms of inclusion and exclusion

By mechanisms of inclusion and exclusion we indicate the causal process through which individuals or groups are enabled or obstructed to benefit from a resource, such as a forest monitoring system in our current case study. In the context of our research we also understand it as being enabled or obstructed from co-shaping how innovation is guided and governed, such as the development process that precedes the launch of a forest monitoring system.

Ribot and Peluso (2003) identify a list of key mechanisms that may influence or facilitate a stakeholder's ability to benefit from a resource. They argue that mechanisms are either rights-based; defined by law, custom or convention, where the state enforces a legal claim or opposes an illegal one. Or that mechanisms are structural and relational; concerning political, economic and/or cultural factors that limit or enable someone's ability to benefit from a resource. These mechanisms include technology, capital, markets, labour, knowledge, authorities, identities and social relations (Ribot and Peluso, 2003, 162).

An example of a rights-based mechanism would be the exclusion of women from driving cars by the Saudi government, or the inclusion of wheelchair bound individuals by making accessibility to all public buildings a mandatory requirement. An example of structural and relational mechanisms would be the exclusion of neighbourhood residents from access to fresh foods due to the lack of available produce stores, or the inclusion of migrant children by offering bilingual school supplies and classes. Other authors have specified a myriad of related factors that can be potential mechanisms of inclusion and exclusion. Such as network effects, ownership of social, economic, and cultural capital, discrimination, education, stereotyping, knowledge inequality, micro-level workplace dynamics, and large scale sociocultural and economic developments (e.g. Rydgren, 2004; Elling and Claringbould, 2005; Chaskin, Khare, & Joseph, 2012; Döll & Knappik, 2015). Like Elling and Claringbould (2005, 499), we consider these mechanisms as being 'dynamic, often paradoxical, and continuously challenged.' We consider them to be interrelated and can function sequentially, simultaneously or in opposition to each other (Ribot and Peluso 2003).

For our current research we seek to identify mechanisms of inclusion and exclusion in ICT system development for forest monitoring.

2.2 The Politics of Knowledge

Innovation processes, like developing new ways to automatically monitor forest resources, are closely bound up with knowledge politics (Porter 1996; Espeland and Stevens 1998). 'Knowledge politics involves conflicts between narratives about preferred and probable futures, and between the forms of knowledge within which such narratives are embedded' (Di Giulio, Groves, Monteiro, & Taddei; 2016; 94; Alfred and Corntassel 2005). During the development of new ICT systems for forest monitoring, stakeholders seek to influence the direction that the innovation takes by pushing their narratives and their corresponding forms of knowledge.

For this research, politics of knowledge are of special interest as a category of potential mechanisms of inclusion and exclusion. There are several concepts that elaborate on knowledge politics that can help us identify how politics are at play in ICT system development for forest

monitoring in our case study, and how the related mechanisms of inclusion and exclusion have emerged over time. These concepts are discussed below.

2.2.1 Privileged knowledge

Alfred and Corntassel (2005) argue that not all types of knowledge (or epistemologies) are equal. Some are more socially privileged than others. As such, the type of knowledge that stakeholder narratives are based on matters, because it relates to them being prone to marginilarizions and, as a result, exclusion. Narratives that become dominant tend to be constructed around definitions of need or national priorities. Technical knowledge is then seen as the primary source of solutions. As such, stakeholders that have an epistemology encompassing socially privileged forms of knowledge and expertise, get to frame what the presumed benefits and risks of particular development options are. Marginal narratives on the other hand, are argued to be rooted in specific stakeholder epistemology, needs, and vulnerabilities, which may reflect the legacy of colonialism or environmental racism (Alfred and Corntassel 2005; Di Giulio, Groves, Monteiro, & Taddei; 2016; 94).

Considering the assumed relevance of a stakeholder's epistemology, we are mindful of this as we seek to identify mechanisms of inclusion and exclusion in the development process of ICT systems for forest monitoring in our case study.

2.2.2 The significance of storytelling and strategic communication

As we speak of 'narratives' it becomes clear that shaping an innovation process is about selling a good story. To mobilize support, stakeholders in the innovation network aim to fit them into tangible visions to serve as vehicles that foster understanding about a future in which the (digital) innovation is embedded. The success with which these stories and visions take hold, is largely dependent on who is telling them and on how tangible they are made. The extent to which an actor has gained the position, power, and legitimacy that is required to tell a story convincingly is key (Klerkx, Aarts, Leeuwis, 2010, 2). This also links directly to the existing definition of (privileged) knowledge among their audience.

Narratives, and the way they evolve and become marginalized or dominant during the innovation process, is something of interest to us in this research. Tracing narratives can be a method to identify mechanisms of inclusion and exclusion, but storytelling is also a form of strategic communication (a political tool) that can be used by actors to purposefully hide or transform such mechanisms in the eyes of onlookers or network partners, including researchers such as ourselves.

2.2.3 A struggle to control definitions

Nature conservation and development in itself can be understood as a battlefield of knowledge, because various actors and organizations are struggling to control its definition (who has knowledge, who creates it, and who divides it). Controlling the definition of knowledge allows actors to shape who has a say in how problems are defined, whose insights should be relied upon to solve them, who are legitimized to speak on specific issues or be a representative for certain groups, and who is allowed to control a budget. As such it is a means to control how conservation and development practice is shaped, effectively legitimizing or delegitimizing the influence of stakeholders (Holmen & Jirstrom, 2009; Long & Long, 1992).

Classification systems, that are an inherent part to monitoring, are also essential pieces of knowledge in all (scientific) activities because they 'reflect the differences that make a difference' (Turnhout, 2016, 5). We note that, when electing to represent the environment in a specific way, as is done through classification, objects are produced that are amenable to specific governance logics. These logics attract, privilege, and benefit certain groups of actors, and consequently exclude other actors and other governance logics. As such, these representations of the environment are never neutral, always selective, and to an important extent contingent. Seen from this perspective, producing knowledge constitutes world-making, and that is inherently political. More specifically, it concerns ontological politics (Turnhout, 2016, 11-13).

Therefore, paying attention to how knowledge is defined, who controls definitions (of knowledge and otherwise), and what constitutes the consequences of these definitions in terms of world-making, are important to understanding the knowledge politics and the related mechanisms of inclusion and exclusion that are at play in ICT innovation processes, such as to one in our current case study.

2.3 Research questions

In the theoretical framework we have identified and discussed theories and concepts that are relevant in light of our research question and that also direct the sub questions for which we seek answers. In the next chapter we discuss the research design that is employed to answer them.

Main question:

How do politics come into play during ICT system development for forest monitoring, and how are they part of the mechanisms of inclusion and exclusion that emerge?

Sub questions:

1. Which stakeholders are out there?
2. Who among them are included in the development/innovation process?
3. How do those included seek to exercise influence on the way the ICT system takes shape?
    a. How does this influence affect world-making?
4. How are politics of knowledge enacted during the ICT development process? Through:
    a. privileged and marginalized epistemologies?
    b. evolving stakeholder narratives and strategic storytelling?
    c. endorsement of definitions (of knowledge and otherwise)?
    d. consequences of enacted definitions in work-making?
5. What knowledge and technology based mechanisms of inclusion and exclusion can be identified?
6. What makes these mechanisms persistent through time and context?

3. Research design; action research in a single case study

The research design employed for this thesis helps us to provide answers to the research question and subquestions as introduced in the previous chapter. We use an innovation history approach in a single case study to identify how politics come into play during ICT system development for forest monitoring, and how they are part of the mechanisms of inclusion and exclusion that emerge.

3.1 Action research in a single case study: Scope

For our single case study we chose the case as introduced at the opening of this thesis. As the researcher is an active participant in this innovation process (the co-founder and one of the key representatives of the startup during the period under study) this case is a strategic choice. Here we have the benefit of good timing and direct and continuous access to other key players involved in the innovation process for a period of almost 2 years. This puts us in a rare position where we can gather real-time primary data as a participant observer from the very inception of technical development to the implementation process, helping us identify how politics come into play, and understand how they relate to mechanisms of inclusion and exclusion that we observed and trace back at in the ICT development process.

The case under study concerns the development and introduction of an ICT system that drives the digitization and automation of manual (monitoring) work. In broad terms this is a typical example for the digitization and automation trend that has been dominant for decades, in most sectors and in most regions in the world. The methods and tools used in the project under study (artificial intelligence- and cloud-based analysis of (remote sensing) data) also largely represent the industry's current cutting edge of technology. The observed dynamics between the private sector, end user, and facilitator is also a signature partnership for many development projects. As such we argue that this case is a fitting example of how ICT systems are developed and introduced into the realm of nature conservation and environmental justice, but is also in more general terms across other (development) sectors. In the context chapter of this thesis, our case study is introduced in detail with an eye for the factors and dynamics that have been deemed important in the theoretical frame, and through the data gathering methods introduced this research design and methodology section.

As explained above, we use an innovation history approach to find answers to our research question and subquestions in our single case study. Throughout the innovation history, primary attention is paid to stakeholder interactions. In line with the points of interest as identified in the theoretical frame we reconstruct which stakeholders are included in interactions, what narratives they push, what the nature of their involvement and influence is, which definitions (of knowledge) they endorse, what technical ICT design choices they are involved in, and how these factors impact world-making. In order to understand how these inter-stakeholder dynamics relate to each other, to knowledge politics, and to the mechanism of inclusion and exclusion that we see emerge, we look to fill in these details chronologically for 2 to 3 month episodes throughout the innovation history spanning approximately 1.5 years from initiation to implementation. We use this structured history of relevant inter-stakeholder dynamics and developments as our input to find cause/effect relationships and build a grounded theory on how identified knowledge politics at play in ICT system development relate to the mechanisms of inclusion and exclusion as observed during implementation.

3.2 Action research in our single case study: Benefits, drawbacks, and considerations

Usually innovation history reconstructions are based on document analysis and semi-structured interviews with key actors from the innovation network, as opposed to participant observations (Crossan & Apaydin, 2010). As such, most theories on knowledge politics and inclusion and exclusion mechanisms in innovation processes are based on secondary data, representing espoused theories and the memories of participants. As a result, what practitioners actually do in their interaction with each other, as well as how this affects inclusion and exclusion, has not been extensively researched. Observation methodologies thus present an underexploited method along this line of inquiry (Crossan & Apaydin, 2010, 1178-9). Therefore, by tracing an innovation history through (participant) observation, we go beyond secondary reports of key events and get to access practice. Due to the researcher being a stakeholder in the innovation process under study, we are able to gather primary data as the events take place. These data are then reflected upon and compiled into a structured timeline with the above mentioned factors and inter-stakeholder dynamics as our theory based focal points. These data consist of primary observations of stakeholder interactions, meeting notes/jottings, unstructured interviews, email records, press releases, articles, and project related documents including (draft) proposals and contracts/term sheets.

Table 1: Metadata

Data type	Quantity	Collection period
Observation notes from meetings and calls	19	July 2018 - December 2019
Email exchanges between project partners including attachments	77	June 2018 - December 2019
(Draft) proposals, contracts and term sheets	7	August 2018 - April 2019
Press releases and online articles	4	March 2019 - november 2019
Interviews with project managers	4	July 2019 - December 2019

Aside from the above mentioned methodological novelty in creating an innovation history based on primary data from participant observations, this method implies some benefits and drawbacks we need to be explicitly aware of. As the other stakeholders in the innovation network are unaware that they are subject of observation, we do not run the usual risk of affecting the behavior of research subjects as a result of this (Murray, 2003). This favours the internal validity of observations. At the same time, the researcher is not only an observer but also a participant, with a real stake in the situation. Of course, there is a general consensus that researchers must recognize that, as people, they have personality traits, backgrounds, and perceptions, that always shape the research process and their interpretation of data (Beatty 2010; Coffey 1999; Denzin 1997; Madden 2010). Therefore no researcher can reasonably claim to be objective or completely bias free. Yet, the fact

that the researcher is participant first, and observer second (the so called 'observing participant', or 'participant who observes'), does make reflexivity, understood here as the "reciprocal interplay of one's relationship with oneself and with others" (Jackson 2010, 36) an "unavoidable pre-condition" (Madden 2010, 23). While implying a host of complications, complete submergence is arguably also the only way to truly understand a situation or process of interest. As such, we see it as an opportunity to come unusually close to a relevant innovation process with the benefit of observing without disturbing, and having full access to key events, stakeholders, and texts. At the same time, proper reflection is required on what it means to research oneself and having to juggle multiple identities (Murray, 2003).

Proper reflection on our role as researchers also requires us to think about the morality of including people as central figures in a qualitative single case study without them being aware of this. Our research subjects are only aware of the researcher's identity as a participant in the innovation network. Not telling them that the innovation process, in which their person plays a central role, is also used as case study for research, can be considered a lie by omission. As the researcher is participant first and observer second, we may assume that our stakeholders have not experienced negative effects of any double agenda during the study period. However, it is possible for them to experience negative effects when this research is tied back to their organizations and their person. To avoid any possible negative effects that may result from a direct connection between our research and the identity of the people involved, we have chosen to anonymise the stakeholders in our case study to the point where the context is still clear, but can't easily be traced back to the individuals documented in this thesis. As such we choose not to refer to specific people, organisations, or the monitoring system central to our study by name.

Our grounded theory on how knowledge politics relate to the mechanisms of inclusion and exclusion that we observe during ICT system development and innovation, may not necessarily generalize to other cases due to its lacking external validity. After all, the observations on which it is built are based on a single case study (Campbell, 1979). Therefore, we seek to strengthen its generalizability by validating our theory with key insights from similar ICT innovation trajectories that we identified as an observing participant. However, due to constraints of time, our data gathering from these other cases (consisting of unstructured interviews with project managers) is rather limited. As such, these findings are only mentioned in the discussion chapter to build out our logic. While this research design still implies a limited external validity, this glimpse into other cases represents a valuable addition to the thesis as it broadens our perspective and deepens the appreciation for the potential impact of the main argument. It offers a worthwhile avenue for future research that should employ a multiple case study design.

3.3 Action research as observing participant

3.3.1 Identifying stakeholders

We start out by familiarizing ourselves with the context of our case study. By emerging ourselves as observing participant and interviewing various development and environmental justice practitioners and researchers with whom we cross paths, we learn to identify stakeholders, their interests, their narratives and visions on the state of conservation, and their sources of power to actively pursue this vision. As such, we use our initial observations to establish a general understanding of the case study context and answer the first and second subquestions:

1. Which stakeholders are out there?
2. Who among them are included in the development/innovation process?

3.3.2 Identifying the knowledge politics at play

According to Spielman et al. (2009) innovation history analysis, focusing on important events in an innovation process, is a useful method for mapping innovation dynamics and doing structured analysis. Therefore, to learn how involved stakeholders seek to influence the way the ICT systems takes shape through knowledge politics, we study stakeholder interactions. We pay attention to the narratives they push, the type of knowledge they draw from or expertise they assign themselves, and the nature of the influence they aim to exert. We then consider the extent to which we can reconcile their vision to the concrete technical design choices that are actually made for the ICT system and the world-making that results from these choices. By looking at these inter-stakeholder dynamics chronologically for separate episodes 2 to 3 month, we gain insight in cause effect relationships and are enabled to observe shifts in how stakeholders employ strategic communication to advance their goals throughout the innovation history. This helps us answer the third and fourth subquestions:

3. How do those included seek to exercise influence on the way the ICT system takes shape?
    a. How does this influence affect world-making?
4. How are politics of knowledge enacted during the ICT development process?
    a. Privileged and marginalized epistemologies?
    b. Evolving stakeholder narratives and strategic storytelling?
    c. Endorsement of definitions (of knowledge and otherwise)?
    d. Consequences of enacted definitions in work-making?

3.3.3 Understanding mechanisms of inclusion and exclusion

As we consider the extent to which we can reconcile individual stakeholders' visions to the concrete technical design choices that are made and the world-making that results from them, we come to understand the extent to which the innovation process is inclusive and to whom. The theory on the mechanism through which the knowledge politics that we observe cause this inclusion and exclusion of stakeholders, is built though the grounded theory approach (GTA) as first formulated by Glaser & Strauss (1967) and adapted by o.a. Clarke (2005) and Charmaz (2006). We formulate a grounded theory through our cycle of data gathering and reflection as observing participant in our single case study from a very early stage. As we become more familiar with our case, we formulate our theory on the knowledge and technology based mechanisms of inclusion and exclusion. We also look to structure our data gathering effort beyond the context of the initial case to validate our theory based on observations in other ICT development processes in the realm of forest monitoring as mentioned above. This brings us an answer to the last sub questions and, consequently, our main research question as well:

5. What knowledge and technology based mechanisms of inclusion and exclusion can be identified?
6. What makes these mechanisms persistent through time and context?

4. Case study context: Eyes on the Gran Chaco Americano

On November 8th 2019 a Latin American civil society organization, that will be referred to as 'Local NGO', launches an automated monitoring system that helps to timely identify (illegal) deforestation in the Gran Chaco Americano (GCA). In this thesis this monitoring system will be referred to as 'GCA Monitor'. As explained by Local NGO, GCA Monitor is an interactive platform that provides data on the changes in natural vegetation cover in the Gran Chaco Americano, as well as associated territorial information of relevance, for open consultation and analysis by users. The monitoring system makes use of Artificial Intelligence (AI) technology applied to Sentinel 2 satellite images from the European Space Agency to automatically classify land cover and detect changes on a monthly basis.

4.1 Deforestation in the Gran Chaco Americano

The Gran Chaco Americano is an area of about 1,066,000 km² that is located in the heart of South America and contains the second-largest forest on the continent after the Amazon. It is a biodiverse area that is home to unique and emblematic species, but it has been under threat of rapid deforestation for years. The agricultural frontier has been expanding and governmental institutions lack the capacity to combat illegal deforestation practices in the large land area with over 100.000 known reserves and concessions. Regulating and monitoring clear cut, logging and forest fires has proven to be an enormous challenge for stakeholders. This has led to an alarming rate of forest loss of approximately 3,700,000 hectares from 2012 until 2019.

4.2 Monitoring in the Gran Chaco Americano

Forest monitoring is defined by the International Union of Forest Research Organizations (IUFRO) as the regular and periodic measurement of certain parameters of forests (physical, chemical, and biological) to determine baselines and to detect and observe changes over time. The monitoring of land use changes, surface water quality, and fire events in the area of the GCA is an initiative carried out by Local NGO since 2010. This monitoring was said to be initiated in response to the need for studies on the state of conservation and the impact of natural ecosystem transformations on biodiversity.

As a result of years of work, Local NGO built a series of conservation and education initiatives on the importance of natural resources with an ecoregional vision shared between Bolivia, Argentina, and Paraguay. The results of their monitoring efforts became the basis for studies on specific species of flora and fauna in the GCA, providing insight into the impact of the transformation of the natural ecosystems on their ecology, their populations, and their distribution. Local NGO has been constituted as a reliable, open, and understandable source of information by local researchers, government and journalists. The monitoring data has proven to be a tool to influence public policies at national and regional levels, and are considered critical for informed decision making on land management and distribution in the territory across sectors and borders.

4.3 Redesigning monitoring and advocacy work

Despite booked successes in terms of creating influential knowledge, Local NGO staff found themselves spending a large amount of time on manual analysis of satellite images to detect

deforestation in the Gran Chaco. In order to free up time to actually address the illegal deforestation they observed, automating monitoring work was considered something worth exploring. At this time there were multiple digital, satellite based monitoring initiatives online that also covered the GCA. Among them initiatives by Map Biomas and Global Forest Watch. Yet, these initiatives did not appear to satisfy the information needs and workflow of Local NGO and their network partners. Local NGO's interest to explore options to automate forest monitoring beyond the initiatives they were already familiar with, the (financial) support and encouragement of their Netherlands based partner NGO (from this point onward referred to as 'NL NGO'), and the proposition of a young startup company that held the promise of providing what they felt they needed (further referred to as 'Startup'), resulted in a project plan to develop a unique automated large scale monitoring system. The first talks between all three parties took place in May 2018. As a result from the initiative between Local NGO, NL NGO, and Startup, the GCA Monitor was launched on november 8th 2019, allowing users to monitor, verify, and act on changes in forest and other natural vegetation cover in the Gran Chaco Americano.

4.4 The GCA Monitor

The GCA Monitor was designed to facilitate:

- Inventory taking and monitoring of large stretches of land for land cover, and land cover changes.
- Aggregating conclusions about land cover, and land cover changes, to territorial geometries that are meaningful to local organizations and authorities, such as reserves, concessions, areas rich in biodiversity, and indigenous territories.
- Monitoring, and distinguishing between, land cover and vegetation types that are considered relevant for local organizations and communities. How these land cover types are defined, can be decided upon by those involved.
- Differentiating in what conditions and changes raise an alert based on the KPIs or legislation that rests on the teritorial geometries of interest.
- Bringing computer generated land cover classifications and alerts together with human insights and data interpretation.
- Continuous learning as people who work with the platform continuously mark errors. These are fed back as training data for the AI model, so it can be improved and updated.
- Controlling the data flow about deforestation by admin users, allowing them to differentiate between information that is highly sensitive, or yet unclear, and information that has been validated and that they want to make public.

4.5 Method behind the GCA Monitor

The monitoring system makes use of computer vision technology (or machine learning algorithms) applied to Sentinel 2 satellite images of 10 meter spatial resolution to make monthly classifications of the entire GCA. To execute the analysis, a cloud based computing cluster pulls in the satellite data from the European Space Agency, constructs a monthly cloud free mozaic by combining several data captures, and applying the computer vision model to conduct the classification (a per pixel segmentation of the image).

Before the model is able to make the segmentation, it needs to be trained (or fitted) based on example data. This example data (or training data) consists of a random sample of sentinel 2 images of the entire GCA with all relevant classes that show up on them correctly drawn in. With these ingredients, the computer can fit a neural network algorithm to output a per pixel land cover classification based on Sentinel 2 data only. When fitting the model, the computer starts out with baseline values in its algorithm and outputs a certain image segmentation. It then checks to what extent it managed to match with the correct example that it was also provided with. It then keeps making incremental changes to the algorithm until it reaches an optimal score. There are quite a few nuances and technical details that can be considered and explored further. However, at this point, these are outside of the current scope of this research. As such, for a walk-through of how a neural network can be fitted to segment raster data we refer to the work of Schmidhuber (2015).

When applying machine learning methods, the data that is used to train the model directly influences the nature of the information that the monitoring system creates. The example set that a model is fitted on, will echo through all the classifications that this model makes. As such, creating training data is a key moment in the innovation and development process. It dictates how land cover in the GCA is divided up in classes and defines what the monitoring system actually monitors for. Due to its importance, the training data was created in consultation with Local NGO. With an online annotation tool, they were asked by Startup to define land cover classes that were relevant for them by drawing them in on a sample of images. These were then used as an example to create a training data set of sufficient size.

In order to carry out useful territorial analyzes at national and/or regional level, the data on land cover is aggregated to relevant teritorial geometries to provide actionable statistics and change alerts that line up with location bound regulation, legislation and KPIs. Examples of such geometries are Protected Wild Areas, Areas of Importance for Bird Conservation (IBAs), and Indigenous Lands, and National Cadastral information.

4.6 Stakeholders of deforestation and deforestation monitoring in the GCA

As the thesis seeks to identify how politics come into play during ICT system development for forest monitoring, and how they are part of the mechanisms of inclusion and exclusion that emerge, knowing which stakeholders are out there is important. Without having this overview, it is not possible to determine which actors do not have a seat at the table during key moments in the development process. Here we define stakeholders as the groups of people whose interests may be affected by (the outcomes of) a phenomenon or process in question (Di Giulio, Groves, Monteiro, & Taddei; 2016; 92). For the extent of this research this includes groups and publics whose interests are tied up with tropical forests and the possible outcomes of ICT innovation processes that seek to facilitate their conservation and help uphold (environmental) justice.

According to the World Resource Institute (2019), Edmund, Clarke, Grundy, Jones, Kamugisha-Ruhombe, and Yemeserach (2002), and Boekhout (2014; 2019) such stakeholders are; forest managers, law enforcement officers, departments of justice, local, regional, and national government, private commercial landowners or entities with a licence/lease to commercially exploit (government owned) land such as farmers, ranchers, and loggers, international corporations sourcing from tropical forest areas, NGOs and environmental activists, certifiers, indigenous peoples, and international research communities and knowledge institutes. Throughout the years in which

Local NGO has been monitoring land use changes in the Gran Chaco, there were also several organizations that were actively partnering with them in elaborating and disseminating monitoring results with technical, financial, and network support. These organizations include the World Land Trust WLT, Chaco Networks Initiative - AVINA, Ecosystems Alliance, the WCS-USAID, IUCN the Netherlands Committee, the CAF Latin American Development Bank, World Resource Institute, and Global Forest Watch.

Aside from knowing who the stakeholders are, it is also important to have a sense for the interests and vision of each stakeholder group in order to determine which stakeholders are, and which stakeholders are not served by the GCA Monitor as it is being developed. These stakeholder interests are viewed in the context of their relation to, and dependence on, tropical forest lands (Denzin, 1978).

4.6.1 Enforcement officers

Forest managers, law enforcement officers, and departments of justice have a central interest in being aware of all changes and dynamics in forest lands that are relevant in light of local legislation and land ownership. They have a need to attain this knowlange with as little effort and risk to their personal safety as possible. They also have an interest in knowing which violations of land use legislation should be prioritized in order to better direct their limited resources (Boekhout, 2019; GFW 2019).

4.6.2 Governments

Government actors have a general interest to develop their forest lands and exploit forest resources to spur economic growth (Monteiro, 2018). They also have an interest to safeguard the sustainability of these developments for long term prosperity. Aside from the need to balance exploitation with conservation, they also have an interest to uphold their land use laws, human and indigenous rights, and environmental justice (Van Boekhout, 2014). Governments balance these (sometimes contradictory) interests. Their balancing act is based on various political dynamics, socio-economic pressures, institutional constraints, and the worldview of its elite. This, and the unfortunate occurrence of corruption, derails our attempts to further specify or prioritize government needs. As such, we choose to crudely formulate government interest in terms of control. When a government (local, regional, or national) gains more control over what happens in their forest lands, it benefits their agenda, whater the content of this agenda may be.

4.6.3 Private commercial landowners/-leasers

Private commercial landowners or entities with a right/lease to exploit government owned land are, at least to an extent, subject to capitalist market forces. As such they have a vested interest in making that land profitable. While there are of course individual differences between commercial land exploiters, we find the assumption that all of them seek to make and grow their fortune, highly plausible. This can be done with an eye for short term gain or long term gain, and it can be done within the limits of the law, outside of it, or within the gray areas it may provide.

4.6.4 International corporations

International corporations sourcing from tropical forest areas are also commercial entities in a capitalistic market. As such seek to (maximize their) profit as well. As they source from tropical forest areas (the activity that makes them a stakeholder in our case study), they have an interest to

‘de-risk’ their supply chain. To de-risk the supply chain they need to map, monitor, and mitigate current risk factors. These risk factors encompass environmental risks (such as depleted soils, pests, and extreme weather events that recuse yield), economic risks (such a changing commodity prices and opaque supply chains endangering reliable sourcing), and public image risks (such as a consumer backlash from polluting the environment or sourcing from plantations that have resulted from recent conversion of primary forest). The financial sector, investing in industries that exploit tropical forest areas, have a very similar interest. They also have a need to de-risk their investments portfolio by mapping, monitoring , and mitigating environmental, economic, and public image risks.

4.6.5 Certifiers

There is a keen interest under certifiers to accurately judge whether a situation is compliant with key management criteria and the critical commitments they make towards the consumers of the products they certify. They have a need to be alerted of any breaches as soon, as reliable, as convincingly, and as cost effectively as possible.

4.6.6 Indigenous people

Indigenous peoples need unrestricted access to forests and forest products in and around their places of residence and other territories to support their livelihoods and ways of living. They need these forests to retain their cultural, social, and economic value, and their management to be in line with customary processes and social dynamics. Within groups of indigenous people, elites and marginalized can also be identified. They have differing capacities to draw benefit from (commercial) exploitation and conservation of forest resources. As such the nature of their interests and needs differ as well, reflecting their respective resource endowments and livelihood strategies (Edmund et al., 2002, 14, 17, 25).

4.6.7 NGOs and environmental activists

NGOs and environmental activists, including the partner network of Local NGO that supports its dissemination of monitoring results, have a need for cutting edge, locally sourced, and contextualized knowledge and information on environmental, social, cultural, political, legal, and economic dynamics in forest lands. Their assumed right to speak out on certain matters, or for certain groups, is based on the fact that their target audiences perceive NGOs as having a unique knowledge and understanding of these issues and groups. If they cannot defend this position convincingly, they will have difficulty to effectively push their narratives, raise money, and implement their agendas or visions for change.

4.6.8 Researchers

International research communities and knowledge institutes have a general need to create and to spread (impactful) knowledge that is held in high regard by (peer) audiences that matter to them.

5. Results: Innovation history of the GCA Monitor

As discussed in the research design, we use an innovation history approach to find an answer to our research question in a single case study. Here primary attention is paid to stakeholders interactions. In line with our theory based focal points, we reconstruct which stakeholders are included in interactions, what narratives they push, what the nature of their involvement and influence is, which definitions (of knowledge) they endorse, what technical design choices they are involved in, and how these factors impact world-making. In order to understand how these inter-stakeholder dynamics relate to each other, to knowledge politics, and to mechanism of inclusion and exclusion that we see emerge, we look to fill in these details chronologically for 2 to 3 month episodes. We use this structured history of relevant inter-stakeholder dynamics and developments as our input to find cause/effect relationships and build a grounded theory on how identified knowledge politics at play in ICT system development take a part in the mechanisms of inclusion and exclusion as observed during the innovation process.

In this chapter we present the results per episode as a walk-through of interactions amongst Local NGO, NL NGO and Startup. It is not a thick description of what each interaction looked like, but rather an attempt at capturing the essence of the discourse from each stakeholder related to the factors that are of interest to us in the context of our theoretical frame as they engage with each other and with their network. We further enrich the innovation history by including a recap of the technical developments and design choices that were made during these same periods. We do this not with the intent to focus on the technical aspect perse, but rather with the intent to reveal how the actual ICT system takes shape in relation to the visions that are expressed by the different stakeholders and the choices that they make.

These per episode descriptions are intermitted by short analysis pieces that highlight central developments and/or observations that stand out to us in light of our theoretical lens. We use the structured data as input to build a theory on how politics come into play during ICT system development, and how they are part of the mechanisms of inclusion and exclusion that emerge. The analysis pieces are included as extra stepping stones that tie ‘dry’ observations from our innovation history to our theory building effort in the next chapter called ‘further analysis and discussion’. In that chapter we also give further meaning to the dynamics we observe and validate our theory on how knowledge and technology based mechanisms of inclusion and exclusion come into play, and persevere through time, with other cases.

5.1 Project inception: July - August 2018

NL NGO to Startup

In conversation with two representatives of NL NGO, we are told that Local NGO needs to free up time so their team can take action against observed illegal deforestation as opposed to just detecting it and reporting about it. ‘Now they are stuck behind a computer screen with little resources left to act on their findings’. They tell us that other monitoring systems, like the one from Global Forest Watch, are not generating the information that is needed at an appropriate level and speed, and are therefore not actionable sources of data. In follow-up email correspondence the same representatives write that the primary project focus should be on the part of the Chaco that

Local NGO has the most data about in terms of concession and reserve areas, land use legislation, and land ownership. In a separate email detailing the envisioned project focus, we are told that there is a need to also think about other land cover classes to be monitored in order to provide more insight in ecosystem degradation and drivers of land use change. During a phone call in early August a senior representative tells us that they are in need of more clarity on the legality of the deforestation they see happening: 'We are especially interested to learn what happens in concession areas, reserve areas, and in areas where no clear legislation or land ownership is in place'. He lets us know that NL NGO expects that our technology could play a key role in creating a more automated monitoring system. He also lets us know that, in creating this monitoring system, we need to be mindful of potential commercial exploitation. They do not want it to be misused somehow. Toward the end of August NL NGO representatives start to voice their worries over potential fear of job loss by Local NGO, IP issues, and the formats of output files to make sure Local NGO can effectively use it within their current work habits and available skill sets. This is discussed over the phone and via email. Startup is asked to write up a first draft proposal and term sheet for contracting.

Local NGO to Startup

After our initial video call with three representatives of Local NGO, the senior representative confirms via email that the proposition of automated monitoring is very interesting as 'it is our ambition to monitor the entire Chaco more closely. Now we mainly focus on a subregion of the Gran Chaco. However, we found that the entire Gran Chaco Americano is too big for automatic classification.' When asked to elaborate on the difficulties they encountered with this over another video call, they let us know that they have tried to use a decision tree model and that too much hardware was needed. 'We found it wasn't feasible. Still,' the senior representative states 'monthly monitoring of the entire GCA is our ambition. We want to share information on how many hectares are converted every month and where this happens.' They communicate that they aim to share forest cover loss in numbers of square kilometers and as shapefiles with their network, as is their usual conduct.

Startup to NL NGO and Local NGO

In an email to Local NGO, detailing a first draft proposal after the initial meetings in Juli, Startup writes: 'Because the largely manual analysis of deforestation over a land area of over one million km^2 is a rather labor intensive and time consuming process, we propose to automate this using Deep Learning computer vision algorithms applied to remote sensing data from the Sentinel satellites ... We are absolutely positive that lacking hardware will not be an issue in this effort ... When building a monitoring system, we want to make sure it yields meaningful and actionable information for end users ... As we are technical experts, who lack domain expertise in tropical deforestation, we look for active participation and input from project partners who will be using the platform. We look to your knowledge to indicate what it is that you wish to monitor and which questions you would like to see answered about your areas of interest ... Local NGO should assist in creating a representative set of examples with relevant land cover classes to train the AI model with. We assume that Local NGO is intimately familiar with the area and the running challenges, and therefore in the best position to make the distinction between land cover classes that are relevant to monitor ... As we start building and designing the web viewer in more detail, we will also need feedback from Local NGO on intuitive design.'

5.1.2 Technical developments and design choices during project inception

Startup works from the notion that land cover changes (such as deforestation) are best detected by 1) classifying land cover types on satellite data using AI analysis, and 2) comparing differences in detected forest cover between two points in time. This means that deforestation cannot be detected with a single satellite data capture. It always needs a comparison. It also means that model is only fitted to the project region, therefore it cannot be used with the same accuracy on other ecosystems/regions.

Startup chooses to aggregate raw model output to specified geometries. Here, individual pixel values are lost and only the aggregates are saved. As a result, new geometries of interest can be made available towards the future, but cannot easily be reconstructed towards the past, because the necessary per pixel information is already gone. To mitigate this, the raw results are also aggregated to a standard grid of the full region. This way the amount of saved data is significantly smaller (and thus the system more financially viable), while it remains possible to provide insight on changing forest cover of a new geomerie of interest for past years by intersecting that shape with the grid. The tradeoff is that this yields less accurate numbers, especially when the shape is relatively small, due to the grid tiles being bigger than the original pixels.

Startup decided that the aggregated results and visualisations are posted to a cloud database and file server and made accessible via a flexible REST API and a browser based dynamic mapviewer. The contents of the map viewer can be exported into a digital work environment as GeoJSON and WMTS. This means that data and visualizations can also become available for use in applications of third parties, allowing others to use the data from more specialized uses and services. As such the system is not closed off and instead supports other (technical) users to further enrich and build on the data.

5.1.3 Intermediary analysis

We note that Startup (and as such myself included) is clearly pushing its vision on how knowledge and expertise is divided amongst NL NGO, Local NGO and itself, also indicating how this translates into a ‘natural’ division of tasks and responsibilities. This directly impacts how each stakeholder may influence the development and innovation process. We also see that while NL NGO and Local NGO are still discussing whether, how, and under what circumstances a new digital monitoring system should be built, some key technical design choices are already made by Startup. Something it also deems itself in charge of.

5.2 Getting the ball rolling: September - October 2018

Startup to NL NGO

During a phone call we tell the representatives of NL NGO that we are very interested in, and challenged by, the monitoring task as faced by Local NGO and NL NGO. We tell them that the data, tools, and methods we have at our disposal seem very well fitted to take the challenge on. ‘We are very excited to introduce AI analysis and cloud computing to this field.’ The necessary developments to do this are also in line with our companies’ development strategy so we tell them that we are happy to get started before we get the official *go ahead*. ‘As we move forward, the input we need from Local NGO does shift slightly. As we have already trained the first version of the model based on our own understanding and interpretation of the challenge, we now need them to correct any

errors in the model output and add/distinguish land cover classes as they see fit.'

NL NGO to Startup

During a video call NL NGO let us know that it is excited about the possibilities that Startup could offer to Local NGO under the right circumstances. 'We are also impressed with the intermediate results as shown and see the positive impact it could make in the monitoring of the health and degradation of ecosystems at scale as well as in determining the drivers and legality of deforestation'. During the call NL NGO has let us know that, while they do not primarily identify as technical experts, 'we are a pretty data driven and GIS savvy organization amongst NGOs. We've often used various new GIS and remote sensing related technologies in our past and current nature conservation projects.' They tell us that, while Local NGO is relatively proficient in the technical side of GIS amongst its network and peers, they still have limited capabilities and propositions towards them should be simple (or simplified). we are asked to work on such a proposal. The senior representatieve stresses that they can only move forward if Local NGO wants this to happen and is willing to commit time and people to this project; 'We can finance the effort, but Local NGO needs to make the move. As NL NGO we need a few good meetings with the right people at Local NGO, to get them on board with sufficient input and effort from their side. We can make this happen.'

Local NGO to NL NGO and Startup

Local NGO notifies NL NGO and Startup via email that the project has been greenlighted by the new director and that they are eager to get started. 'We are very grateful for the work that has already been done in the meantime. We are very impressed and interested to learn more about the proposed method.' Local NGO writes that it has focused on creating kml files of relevant deforestation for its partner network and that it is interested to see how this system can assist in this effort. During another video call with a junior representative at Local NGO we are told that we should be aware that the people they provide information to are not very tech savvy. Such as journalists, students, and government agencies. On the matter of which vegetation classes to monitor, Local NGO confirms that this is an important issue right now 'as the new executive director is currently revising the monitoring baseline to enrich our information on land use change. We discussed the advantages and disadvantages of including more classes to the current monitoring baseline.'

5.2.1 Technical developments and design choices while getting the ball rolling

The Startup's framework is set up to fit all it's monitoring systems on maps with multiple layers of information that are generated on a running basis. These maps are initiated by defining an area of interest, land cover types to be monitored, fitting data sources, and aggregation levels of interest.

Between the stakeholder it is established that Local NGO receives non-transferable user rights to the model algorithm, the viewer, and its raw output for non-commercial purposes. These can therefore only be used by Local NGO and not be sold to/shared with third party organizations without permission. Output can be freely shared in non-raw format via a viewer, in tables, graphs, and in images. User rights to the viewer and its output ends if/when Local NGO decides to no longer make use of Startup's services, but the user licence to the algorithm will always remain with Local NGO. This means that the organization can choose to host it in their own system or that of a third party if they wish to do so.

5.2.2 Intermediary analysis

We note how Startup proposes to get started on the project without the official go-ahead. By doing so they provide NL NGO and Local NGO with some more guarantees in terms of technical feasibility at its own risk. It also provides them with more visual material on the potential workings of the monitoring system, successfully jogging their trust and imagination to get the ball rolling more quickly. Also notable is that NL NGO and Local NGO mention their relative technical prowess in respect to their peers, letting Startup know that they need information delivery to be pretty *cut and dry* if they want to make sure their network will also be able to catch on. We also observe that now Local NGO has committed to the project, their representatives start to try and influence technical developments by calling attention to their needs as users of the system and by communicating their interest in being brought up to speed on the 'method'. While we see both Local NGO and NL NGO starting to push their narratives about who they are and how they do things, Startup is still making more technical decisions without actively keeping them in the realm of discussion.

5.3 Defining and negotiating project scope; November - December 2018

Local NGO to Startup

In a document detailing feedback on model classifications Local NGO writes to Startup; 'We are very pleased with the tools and progress thus far. We need to be made more aware of the base program and how the algorithm that is used works, in order to understand the possibilities that they present better ... It is important to note that the main purpose of the monitoring effort by Local NGO is to recognize areas that have suffered a land use change due to deforestation in the Gran Chaco Americano, and to provide the most accurate numbers on this. This should always be considered when talking about adding classes and features to the classification and platform ... We need to identify deforestation and distinguish this from other types of land cover changes. This is something we will not compromise on.'

Startup to Local NGO

In an email replying to the provided feedback, Startup writes; 'We understand the aim to monitor forest loss and have this at the center of our development efforts. We are happy to explain how our current methods contribute to that end at any time. Any extra features or classes to be included into the monitoring system is entirely dependent on whether Local NGO and NL NGO see good use for it. We ask you to think about the specific questions you would like to have answered for yourself and your partner network so we can tailor the monitoring system to these needs and help you as best we can. If no extra land cover classes are relevant, we will simply not include any. If we have misunderstood any of your wishes and concerns, let's discuss them! We understand that pinpointing what it is you wish to know (and thus what information you would like to see constructed on a running basis and at a large scale) in detail is quite a task. It probably also ties into Local NGO's overarching strategy and is perhaps somewhat political as well. So take the time if you need it.'

Local NGO to Startup

In another email Local NGO let's Startup know; 'Due to the large area of the Gran Chaco and the diverse ecosystems it holds, classification with two classes would be the best approach. The most suitable classes we thought of are "forest" (this should include the dry forest), and "no forest" (all the other natural vegetation which are not forest, such as savannas and shrublands). Land use

change should be identified for both.'

Startup to NL NGO

In an email directed to NL NGO, Startup writes; 'We have picked things up with Local NGO and contact is well established. There has been some back and forth between us and them and among the Local NGO's team internally, about which vegetation classes to monitor. By now we have received a definite answer. It will be forest (including dry forest), and all other natural vegetation (including shrubland, sanana, and marshlands). So two classes in total.'

NL NGO to Startup

In a phone call a senior NL NGO representative informs Startup that 'The project is now official and financially backed. Local NGO needs to keep their eyes on the ball, so let us know if and when they stop being responsive.' They tell us that they are involved with a lot of projects and partners simultaneously, so we can't be on the case all the time.

NL NGO to Local NGO

In an email directed at Local NGO, NL NGO writes; 'We trust you can move forward with the Startup team. We will be here if anything comes up for which you can use our help. Please keep us posted on new developments.'

5.3.1 Technical developments and design choices while negotiating and defining the project scope

Local NGO pins down the natural vegetation classes to be monitored as "forest" (including dry forest), and "no forest" (all the other natural vegetation such as savannas, shrublands, and marshlands). In order to start monitoring for changes in land cover types that are sorted into classes differently, the model would need to be retrained. This requires an investment of time (about 2 months) and capital (10-15K in euros).

5.3.2 Intermediary analysis

We see how Local NGO is still working to play catch up ('we need to be made more aware of the base program and how the algorithm that is used works'), while they also feel the need to clearly express that their main interest will remain with monitoring and reporting of the loss of forest cover, regardless of whatever else technology may have to offer ('This is something we will not compromise on'). This discourse suggests that they seek to gain more control over the direction that system development is taking. Startup reacts to this by framing itself as a facilitator and inviting Local NGO to direct their attention and energy to defining land cover classes of interest in order to make the output of the monitoring system they are working on more meaningful to Local NGO. We also realize that both Startup and NL NGO attach a lot of meaning and importance to Local NGO taking the lead on this matter. Even though the scope of possible model output has already been vastly limited by previous technical design choices, they want Local NGO to be in control of this particular decision to safeguard the usefulness of the information the monitoring system will generate, but also as proof of local NGO's commitment to the project.

5.4 Discussing external communication and sharing of results; Q1 2019

NL NGO to Local NGO

During a video meeting involving all three stakeholders, NL NGO tells Local NGO 'As this project is up and running, we also need to start communicating about it. Our network needs to know about the possibilities we are creating and they need to get behind it. They also need to know that there are alternatives to GFW services.' They stress that high resolution and high quality alerts that are not only based on detected forest loss, but also on local land use legislation. 'We provide deforestation alerts with an expert interpretation on legality.' Something they say is lacking in other monitoring systems, where there is currently little to no prioritization and contextualization of deforestation events.

NL NGO to Startup

During a phone call between NL NGO and Startup, NL NGO let's us know that they 'would like areas that have been deforested between two points in time to be marked red in the viewer.' They say this is the most intuitive way to visualize deforestation and communicate about it. 'We would like to use this in our presentations about this project in Latin America.' NL NGO brings to discussion that they are also aware that information about deforestation, whether it is legal, illegal, or something in between, is often sensitive knowledge. So while they seek to gain more clarity on the legality of the deforestation, they understand Local NGO is sometimes hesitant in pursuing it. 'Local NGO is much closer to the heat than we are. Nature conservation and human rights advocates in the region are often threatened and sometimes killed.'

Startup to NL NGO and Local NGO

Over the phone as well as over email Startup let's Local NGO and NL NGO know that 'With our current setup we cannot mark deforested areas as red right this moment. For this we need to introduce a delta layer to the map. While this is a possibility, the idea of the system is that we monitor land cover changes for geometries of interest and provide alerts when certain land cover conditions (or changes therein) have been met. Then the corresponding geometries will be flagged with an alert. As such we don't mark the deforested area as red, but instead direct human attention to relevant places based on automated analysis of big data. This is a logical way of working because this way, only actionable information is being generated and visualized in the platform and the user is not overwhelmed with less relevant developments in the (vast) landscape'. Startup states that automated monitoring has the purpose to effectively direct human attention and effort in a data driven way. It is not meant to cut out human interpretation and intervention out of the loop entirely. Especially when information is sensitive. 'A monitoring platform should allow admin users, such as Local NGO and NL NGO, to check the validity of alerts and curate which information becomes public.'

Local NGO to Latin-American peer network

During a presentation at a conference Local NGO lets its Latin-American peer network know that the system in development is a platform for monitoring forest and other natural vegetation coverage in the Gran Chaco through standardized analysis with machine learning algorithms and satellite images. The objective is to compile data on deforestation accurately and periodically to report on changes in land use, analyze their legality, and report on sustainable land management. With the

platform we perform comprehensive monitoring of the Great American Chaco, while saving time and resources used in manual analysis and thus freeing human capacity for other jobs. The platform gives direct access to actionable information and periodic reports for donors, partners, and others interested. Detailed information to communicate on sustainable land management can be obtained, and areas under high risk/pressure can be located to take preventive measures. This synopsis of what was presented by Local NGO is based on the slide deck that was used for the conference.

Local NGO to Startup and NL NGO

In a video meeting Local NGO let's NL NGO and Startup know that 'We need to be very sure of the deforestation reports we make public.' They stress that we need to have control over this. 'If we are wrong about something, such as land ownership, deforestation, or concession borders, we are discredited and lose the trust we have worked hard to build.'

5.4.1 Technical developments and design choices as external communication is discussed

Startup chooses to implement a system that supports and visualizes both computer generated reports as well as human feedback and data inputs within the platform. As such both people and computer programs can post messages, alerts, classifications, error reports, forms/questionnaires, pictures, and files to geometries on the map. Such as quantitative reports on the amount of forest cover in a concession area every month (something a computer program would do), or the judgement of the legality of deforestation (something an admin user would do). This means that the dynamic map not only displays computer generated information, but also human feedback and inputs. As such people can create workflows on the system in which human users and computer generated information interact (human-in-the-loop).

Startup also chooses to implement a map management system with access control and possible rights restrictions per user group. This means that admins can place other users in defined user groups and decide on their access level (such as viewer rights, search rights, download rights, and editorial rights).

5.4.2 Intermediary analysis

We observe that as soon as presentable results are produced, active communication about the project towards the outside world starts up. We also note that this goes hand in hand with a spike in the awareness of, and concern about, the sensitive nature and visual presentation of the data that is being created. This causes user demands about functional and cosmetic requirements to, all of the sudden, become very specific. At the same time however, we see that facilitating these specific users demands is already somewhat impeded by the technical design choices and development roadmap that have already been implemented and set out by Startup in the previous months. We also note that Local NGO blends together pieces of discourse and narrative used by NL NGO and Startup in the time running up to the presentation at the conference, and also during the presentation itself.

5.5 Working to finalize monitoring system outputs and design; Q2 2019

Startup to Local NGO and NL NGO

During a call, followed-up with an email recapping the meeting, Startup announces that 'Before launch, and to make sure the platform automatically outputs and visualizes relevant information, we need to finalize the aggregation levels (or geometries) of interest. We also need to pin down how we want to query the database to which we save those aggregated numbers. This all dependents on

what you wish to know about which areas and when ... While the queries are flexible, and something you can program yourself, we would like to help you get started. These queries can then function as working examples so you can do it yourself at a later time.' Startup suggests that some time should be taken to demo this, as the platform is most powerful when Local NGO and NL NGO can work with it independently from Startup. 'To familiarize yourselves with the platform, and to form a grounded opinion on how you would like to see it improved, Local NGO and NL NGO should use the platform in its current beta version ... For a successful launch and accurate alerts, we also need to improve the quality of the model. For this we need Local NGO to check for errors and correct them. We should have a satisfactory model before we start using it to construct historic data from 2016 and onward. This is not something we should do more often due to the computing and data cost involved.'

NL NGO to Local NGO

During this meeting NL NGO addresses Local NGO with the need to get the practical developments squared away to launch the platform internally and start generating the data from 2016 to the present and to start the near-real-time monitoring toward 2020. 'Al the shape files and attribute tables of areas we want to see included need to be checked and finalized.'

Local NGO to NL NGO

In an email directed at NL NGO, Local NGO writes: 'The focus now is on improving the model classifications because the quality of the results still needs to be improved. For this the Startup team needs us to provide all the feedback necessary for the classification to be consistent in the Gran Chaco region. We are very happy with how the viewer looks so far and we've been discussing the possibilities we have with the user interface, soon to be developed for us to enjoy! We are also working hard to define definite aggregation shapes and corresponding attributes, as well as the queries we want to start out with.'

NL NGO to Startup

During a separate phone call with Startup, NL NGO let's us know that they would like to extend the monitoring effort to 2021 (at least) instead of 2020, but also want to keep the update frequency the same (monthly). 'How can we work this out budget wise?'

5.5.1 Technical developments and design choices to finalize monitoring system outputs

Local NGO and NL NGO pin down the geometries to which the historic data on land cover from 2016 to the present is aggregated:

- Indigenous areas
- Environmental services
- Protected areas
- Cadastre
- Legal reserves
- Area to deforest
- Water causes
- Standard tiles of 5 by 5 km2

Local NGO and NL NGO pin down the alert thresholds they want to apply to these areas:

- When over 20 hectares disappear within indigenous reserves
- When over 5 hectares disappear within protected areas

- When over 1 hectare disappears within legal reserves
- Any deforested area with an area larger than 110 hectares
- Any wind curtain (strip of forest between agricultural plots) with a width of less than 80 meters

This last alert is difficult to deliver with the current model and monitoring method, as the system does not automatically make these types of observations. It is designed to accommodate queries about surface area rather than one dimensional measurements. This alert is now given by aggregating forest cover to the geometries that are registered as being wind curtains. If the area of forest cover within the geometries is significantly less than the surface area of that geometry, an alert is given. The downside of this method is that compliance to the 80 meter rule can only be monitored for wind curtains who's geometrie is already included in the monitoring system. Another downside is that there is often a lack of forest cover within the wind curtain geometries due to human error as the geometry is not accurately drawn in or projected so it does not properly line up with the satellite image. To answer this last question more directly the model should be retrained to include the class 'wind curtain of less than 80 meters'. This would require additional investment into the system.

Taking budgetary constraints into account, Local NGO and NL NGO also decide on the historic and future periodicity of updates. Once this is acted out, it cannot easily be amended without there being additional cost involved. If an error occurs (due to for example a cluster crash) or users want the historic data updates to be more frequent, then the entire time series would need to be remade, not only the new/missing data captures. This is due to how the analysis cluster is designed.

5.5.2 Intermediary analysis

We see that Startup is pushing Local NGO to familiarise itself with the monitoring system in more depth, and to start using it in its current beta release. We also observe that at this point in time Local NGO and NL NGO are (finally) starting to make definite decisions about the content that the monitoring system should be outputting. They only seem to be doing so at this point in time because circumstances are forcing them to make a choice. We also realize that the choices (in terms of possible monitoring outputs) have already become a lot more limited. While they can control how they define aggregation levels (such as per districts or reserve area) and database queries (alerts), there is no longer any room for discussion about the general premise and functional requirements of the ICT system, as there was roughly one year back. For example, Local NGO and NL NGO have very limited decision power on file formats, data types, download options, publishing locations, and sharing possibilities. All that is left to do now is fill in the flexible components of the monitoring system that have been defined and left blank by Startup.

5.6 Looking for beta users; Q3 2019

NL NGO to Local NGO

During a video meeting NL NGO tells Local NGO; 'We need to become very concrete about branding of, and communication about, the monitoring platform for the official launch. We need to see what image we want to get out there to attract users in the whole Gran Chaco ... We need to get more people to use the platform in its current form for good feedback. Preferably not just Local NGO

but also other Pan Chaco partners. They need to start feeling ownership as well.' NL NGO argues that these other actors should probably be included in branding and promotion, as the more organisations feel ownership, the more it will be promoted and used. 'It is very important that the app reaches authorities, producers, the media, and the public. The goal is that deforestation in protected areas and other illegal areas is quickly detected and acted upon.' NL NGO states that the platform should also be branded in relation to the other activities of Local NGO and partners. 'For this a good communication strategy needs to be designed. Local NGO should provide a first draft for this soon.'

Local NGO to national academic network

In an abstract submitted to the national academic network on nature conservation, Local NGO writes; 'The Natural coverage in the Gran Chaco Americano is subject to high rates of transformation due to the expansion of the agricultural frontier. While there are state mechanisms for monitoring these changes, the timing of the analyzes and data accessibility is limited. Because of this, there is a need for a publicly accessible platform that generates and presents data on forest cover changes and enables the user to overlay them with territorial information at national and regional level. The objective of the monitoring platform is to generate data on changes in natural vegetation coverage of the GCA and combine it with official information on forest resources and the regulations that govern them, to understand the meaning and impact of observed changes. The platform is available for the general public. For anyone interested in obtaining information on coverage transformation in the GCA.' [translated from Spanish to English].

Startup to NL NGO and Local NGO

During a call, Startup tells NL NGO and Local NGO; 'Even though it was not part of the project scope, we will put effort into making the platform available as a mobile app. We think it will benefit us all to make the information available at a low threshold for our target audiences.' Startup says that it needs inputs from NL NGO and Local NGO regarding their decisions and preferences on branding, content, and design features to get this done in a timely fashion.

5.6.1 Technical developments and design choices like looking for beta user

Startup decides that all web and mobile apps developed by Startup are branched of its general app. This web version is ported to mobile operating systems. This means that, when the web version is updated, the mobile version automatically changes with it. As all apps are branched of the general app, the first version of the UI will always strongly resemble this original staging arena. Depending on the user demands and budget, the design and functionality can be further amended to fit the needs and wishes of users. This means that users with little to no budget will end up with an app that resembles the original app more closely, while those with more budget can permit themselves custom features.

5.6.2 Intermediary analysis

We observe how Local NGO is being pushed to engage their network and get more beta users on the platform, foster a sense of ownership amongst them, and take the lead in making a communications plan. We also note that towards the academic community Local NGO voices a message that has been drafted and edited by Startup. NL NGO and Startup are not referenced at all, but neither of them protest this fact. We also observe that Startup offers to conduct more work on its own accord that it was not initially contracted to do, in order to benefit the potential impact of

the project.

5.7 Getting ready for launch; Q4 2020

*NL Startup t*o journalists (official press release)

In an official press release NL Startup writes 'On November 8 2019, civil society organization *Local NGO* launched an automated monitoring system that helps to timely identify (illegal) deforestation. Previously, Local NGO staff found itself spending a large amount of time on the weekly monitoring of satellite images to detect deforestation in the Gran Chaco Americano, the largest forest mass in South America after the Amazon, which is currently suffering the largest deforestation in world history. What if this monitoring work could be done by computers? Then Local NGO would have more time to actually address illegal deforestation. Together with *NL NGO*, Local NGO approached *Startup*. They jointly developed a unique automated large scale monitoring system that provides its founders, their local partners, and the public at large with the information and the digital tools that are needed to give insight into the drivers behind the rapid land use change in the Gran Chaco. Artificial intelligence offers the solution to monitor changes in land use in vast areas. The automated monitoring system was developed especially for this purpose.'

NL NGO to Startup

During a meeting with Startup, NL NGO lets us know that they see the need for more technical developments and assistance as well as a higher update frequency of deforestation data toward 2021. 'We have some budget left for this but before we can commit it to this purpose, we need to see actions from Local NGO. They are always enthusiastic and positive when you speak with them, but we need to see them act again before we can agree to a new contract.'

Local NGO to journalist network (press release)

In an official press release Local NGO writes; '*GCA Monitor* monitors the American Chaco through artificial intelligence. It is an integrated information system of the territorial dynamics of the Chaco. Natural coverage in the Great American Chaco (GCA) is subject to high rates of transformation due to the expansion of the agricultural frontier. Although there are mechanisms for monitoring these changes, the timing of the analyzes and accessibility to the data is limited. Because of this, Local NGO, with support from NL NGO, created a tool that allows information to be generated through a publicly accessible platform that presents data on changes in land coverage and allows the user to overlay them with layers of territorial information at national and regional levels. With great ease and practicality users can access data of the entire region, consult, analyze and generate reports on areas of interest (including graphs, tables and maps). This system constitutes the next step in the monitoring of land use changes in GCA, making use of the technical possibilities to improve the analysis, achieving a temporal readjustment and spatial resolution that wasn't met before. In the effort to achieve the automation of the monitoring process that was originally carried out through visual interpretation of satellite images and manual vectorization of forest cover changes, we combined experiences with Startup and applied Artificial Intelligence (AI) methodologies.'

Local NGO to NL NGO

During a call, and later also over email, Local NGO lets NL NGO know that they need a higher temporal frequency to be more relevant for their audience. The more recent the information the more impactful and actionable it is perceived to be.

Local NGO to Startup

Following up on a call, Local NGO lets Startup know that they have compiled a list of questions and adjustments they would like to see answered and carried out to improve the platform's user experience for their non-technical audience. An important one is the possibility to download deforested areas as .kml shapefiles.

Startup to NL NGO

During a call Startup lets NL NGO know to be very proud of what we have accomplished together, but we are not done yet. 'The model needs further improvement. A few new features that we have built will help with this. Local NGO has also made some specific user requests that they argue will greatly improve usability. We are also happy to provide support and are very motivated to guide Local NGO in transitioning their workflow over the coming months and to increase the frequency of analysis.' Startup tells NL NGO that this also means that they need a new contract with financial backing. 'In order to make this the success we all want it to be, new time, energy, and resources need to be committed.'

Startup to Local NGO

In an email, Startup writes; 'We are happy to support your requests within the current limits of the project, the budget of which is running to an end. As such larger adjustments, such as creating a .kml output instead of a GeoJSON, can't be made, but (relatively) small fixes and alternatives we can help you with. For instructions on how you can use the UI and API to make any required changes yourself, you can always reach out ... If we want to continue this effort, it is very important to further improve the model and get the feedback of mistakes on a running basis. We hope that we will both be able to allocate some time and resources for this project next year.'

5.7.1 Technical developments and design choices while getting ready for launch

Startup decides to implement a human/machine feedback loop that is baked into their monitoring systems. This means that people can also correct errors or start including new land cover classes in the current platform. Any changes are directly visible for all users and the feedback is fed to the AI model as new training data, thus making it a self-learning system that can potentially accommodate changing interests without Startup needing to be actively involved.

Somewhat in line with Local NGO's request, Startup also implements the possibility to directly download selected changes in forest cover as GeoJSON via the UI, as opposed to only supporting this in a scripting interface via API. These deforested shapes also appear directly in the GCA Monitor app under the 'Automated deforestation polygons' layer. Startup decides that downloading .kml files is not a sufficiently pressing issue and pushes that to another time when a new budget is available. For now it decides to stick with its standard API outputs; GeoJSON and WMTS.

Lastly, Startup decides to make a Python package available that makes data analysis via API more user friendly for data analysts and data scientists.

5.7.1 Intermediary analysis

We see that NL NGO and Local NGO are readily pushing polished stories towards their network that are only loosely in line with the innovation history as recorded for the benefit of this research.

Both NL NGO and Local NGO place more agency with Local NGO, creating the suggestion that the new monitoring system is primarily the brainchild of this organisation, while framing Startup as a facilitating tech partner that carried out this vision. We also see that Startup and Local NGO are actively angling for a project continuation financed by NL NGO. Functionalities and features that have been previously delayed due to the preexisting product roadmap as laid out by Startup, are now used as reasons to continue development in 2020; 'specific user requests that ... will greatly improve usability.' Amongst these requests to improve usability is also the request to output observed changes in forest cover as .kml files. Something that was already brought to the table by Local NGO well over a year previous.

6. Further analysis and discussion

In this chapter we reflect on our observations and intermediary analyses from the innovation history in the previous chapter. We use them to identify how politics came into play during the development of the GCA Monitor and how they are part of the mechanisms of inclusion and exclusion we have seen emerge. To structure this discussion and build our argument we use the subquestions as posed in the theoretical frame. As mentioned in our research design chapter, we also make an argument that the identified dynamics constitute a pattern that can also be observed in other cases where a new digital monitoring system is being developed and introduced in the field nature conservation and environmental justice.

---

1. Which stakeholders are out there?

When we define stakeholders as any actors who are impacted by the outcome of the innovation process, we found that forest managers, law enforcement officers, departments of justice, local, regional, and national government, private commercial landowners or entities with a licence/lease to commercially exploit (government owned) land (such as farmers, ranchers, and loggers), international corporations sourcing from the GCA, NGOs and environmental activists working in the region, as well as certifiers, indigenous peoples, and international research communities and knowledge institutes to be stakeholders here.

As described in detail in the context chapter of this thesis, their interests vary greatly and include; awareness of all changes in forest lands that are relevant in light of local legislation and land ownership, increased control, maximized profitability, minimized risk, awareness of non-compliance, unrestricted access and retention of cultural and economic value, and the gain of unique, local and impactful knowledge.

---

2. Who among them are included in the development/innovation process?

Based on our observations focused primarily on stakeholder interactions, we found that only Local NGO, NL NGO, and Startup were active participants in the innovation process. Only in the last 7 months of our study period, other stakeholders were being included. These were mainly actors from the peer networks of Local NGO and NL NGO, a few local authorities, and local academia. Still these stakeholders were primarily approached as an accepting audience to create support for the monitoring system, and not as active and critical agents invited to discuss the innovation at hand and help shape its outcome.

3. How do those included seek to exercise influence on the way the ICT system takes shape?

a. How does this influence affect world-making?

We find that the stakeholders with a seat at the table sought to influence the way the GCA Monitor took shape by leaning into the role they had collectively assigned themselves and each other. As we observe in results (episodes 5.1 *Project inception* and 5.2 *Getting the ball rolling*), NL NGO takes up the role of innovation facilitator in the field of environmental monitoring. Local NGO claims the role of key local disseminator of critical information on changes in the GCA. Meanwhile Startup leans into its (self) assigned role of executor of Local NGO's vision and provider of technical advice to make that vision a reality.

When looking at our case study with a theoretical lens attuned to knowledge politics, we find that these roles are strongly based in their assumed expertise. This collective assignment and acceptance of specific knowledge is leveraged by stakeholders as their main source of power to influence technical development and design choices that relate to these claimed areas of expertise. As we experience through contracting processes and the stories told by NL NGO during episode 5.1 *Project inception*, even access to capital (another source of power), is driven by assumed expertise of stakeholders in the eyes of external financiers. As such we find our innovation history to be a battlefield of knowledge from the very start. A battlefield in which the lines in the sand (that divide relevant areas of expertise and thus sources of power and influence between stakeholders) are the product of knowledge related storytelling. Where the lines end up, depends on how compatible and how convincing the stories of the stakeholders are. We will circle back to this later in the discussion section.

As we observe the stakeholders engage with each other to define deliverables, scope the project, and finalize the details for the monitoring system's outputs in episode 5.1 and 5.2, we see how knowledge politics are brought into play to nudge the outcome of the innovation process in their desired direction. In answer to subquestion 4 these dynamics will be discussed below. The more successful this influence is exercised, the more effect a stakeholder has on the type of information that is constructed, the frequency with which this is made available, how it is packaged, and through which channels it is distributed. We found that this directly constitutes world-making, as the details regarding data outputs define the purpose for which this can be used as well as by whom. As such, this is also crucial in terms of including and excluding stakeholders from benefiting from the monitoring system. This too, will be discussed in further detail under subquestion 5.

---

4. ***How are politics of knowledge enacted during the ICT development process? Through:***
    a. ***privileged and marginalized epistemologies?***
    b. ***evolving stakeholder narratives and strategic storytelling?***
    c. ***endorsement of definitions (of knowledge and otherwise)?***
    d. ***consequences of enacted definitions in work-making?***

Within the innovation network the narratives of the stakeholders appear to coexist quite well as each of them favors a scientific epistemology where objective knowledge about changes in the landscape offers practical solutions. As discussed under subquestion 3, each stakeholder has also claimed an area of expertise. The boundaries of which are largely understood and respected by the other parties. As such the narratives are more complementary than they are in competition.

Each stakeholder's narrative, about who they are and what they want from the monitoring system, is different. In episode 5.1 *Project initiation* and 5.2 *Getting the ball rolling*, NL NGO highlights its savviness in the field of earth observation and GIS, as well as its role as a booster of innovation in the field of environmental monitoring. In terms of what they want from the monitoring system, NL NGO underlines the need to save time and gain better insights in the legality of deforestation in the GCA. Local NGO presents itself as a frontrunner in land use monitoring in the region, as a central node in the local (knowledge) network. In episode 5.3 *Defining and negotiating project scope,* they also reaffirm their commitment to providing regular information on land use change for the entire GCA and their need for the monitoring system to support that commitment. In episode 5.1 to 5.3 Startup continues to frame itself as the tech partner that has the knowledge and tools to make the monitoring ambitions of Local NGO and NL NGO a reality. Startup suggests that they just need to be filled in on what Local NGO and NL NGO wish to monitor, for which regions of interest, and at which time interval.

Observations about the knowledge politics as leveraged by NL NGO

We note that the manner in which NL NGO frames its role is slightly different depending on the stakeholder it addresses. Towards Local NGO it appears to portray itself as a facilitator and inspirator, while towards Startup they reveal more of their own agenda on the monitoring front, their ambitions to manage a flagship project, as well as their sense of responsibility in making sure that Local Startups 'keeps its eyes on the ball'. As Startup carries out the vision that they have a stake in, this two-faced character is understandable. NL NGO appears to want to refrain from pushing Local NGO in a specific direction, while at the same time wanting to see their own goals being met.

Observations about the knowledge politics as leveraged by Startup

Having reflected on the narrative of Startup we see no real difference in how it frames its own role when speaking to either stakeholder. In episode 5.3 *Defining and negotiating project scope* and episode 5.5 *Working to finalize monitoring system outputs and design,* we do note how Startup seeks to influence decision making by looking to convince each stakeholder of its own visions separately, while exaggerating the degree to which the other stakeholder has already agreed with its logic and sensibility. Much like children might try to manipulate their parents into getting their way

('dad already said its fine'); making use of the gaps in communication and the resulting information imbalance between the two. Using this strategy, Startup often sought to control which types of features and functionality NL NGO and Local NGO would confirm a need for. Both towards Startup as well as towards each other. To have them voice needs in line with Startup's own vision and product roadmap was considered highly beneficial.

In line with this interest we have also observed that Startup sometimes tries to transfer its own visions for the monitoring system to either Local NGO or NL NGO with the expectation that the third stakeholder involved (so either NL NGO or Local NGO) would be more perceptive to their ideas if the opinion is voiced by the other stakeholder. This happened during episode 5.3 en 5.5, but also around contracting moments in episode 5.2. and towards the end in episode 5.7 *getting ready for launch*. Transfering ideas was perceived to be a strategic move because the success, and thus continuation, of the project was (amongst other factors) measured by the extent to which Local NGO was, and wanted to be, actively involved. Having their team express specific and thoughtful wishes was expected to be perceived positively in this light.

Observations about the knowledge politics as leveraged by Local NGO

Local NGO appears to be relatively consistent in how it frames its own role and goals in the project toward Startup and NL NGO. We do note how its interactions with NL NGO appear slightly more formal than its interactions with Startup throughout the innovation history. This is possibly attributable to the fact that NL NGO is the source of funding in this context and therefore approached with some more caution and restraint. Later in this chapter we will circle back to the narrative and focus on how the stakeholders push them not towards each other, but toward their external networks as well.

Missing narratives

Throughout all episodes of the innovation history, we have noticed a distinct lack of active involvement and voiced narrative from a multitude of stakeholders as identified in the context chapter and mentioned under subquestion 1. As no other stakeholders were enabled to exert any active influence on how the technology was shaped, it appears that the above mentioned stakeholders (NL NGO, Startup, and Local NGO) were the only ones that were collectively recognized as having a stake that was deserving of representation. Over the period of this innovation history, we observed the three of them keep the circle purposefully small. Making a conscious trade-off between responsive and inclusive innovation on the one hand, and speedy development that would yield tangible results fast on the other.

After about 8 months (during episodes 5.4 through 5.7), we do see that NL NGO and Local NGO start to actively reach out to stakeholders in their networks. However, this was done with the intent to create a broad support and user base for what was already there. Not to gain insights in the visions, needs, and opinions of other stakeholder groups. As such, exclusion from key design choices that influence the nature of the information that is created, how this is done, and how this can be distributed, has already happened. More about this in the next section under subquestion 5.

Under the current subquestion (4) we have discussed how politics of knowledge in our case study are enacted through privileged and marginalized epistemologies (a), the endorsement of definitions of knowlande (c), and evolving stakeholder narratives and strategic storytelling (b). Under

subquestion 5 we will continue to discuss how it is enacted through narratives and strategic storytelling, as well as and what the consequences of enacted definitions are for world-making (d). The role and impact of storytelling is further built out and wrapped up under subquestions 6.

---

5. ***What knowledge and technology based mechanisms of inclusion and exclusion can be identified?***

Reactive decision making

As we reflect on our innovation history, both NL NGO and Local NGO appear to be quite reactionary in their decision making. Throughout the episodes included in our results chapter, most decisions are made as a result from active prompts by Startup, including but not limited to demonstrations of monitoring possibilities (episode 5.1 through 5.3), concrete project proposals (during 5.1 and 5.7), UI designs (5.4 and 5.5), and requests for input (5.1 through 5.7). Such demonstrations, proposals, and requests are then considered by NL NGO and Local NGO and result in a handful for tweaks, changes, and answers. During episode 5.1 NL NGO also abboarded its attempts to make a first draft of a Terms of Reference and instead requested Startup to provide them with a detailed proposal and term sheet that they could use as a basis for negationations and contracting. It looks like NL NGO and Local NGO are uncomfortable with taking initiative in a field that they do not master. This moves them to take a more passive role.

The rationale of reactive decision making

This hesitance in formulating technical system requirements and inputs towards market parties is neither unusual nor irrational. Organisations who need to do this more often, such as government agencies and larger corporates have extensive protocols and dedicated advisors and procurement teams in place to formulate their needs and demands correctly. Some degree of failure is quite common. As such, to avoid asking the wrong questions and making ill suited demands, NL NGO and Local NGO place that responsibility with Startup.

Another reason why we would indeed expect to see this reactionary behaviour is the natural incentive to keep complex work from one's own *to do* list and, as such, externalize it to another organization that is willing to pick up the slack. Making plans concrete takes time and effort, and this is something that people in general do not always want to invest themselves. In general, it is significantly less time consuming to comment on an existing proposal, then to draft it yourself.

Consequences of reactive decision making

Whilst far from irrational, the reactive behavior of NL NGO and Local NGO has negative repercussions on their ability to influence world-making. After all, the one drafting the proposals, developing the first proof of concept, and making the first move, also sets the standard from which the thoughts and ideas of others depart. The first mover may control the narrative by being the first to make their vision tangible. As mentioned in the theoretical frame, we see that being the first in making visions tangible and concrete, also makes you influential. Reflecting on our innovation history, we also realize this privilege or opportunity is often reserved for the executing tech partners

in an innovation network. They are, after all, the ones who possess the knowledge and skills to develop the envisioned ICT systems. This gives these types of actors a unique headstart on directing the narrative and further though on a subject.

We argue that during ICT development processes, technology oriented stakeholders have a natural advantage to influence the outcome of innovation processes. They have the technical knowledge and ability to make abstract visions tangible, while the knowledge base of other stakeholders naturally excludes them from being able to play a very active role here.

Possible applications of monitoring outputs

The information that is made available by the GCA Monitor can be used to locate areas where observed land use changes do not line up with official land use plans as represented in administrative registers. As such, landowners who may be conducting or allowing illegal activity, can be identified and held accountable. The information can also be used to estimate the impact of change on the ecosystem and help define conservation plans to protect biodiversity and indigenous rights. This is all useful for environmental NGOs, activists, journalists, law enforcement, and governments, as well as researchers and knowledge institutes. They are all provided with insights that may serve their interests in a packaging they can (learn to) work with.

The GCA Monitor can also be used by communities as a weapon against trespassers who use (or convert) the land and its resources illegally. To bring conflicts of interest to light and trace back developments for verification and proof. Yet, it is unlikely that indigenous people, not belonging to any social elite, are able to leverage technical geo-information provided to them via an app in the Spanish language that requires a smartphone or computer with a reliable internet connection. As such, they are likely to remain dependent on representation by others, who can understand, and work with, such digital information tools.

As set out in the context chapter, certifying organisations also have a keen interest in knowing whether forests are managed in line with their criteria and principles. However, these criteria and principles rely on detailed landscape, economic, and social observations (a.o. Forest Stewardship Council principles and criteria, 2019) that do not match one-on-one with the definitions used in the current GCA Monitor. As the *difference that makes a difference* varies between people and organizations, so does the usefulness of information that is generated in the image of only one. Using different definitions and ways to classify our living environment can thus effectively exclude stakeholders from being able to use the information that a monitoring system provides.

Unequal value of information between stakeholders

Based on this observation we note that everyone's need for information is specific. As such, an information system is bound to service the needs of some better than others. Likely favoring those who had a seat at the table and who are bringing in financial resources. Yet, that is not the only argument that can be made. We also note that some stakeholders are able to make much better use of information in general. Even if it is not ideal for their initial purpose or focus. The interests of Western NGOs, activists, and researchers are arguably already served with the availability of any unique or new information. While some information can certainly be considered more valuable than other information, these stakeholders are relatively flexible in how they can use it to their benefit. In research, evidence based advocacy, and conservation the problems experienced on the ground by

specific local stakeholders are not the only problems that they can focus on. If available information allows them to solve other problems and answer other research questions, they can simply pivot. For them information has an inherent value.

Local stakeholders are not able to switch gears so easily. As their information needs and packaging requirements are more specific and more rigid, not all information has value to them. As such we observe that knowledge oriented stakeholders can benefit from the information tools that are provided, even when they are not ideal, while other, arguably mainly local, stakeholders with very specific, location bound interests, cannot. As such, local stakeholders run an increased risk of being excluded from benefiting from monitoring systems, while non-local and knowledge oriented organizations are more likely to be able to move into a position that benefits from what is available to them.

---

6. ***What makes these mechanisms of inclusion and exclusion persistent through time and context?***

The importance of storytelling

As an observing participant we noticed that, as we move toward our first beta version of the monitoring system, the first tendency was not to test it, but to communicate about it (episode 5.4 *Discussing external communication and sharing of results*). When the monitoring system generated the first presentable results at scale, effort was pulled towards putting together presentations and not towards creating an effective workflow to detect and communicate about illegal activity. Here we observe that NL NGO begins to push the need for letting their network know about the possibilities they were creating and to get them behind it.

While noteworthy, this should not be surprising from both a professional and theoretical vantage point. As argued several times in this thesis, a good story may be the most powerful weapon an NGO has to defend its position as an authority and to achieve its envisioned changes. We can easily observe this same tendency with other monitoring initiatives. The organisations operating these monitoring systems are looking for stories to communicate. The monitoring systems themselves are seens as a means to find them. Project managers at GFW, WWF, and ICCO all actively voice that their central goal in the use of monitoring systems consists of finding compelling stories that support their overarching narratives and convince whomever needs convincing. NL NGO and Local NGO appear to be no exception to this rule.

Rewriting narratives for strategic storytelling

Related to the rather abrupt shift in focus to external communication we also note that, as soon as the external network of partners and press gets briefed on the new monitoring system, there is a clear discrepancy between the presented narrative about how the monitoring system was initiated within the innovation network, and the events that we logged for this innovation history. At the launch, Local NGO is portrayed as the initiating party while, from our vantage point as observing participant, this appears to be an inaccurate portrayal. Still, the initiating role is attributed to, and

claimed by, Local NGO, and this narrative is accepted by all stakeholders directly involved in development.

Recreating the narrative like this puts Local NGO in the driver seat in the eyes of external onlookers. Arguably this benefits Local NGO's status within its network and, as a consequence, (re)affirms its claimed authority on the subject of forest monitoring in the GCA. This also solidifies NL NGO's presumed role of facilitating and empowering partner organisation, and Startup's role as the trusted executor and enabler of Local NGO's vision. This paints a picture that development and conservation practitioners would be rather pleased about. This positive image, in which every organisation keeps to a role that their peers and partners would approve of, benefits all three stakeholders. At the same time though, it creates a false sense of origin and ownership that hides all the politics of knowledge at play, as well as their consequences on inclusion and exclusion of stakeholders. It hides how Local NGO has actually been excluded from many opportunities to play a more active role in defining the outcomes of the innovation process.

Non-vocal does not equal non-influential

Furthermore, just because Startup never actively pushed its vision and narrative towards the targeted user and support base, doesn't mean it is not present. Its views are strongly represented. Aside from the mechanism as discussed under subquestion 5, in which Startup gains a first mover advantage by possessing unique technical knowledge that allows it to set the stage on how the monitoring system is shaped, it also controls how this system is talked about. Everything that NL NGO and Local NGO communicate about this system with the outside world during episodes 5.4 through 5.7 was either (co-)drafted or curated by Startup's staff. The organisation practically functions as a ghostwriter in this context, shaping the monitoring system as well as the discourse about it. As such, the politics of knowledge that are at play here, also remain hidden for the casual onlooker who can't, at first glance, know whose words they are really hearing or reading.

Unchecked mechanisms are persistent mechanisms

Because it is a shared interest to keep knowledge politics hidden, as they reflect badly on project outcomes and involved stakeholders, the knowledge and technology based mechanisms of inclusion and exclusion at play are left unchecked. As such they are sustained through time, becoming persistent fixtures in the development of ICT systems in nature conservation and environmental justice. The fact that we can find no public information on WWF's Early Warning System and GWF GLAD alert system where technology partners are credited for their strategic involvement beyond facilitating or carrying out the vision of the involved development and environment protection professions, strengthens the argument that such knowledge politics are kept purposefully obscured by involved stakeholders to hide their loss of agency. Also beyond the context of our current case study.

6.1 Persistent knowledge and technology based exclusion due to free service offerings

Throughout the innovation history we have observed how key design choices were often made before Local NGO and NL NGO had fully understood and discussed their implications and alternatives internally and with each other. For example, we observe that the technical design of the monitoring system was already taking shape months before Local NGO even got actively involved. It was almost 5 months after the project's initiation that Local NGO starts asking questions about the underlying methods and framework (during episode 5.3), seeking to understand the possibilities and

impossibilities that these imply, and grappling to gain control over the direction of development. Interestingly, at the time Startup got started on this work, no contract or payment schedule was yet finalized. The GCA Monitor app for mobile devices was also not a part of the original project scope and was offered free of charge, and other features were included below market value.

Looking at our current case study, as well as considering related monitoring initiatives, we can both rationalize and recognize this risk taking behaviour where commercial technology stakeholders take the liberty of getting started without assurance of payment and/or offer their service, products, and infrastructure to NGOs for free or below market value.

6.1.1 The rationale of free service offerings

To no one's surprise, such free service offerings are never handed out without reason. Companies may, for example, aim to increase their market share by locking in new users. We see how Microsoft, Google and Amazon hand out cloud credits and grant money to organizations with cloud based solutions in order to get them to set up shop in their cloud environments. We observe how tech companies are willing to invest time and money in unfunded projects when this means that NGOs can be their launching customer for something new they are developing. We also see that large consultancy firms foster a positive public image and break in their junior employees by letting them invest their time in helping NGOs solve pressing environmental problems. Global Forest Watch and the WWF Early Warning System, both cases mentioned in the introduction chapter, have for example received a lot of free services from Google, Amazon, and the Boston Consulting Group in the form of computing space and consultancy hours.

6.1.2 The practical consequences of accepting free service offerings

We have already observed a tendency of reactive decision making due to lack of sufficient technical knowledge to make confident demands as well as a lack of willingness and ability to invest the necessary time. Related to this, we have also observed that having to spend less or no financial resources is a very strong incentive to move in a certain direction. We see this in our current case study, but also observe it in the case of Global Forest Watch, Resource Watch, IUCN, and WWF's Early Warning System.

We verified this tendency in these additional cases through direct observation as well as with a series of unstructured interviews with senior project managers. As observing participant we have seen Startup offer monitoring and development services below market value to Global Forest Watch, which resulted in them including our methodology in their bi-yearly proposal for one of their lead funding partners. Had another company made another (free) offer, it is very likely that this alternative methodology or approach would have been pitched and approximately 150.000 US dollars would have been spent differently. This demonstrates how impactful strategic choices by NGOs can be easily influenced by free of below market value offers made by technology oriented actors.

During the series of interviews all senior managers also confirmed that initial framework and infrastructure choices for their flagship monitoring systems were made based on free service offerings from both commercial as well as academic partners. In the case of GFW these free services came at a very early stage when development had hardly started, and were offered by Amazon (AWS Cloud Services) and by the University of Maryland. In the case of WWF these free services

were already extended in the technical feasibility phase and came from the Boston Consulting Group, Microsoft Azure, and to an extent also from a small Netherlands based remote sensing company. For IUCN free services were offered by Esri, moving them to host their projects in ArcGIS Online. All senior managers leading these projects recognized that these early stage offerings greatly influenced the technical design choices that were made and that these choices still echo through their current monitoring offerings, also manifesting themselves as the root cause of key limitations they now find themselves running into. These limitations include;

- the creation of a lot of false positives in detecting deforestation and forest fires
- an inability to provide alerts with further specifications about their causes and level of priority,
- a difficulty to incorporate data visualizations for human interpretation as readily accessible data layers in the monitoring system
- a difficulty in integrating human feedback for improve the quality of system output and model classifications
- a dependency of data sources and models that are not scalable beyond the initial project focus area,
- a dependency on paid services to further advance analysis on project data or scale up sharing possibilities,
- restricted sharing of monitoring results due to limited 'seats' per software licence.

All of the interviewed managers also recognize that by making use of services that were offered free of charge, they have limited their freedom of movement to a somewhat painful degree. Now they find themselves in a situation where they need to seek creative solutions to alleviate or bypass some of the abovementioned inconveniences that have consolidated in their ICT systems. One of them also tells us why she expects this to happen; 'due to both a lack of technical knowledge and a drive to get things off the ground, teams become less critical and observant towards offers that imply cost effective acceleration'.

6.1.3 Self-inflicted exclusion as a result of accepting free services

While many organisations active in development, nature conservation, and environmental justice may be sensitive to (and partially dependent on) free service offerings, they do aim to be critical about this. All NGOs under study in this thesis aimed to ask critical questions and steer towards shared ownership, open data, and no lock in. But even though this may be the case on paper, a critical level of dependency and lock-in is still very much there. People and organisations grow used to certain ways of working and habits are hard to change. Big technology companies thrive on this fact, offering services for free until their target audience is too addicted to change vendors.

We find that, when making use of free services or services below market value, stakeholders are effectively swept along in the marketing and/or technical development strategy of other actors. Accepting such service offerings means playing into an agenda that may interfere with their own vision for change. Whether this happens right away or down the line. As such, by doing so stakeholders give up control and run the risk of inflicting their own sustained exclusion.

7. Recommendations for policy and practice

Based on our research we recommend practitioners, policy makers and scholars in development, nature conservation and environmental justice, who seek to adhere to the principles of Responsible Research and Innovation, to be keenly aware of the identified patterns of hidden knowledge politics and strategic communication at play in ICT development processes. There needs to be a realization that stakeholders who are directly involved in the innovation process, share a common interest to spin a narrative that obscures knowledge based exclusion. Making it so that the stakeholders who are close enough to know about the existence of knowledge based mechanisms of exclusion, may also be the least likely to tell you about it.

In addition, we recommend policy makers and development practitioners to realise that there is a tradeoff between cost and control. When choosing to give up control in favour of spending less money, the knowledge and technology based mechanisms of exclusion as identified under sub question 5 in the previous chapter will go into effect. Alternatively, a choice to remain in control implies a need to invest. If a stakeholder fails to pay market conform rates to technology partners, they run the risk of being used as a means to advance another's agenda. In order to attain desired change, investment of time, money and knowledge is unavoidable. Commercial and technical stakeholders are doing the same. They invest, and as they do so, they are winning the struggle for control over what tomorrow looks like. In order to take part in shaping the future, stakeholders need to keep themselves from choosing to hitch their rides. Instead, they need to either gain the skills to climb behind the wheel themselves (invest time and knowledge), or pay a driver enough money to be taken to the destination of their choice (invest money).

8. Reflection

In chapter 3 we have already discussed some benefits, drawbacks, and considerations that we need to be aware of when using a research design as employed for this thesis. We find that our research design is a methodological novelty as innovation history analyses usually comprise of gathering and analysing secondary accounts from stakeholders. However, as an active participant in the innovation network we can gather primary data. We are uniquely enabled to fully submerge ourselves and observe behaviour directly, rather than relying on secondary reports. In addition, we can do so while the research subjects are unaware of being studied, thus not running the risk of the research subject changing their behavior at the knowledge of being observed (myself being the obvious exception here, more on that later). These factors greatly benefit the internal validity of our results. The external validity however, is less strong as the n of our current research is 1. While we have gathered data from a theoretical sample of related cases, supporting our argument and building up our understanding of politics in ICT innovation more broadly, we realise this effort still remains limited. As such, to test the generalizability of the patterns we observe, future research needs to increase the n and further validate our theory by employing a multiple case study design.

As mentioned above as well as in chapter 3, the fact that I, the researcher, am both an observer and a stakeholder in this case study, requires further reflection. By representing one of the key stakeholders in the innovation network, I myself become one of my own research subjects. It is highly likely that I will not be able to observe, and reflect on, my own behaviour the same way that I do with the behavior of others. The level of detachment, or indeed submergence, with which I observe behaviour and interpret data points thus become inherently different. This may lead to an imbalance in terms of the depth of our understanding of each key stakeholder. When observations about one stakeholder are considered in relation to that of others (as we do for this research), this imbalance may interfere with the validity of our conclusions.

Having reflected on the validity of our results, including the impact of the researcher's double role, there are also theoretical implications to our research that are worth highlighting here. We found that the theories and concepts discussed in our theoretical frame have formed a very useful lens during our innovation history analysis. They allowed us to recognize and understand various patterns and behaviour. As what we have observed fits our expectations in light of the cited literature, this suggests that the argument made over the course of this thesis is built on a solid foundation of agreement on how to interpret observed behaviour. As the theory we have created on top of this foundation is compatible with the current body of knowledge, our results and the conclusions we draw from them, are further legitimized.

Aside from finding that mechanisms of inclusion and exclusion indeed spring forth from hidden politics of knowledge in ICT innovation projects, we have also discovered that such mechanisms can be self-obscuring. The existence of a self-obscuring mechanics of exclusion, makes us wonder about those we have not managed to discover yet. What other mechanisms of both inclusion and exclusion are wrapped up in social, political, or economic dynamics that makes them self-obscuring too? We may also wonder whether obscured mechanisms of inclusion and exclusion are always a result of a conscious effort to protect one's interest, or whether there can be other mechanisms at play as well. This line of inquiry may be worth pursuing in future research as well.

9. Conclusion

We find that the politics at play in ICT system development and innovation are mainly knowledge based. Turning the struggle for control over the outcomes of ICT innovations, and consequently world-making, into a battlefield of knowledge in which technical stakeholders have a natural advantage in making their vision a reality. This results in knowledge based mechanisms of inclusion and exclusion. We also find that these knowledge politics remain purposefully hidden due to a common interest of all parties directly involved, to remove from the narrative the exclusion of non-technical stakeholders from impactful decisions during the early stages of development. Stages where critical choices are made about the nature of the information that is created, the workflow in which this happens, and the way in which it can be distributed.

We conclude that ICT system development and innovation is predominantly shaped by technology oriented stakeholders who leverage various forms of technical expertise, strategic communication, and donated services to advance their own agenda. After which the narrative gets collectively hijacked to the point where the lack of control and agency by non-technical stakeholders is obscured. This leads to the public portrayal of ICT innovations as more responsible and inclusive than they in reality are. To regain agency in shaping the future, otherwise excluded stakeholders, should make a conscious effort to stop 'hitching rides' by making reactionary decisions and using free service offerings. Instead they need to either gain the technical skills to climb behind the metaphorical wheel, or pay a driver enough to be taken to their destination of choice: Taking back control requires the investment of time, knowledge and capital.

When looking at other ICT innovation processes a similar dynamic of hidden knowledge politics and knowledge based exclusion can be recognized. This suggests that this pattern of hidden politics and strategic communication is not limited to the current case study, but instead represents a theme that scholars and practitioners should be aware of as they seek to adhere to the principles of Responsible Research and Innovation. Testing the generalizability and impact of our argument with a multiple case study design, would be the next logical step for future research.

10. Literature

Alfred, T., and J. Corntassel. 2005. “Being Indigenous: Resurgences Against Contemporary Colonialism.” Government and Opposition 40 (4): 597–614. Beck, U. 1992. Risk Society: Towards a New Modernity. London: Sage

Asongu, S. A., & Odhiambo, N. M. (2019). How enhancing information and communication technology has affected inequality in Africa for sustainable development: An empirical investigation. *Sustainable Development*.

Beatty, Andrew. 2010. “How Did It Feel for You? Emotion, Narrative, and the Limits of Ethnography.” American Anthropologist 112 (3): 430-43.

Bijker, W. E., & Law, J. (1992). *Shaping technology/building society: Studies in sociotechnical change*. MIT press.

Boekhout van Solinge, T. (2014). The illegal exploitation of natural resources.

Campbell, D. T. (1979). Degrees of freedom and the case study. *Qualitative and quantitative methods in evaluation research*, *1*, 49-67.

Charmaz, K. (2006). Constructing grounded theory. A practical guide through qualitative analysis. London: Sage.

Chaskin, R., Khare, A., & Joseph, M. (2012). Participation, deliberation, and decision making: The dynamics of inclusion and exclusion in mixed-income developments. *Urban Affairs Review*, *48*(6), 863-906.

Clarke, A.E. (2005). Situational analysis. Grounded theory after the postmodern turn. Thousand Oaks: Sage.

Coffey, Amanda. 1999. The Ethnographic Self: Fieldwork and the Representation of Identity. London: Sage

Crossan, M. M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: A systematic review of the literature. *Journal of management studies*, *47*(6), 1154-1191.

Crowther, T. W., Glick, H. B., Covey, K. R., Bettigole, C., Maynard, D. S., Thomas, S. M., & Bradford, M. A. (2015). Mapping tree density at a global scale. *Nature*.

Davies, A. 2001. “What Silence Knows: Planning, Public Participation and Environmental Values.” Environmental Values 10: 77–102

Denzin, N. K. (1978). Triangulation: A case for methodological evaluation and combination. *Sociological methods*, 339-357.

Denzin, Norman K. 1997. Interpretive Ethnography: Ethnographic Practices for the 21st Century. London: Sage.

Di Giulio, G., Groves, C., Monteiro, M., & Taddei, R. (2016). Communicating through vulnerability: knowledge politics, inclusion and responsiveness in responsible research and innovation. *Journal of Responsible Innovation*, *3*(2), 92-109.

Döll, M., & Knappik, M. (2015). Institutional mechanisms of inclusion and exclusion in Austrian pre-service teacher education. *Tertium Comparationis*, *21*(2), 185.

Elling, A., & Claringbould, I. (2005). Mechanisms of inclusion and exclusion in the Dutch sports landscape: Who can and wants to belong?. *Sociology of Sport Journal*, *22*(4), 498-515.

Foster, C., & Heeks, R. (2016). Drivers of inclusive innovation in developing country markets: A policy perspective. In *Inclusive innovation for sustainable development* (p. 57-74). Palgrave, Macmillan, London.

Glaser, B. & Strauss, A. (1967). The discovery of grounded theory. Strategies for qualitative research. Chicago: Aldine Publishing Company.

Groves, C. 2009. “Nanotechnology, Contingency and Finitude.” Nanoethics 3 (1): 1–16

Holmén, H., & Jirström, M. (2009). Look Who's Talking! Second Thoughts about NGOs as Representing Civil Society. *Journal of Asian and African Studies*, *44*(4), 429-448.

Jackson, Michael. 2010. “From Anxiety to Method in Anthropological Fieldwork: An Appraisal of George Devereux’s Enduring Ideas.” In Emotions in the Field: The Psychology and Anthropology of Fieldwork Experience, edited by J. Davies and D. Spencer, 35-54. Stanford, CA: Stanford University Press.

Latour, B. (1990). Technology is society made durable. *The Sociological Review*, *38*(1_suppl), 103-131.

Long, N., & Long, A. (Eds.). (1992). *Battlefields of knowledge: the interlocking of theory and practice in social research and development*. Routledge.

Macnaghten, P., R. Owen, J. Stilgoe, B. Wynne, A. Azevedo, A. de Campos, J. Chilvers, et al. 2014. “Responsible Innovation across Borders: Tensions, Paradoxes and Possibilities.” Journal of Responsible Innovation 1 (2): 191–199.

Madden, Raymond. 2010. Being Ethnographic: A Guide to the Theory and Practice of Ethnography. London: Sage

Madon, S., & Krishna, S. (2018). *The Digital Challenge: Information Technology in the Development Context: Information Technology in the Development Context*. Routledge.

Marris, P. 1996. The Politics of Uncertainty: Attachment in Private and Public Life. London: Routledge.

Parkinson, S., & Ramirez, R. (2006). Using a sustainable livelihoods approach to assessing the impact of ICTs in development. *The Journal of Community Informatics*, *2*(3).

Rydgren, J. (2004). Mechanisms of exclusion: ethnic discrimination in the Swedish labour market. *Journal of ethnic and migration studies*, *30*(4), 697-716.

Sayer, A. 2011. Why Things Matter to People: Social Science, Values and Ethical Life. Cambridge: Cambridge University Press.

Schmidhuber, J. (2015). Deep learning in neural networks: An overview. *Neural networks*, *61*, 85-117.

Sein, M. K., & Harindranath, G. (2004). Conceptualizing the ICT artifact: Toward understanding the role of ICT in national development. *The information society*, *20*(1), 15-24.

Thompson, M. (2008). ICT and development studies: Towards development 2.0. *Journal of International Development: The Journal of the Development Studies Association*, *20*(6), 821-835.

Zheng, Y., Hatakka, M., Sahay, S., & Andersson, A. (2018). Conceptualizing development in information and communication technology for development (ICT4D).