
# VILLAGE LANDSCAPE FROM NEAR AND FAR

## Participatory geospatial methods to integrate local knowledge into formal land use planning in Tanzania

Salla Eilola

TURUN YLIOPISTON JULKAISUJA – ANNALES UNIVERSITATIS TURKUENSIS
SARJA – SER. AII OSA – TOM. 370 | BIOLOGICA – GEOGRAPHICA – GEOLOGICA | TURKU 2020

UNIVERSITY OF TURKU

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## University of Turku

Faculty of Science and Engineering
Department of Geography and Geology
Doctoral Programme in Biology, Geography and Geology

## Supervised by

Associate Professor, Niina Käyhkö
Department of Geography and Geology
University of Turku
Turku, Finland

Adjunct Professor (Docent), Nora Fagerholm
Department of Geography and Geology
University of Turku
Turku, Finland

Dr. Peter A. Minang
Leader of the Landscapes Governance Theme
World Agroforestry – ICRAF
Nairobi, Kenya

## Reviewed by

Professor Karin Pfeffer
Department of Urban and Regional Planning and Geo-Information Management, University of Twente
Enschede, the Netherlands

Senior lecturer Dr. Ally H. Namangaya
School of Spatial Planning and Social Sciences, Department of Urban and Regional Planning, Ardhi University
Dar es Salaam, Tanzania

## Opponent

Researcher Dr. Maria Tengö
Stockholm Resilience Centre
University of Stockholm
Stockholm, Sweden

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## ABSTRACT

In this dissertation, I explore the use of participatory geospatial methods in improving local knowledge integration and inclusiveness in formal land use planning in Tanzania. Communities and governments in the Global South are tackling multiple challenges to human well-being and ecological integrity. Participatory land use planning that combines knowledge sources and balances needs and values of different land users has been promoted as a prerequisite for addressing these challenges in a socio-ecologically sustainable way. Land use planning practice requires tools such as participatory geospatial methods that capture local spatial knowledge (LSK) on human-environment relationships in forms that are compatible with spatial planning standards. There exists, however, little evidence on the usability and impact of these methods in formal planning processes. For my research, Tanzania offers an exciting opportunity to examine the use of these methods due to its decentralized land and natural resource policies and rapid digitalization of planning processes. Through case studies I study what LSK reveals about land use and land use management-related decision-making, how existing Tanzanian land use planning policies and practices integrate LSK into planning decision-making, and I then codevelop participatory geospatial methods capable of integrating LSK into formal land use planning and study their benefits and adoption potential. Finally, I reflect on the limitations of the geospatial methods in representing LSK and diverse perspectives in these processes.

The research is based on transdisciplinary and mixed methods approach. I frame my assessments of existing policies and practices with literature-based criteria, which I develop for each study. In each study, I also collaborate with Tanzanian practitioners at various research phases and develop a practitioners' manual to guide the use of our participatory geospatial method. I combine interviews, group discussions, surveys, participatory mapping exercises and observations to study the relationship between people, their land uses and environment (Article **I**) and people's experiences in planning processes (Articles **II, III** and **IV**).

The findings show that local knowledge is instrumental in identifying land use patterns in the landscape and in explaining the rationale behind local land use, its dynamics and forest-farmland conversion (Article **I**). The analysis of existing policies and practices reveals that despite the emphasis on inclusive and active participation of local communities, the planning practice does not capture LSK in a georeferenced form or use geospatial tools to facilitate planning deliberation (Articles **II** and **III**). Subsequently the plans fail to recognize local priorities and complexities of land use. The codeveloped participatory geospatial method was observed to increase the quality of spatial data in which LSK is captured, and support learning, deliberation and spatial understanding among participants and practitioners during the formal planning process (Articles **III** and **IV**). The planning practitioners identified several benefits of the geospatial methods to their work, which is a strong incentive for adoption (Article **IV**). Wider adoption, however, requires efforts in geospatial education and on-the-job training to practitioners, as well as general commitment to participatory processes at all administrative levels. While the participatory geospatial methods improve integration of LSK into planning decision-making, future research and method development should focus on recognizing the diversity of local spatial knowledge and community priorities. Here self-determination of what LSK is collected and how it is visualized and used plays an important role.

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## TIIVISTELMÄ

Tutkin väitöskirjassani osallistavien paikkatietomenetelmien käyttöä paikallistason maankäytönsuunnittelussa Tansaniassa. Tarkastelen erityisesti menetelmien mahdollisuuksia tukea paikallisen tiedon hyödyntämistä ja osallisuutta. Globaalissa etelässä paikalliset yhteisöt ja hallinto etsivät ratkaisukeinoja useisiin yhtäaikaisiin ihmisten hyvinvoinnin ja ekologisen kestävyyden haasteisiin. Osallistuvassa maankäytönsuunnittelussa yhdistetään paikallista ja tieteellistä tietoa ja tunnistetaan eri maankäyttäjien tarpeet ja arvot sosioekologisesti kestävällä tavalla. Tästä syystä se on tunnistettu tavaksi ratkoa monitahoisia haasteita. Osallistuva maankäytönsuunnittelu vaatii työtapoja, kuten paikkatietomenetelmiä, joilla on mahdollista kartoittaa spatiaalista tietoa ihmisten ja ympäristön välisestä suhteesta. On olemassa kuitenkin hyvin vähän tutkittua tietoa siitä, miten nämä menetelmät soveltuvat lakisääteiseen maankäytönsuunnitteluun. Tansanian maan- ja luonnonvarojenkäytönsäädökset perustuvat hajautettuun päätöksentekoon ja suunnittelukäytännöt digitalisoituvat maassa nopeasti. Tutkin tapaustutkimuksen avulla mitä lokaali paikkasidonnainen tieto kertoo maankäytöstä ja siihen liittyvästä päätöksenteosta ja kuinka Tansanian nykyiset suunnittelusäädökset ja -käytännöt integroivat lokaalia paikkasidonnaista tietoa osaksi päätöksentekoa. Lisäksi kehitän osallistavia paikkatietomenetelmiä, joilla tätä tietoa voidaan integroida maankäytönsuunnitteluun ja tarkastelen näiden menetelmien hyötyjä, puutteita sekä soveltamismahdollisuuksia.

Tutkimukseni lähestymistapa on transdisiplinaarinen ja yhdistää useita tutkimusmenetelmiä. Käytän nykyisten säädösten ja käytäntöjen arvioinnissa kirjallisuuteen perustuvia kriteerejä, jotka sovellan jokaiseen tapaustutkimukseen sopivaksi. Jokaisessa tapaustutkimuksessa toimin yhteistyössä tansanialaisten asiantuntijoiden kanssa ja kehitän ohjeistuksen osallistavan paikkatietomenetelmän käytöstä suunnittelijoille. Yhdistän haastatteluja, ryhmäkeskusteluja, kyselyjä, osallistavaa kartoitusta sekä havainnointia tutkiessani ihmisten ja ympäristön sekä maankäytön suhdetta (Artikkeli **I**) ja ihmisten kokemuksia suunnitteluprosesseissa (**II, II** ja **IV**).

Tulokset osoittavat, että paikallinen tieto auttaa tunnistamaan maisemassa maankäytön rakennetta sekä selittämään maankäyttöön vaikuttavia tekijöitä ja maankäytön dynamiikkaa (**I**). Nykyisten säädösten ja käytänteiden tarkastelu paljastaa, että huolimatta paikallisten osallisuuden ja aktiivisen osallistumisen painotuksista, suunnittelukäytänteet eivät kykene sijaintiin liittyvän paikallisen tiedon keräämiseen tai hyödynnä paikkatietomenetelmiä keskustelevan suunnittelun tukena (**II** ja **III**). Täten maankäytönsuunnittelu epäonnistuu paikallisten tarpeiden ja maankäytön ominaispiirteiden tunnistamisessa. Kehittämämme osallistavan paikkatietomenetelmän nähtiin lisäävän kerätyn paikkasidonnaisen tiedon laatua ja tukevan osallisten ja suunnittelijoiden välistä keskustelua, oppimista sekä alueen maantieteellistä hahmottamista virallisissa suunnitteluprosesseissa (**III** ja **IV**). Suunnittelijat tunnistivat useita menetelmän hyötyjä työlleen, mikä kannustaa sen käyttöönottoon (**IV**). Laajempi käyttöönotto vaatii paikkatietoalan koulutuksen lisäämistä sekä sitoutumista osallistuvan suunnittelun toteutukseen eri hallinnontasoilla. Koska osallistavat paikkatietomenetelmät auttavat tiedon integrointia, tutkimuksen ja menetelmäkehityksen tulisi tulevaisuudessa keskittyä tunnistamaan paikallisen tiedon moninaisuus ja yhteisöjen prioriteetit. Tämän saavuttamiseksi paikallisten oikeus määritellä mitä tietoa kartoitetaan ja miten sitä visualisoidaan ja käytetään, on hyvin tärkeää.

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Finally, I would like to acknowledge all the relatives and friends in the background who have relentlessly supported me over the years. I'm not listing you all here but hopefully you know how much you have always meant to me regardless of the at times long distance. Mom and dad, I did it. Thank you for always worrying about me yet letting me go on my journeys trusting that I can always come home. Omar, thank you for your patience and caring during the long days of work that you have seen me through over the past few years. Lastly, I owe my utmost gratitude to my grandparents, Kaija, Ilpo and Taimi, for instilling in me the eagerness to explore, open-mindedness, and humbleness toward the diversity of existence in our world.

Turku 26.5.2020
*Salla Eilola*

# Table of Contents

# List of Original Publications

This dissertation is based on the following four original articles, which are referred to in the text by their Roman numerals:

**I** Eilola, S., Käyhkö, N., Fagerholm, N., Kombo, Y.H., 2014. Linking farmers' knowledge, farming strategies and consequent cultivation patterns into the identification of healthy agroecosystem characteristics at local scales. *Agroecology and Sustainable Food Systems* 38: 9, 1047–1077. DOI:10.1080/ 21683565.2014.923800.

**II** Eilola, S., Fagerholm, N., Mäki, S., Khamis, M., Käyhkö, N., 2015. Realization of participation and spatiality in participatory forest management – a policy–practice analysis from Zanzibar, Tanzania. *Journal of Environmental Planning and Management* 58: 7, 1242-1269. DOI:10.1080/ 09640568.2014.921142.

**III** Eilola, S., Käyhkö, N., Ferdinands, A., Fagerholm, N. 2019. A bird's eye view of my village – Developing participatory geospatial methodology for local level land use planning in the Southern Highlands of Tanzania. *Landscape and Urban Planning*, 190, 103596. DOI:10.1016/ J.LANDURBPLAN.2019.103596.

**IV** Eilola, S., Käyhkö, N., Fagerholm, N. Users' perspective on participatory mapping that uses high-resolution remote sensing imagery: lessons learned from land planning practice in Tanzania. Under review in Land Use Policy.

# 1 Introduction

Communities and governments in the Global South are tackling multiple challenges to human well-being and environmental integrity. The global human population is predicted to increase by about two billion by 2050 (UN DESA, 2019). African countries alone will account for more than half of this increase, nearly doubling the population of the continent. At the same time, extraction of natural resources such as biomass and fossil fuels has tripled worldwide in the past 50 years and continues to grow (IRP, 2019). Population growth and increasing demand on natural resources are interlinked with environmental degradation and biodiversity loss, negative externalities of global economic growth and climate change. Tackling these interlinked challenges requires cross-sectoral solutions at multiple scales and resource management that enhances productivity while maintaining resilient ecosystems and human well-being (Brondizio, Settele, Diaz, & Ngo, 2019; Ellis, 2013; Sachs et al., 2019; UNCCD, 2017: 40-50). Ever since the UN Conference on Environment and Development in 1992, land use planning has been promoted as an important tool for the sustainable use and management of natural resources (Rudel & Meyfroidt, 2014; Ziadat, Bunning, & De Pauw, 2017). Land use planning has several linkages to achieving the Sustainable Development Goals, the global aims agreed to by national governments of the United Nation's General Assembly in 2015 (UN, 2015). The goals that are directly linked to land use planning include equal access and control of land, resilient agricultural production, strengthened capacity to adapt to climate change, sustainable settlements and management of natural resources (UNCCD, 2017: 271-308).

Integrating scientific and local knowledge and balancing the needs, interests and values of different land users are seen prerequisites for socioculturally and environmentally sustainable and equitable landscapes (Kozar et al., 2014; UNCCD, 2017; UNESCO, 2017). Participatory approaches to land use planning offer opportunities for various land users and local community members to share their experiences and place-based knowledge of the landscape (Kahila-Tani, Kyttä, & Geertman, 2019). This increases our understanding of where different land uses, resources and sites of importance for recreational, spiritual or cultural value among others are found in the landscape. Place-based understanding of human-

environmental relationships and interactions between global and local processes has been put at the forefront in solving sustainability problems and planning contested landscapes (Chapin & Knapp, 2015; MacGillivray & Franklin, 2015). In land use planning, this place-based knowledge has to be available in georeferenced form that meets the requirements of accuracy and allows analysis of spatial synergies and conflicts between land uses and conservation (Corbett, 2009; Opdam, 2013). Ultimately, addressing sustainable land management and environmental problems also requires deliberation across a wide range of stakeholders, during which value judgements and trade-offs between land uses and planning alternatives can be made to reach acceptable and implementable decisions (Beierle, 1999; Reed, 2008; Tippett, Handley, & Ravetz, 2007).

In the Global South, many countries lack biophysical and socioeconomic spatial data on a local scale to act as a basis for planning and sustainable land management decision-making (Paudyal, Baral, Burkhard, Bhandari, & Keenan, 2015; Valencia-Sandoval, Flanders, & Kozak, 2010). Livelihoods and subsistence of rural communities in these countries depend largely on natural resources such as forests and arable land (Shackleton, Delang, & Angelsen, 2011; WRI, 2005: 33-53). The multiple and nature-based livelihood strategies of rural communities, together with increasing large-scale commercial establishments in, for example, agribusiness and mining, create and maintain these multifunctional landscapes. Land use and values of numerous land users in these multifunctional landscapes are especially difficult to discern and take into account without local knowledge of the planning area, which makes participatory data collection and planning approaches essential (Denier et al., 2015; UNCCD, 2017). Geospatial methods such as online or printed remote sensing imagery for participatory mapping offer possibilities in capturing such knowledge from local land users in a spatially explicit form (e.g. Brown & Fagerholm, 2015; Ramasubramanian, 2015; Ramirez-Gomez, Brown, Verweij, & Boot, 2016). They can also be used to support collaborative decision-making during land use planning. With ICT infrastructure expanding and digital devices becoming common in the Global South, geospatial technologies are increasingly available to be used in planning processes (Amade, Painho, & Oliveira, 2018; Geospatial Media and Communications, 2019; Sala & Dendena, 2015; Verplanke, McCall, Uberhuaga, Rambaldi, & Haklay, 2016).

There is however, little evidence on the usability and influence of participatory geospatial methods in formal participatory planning processes (Brown & Kyttä, 2014, 2018). Usually studies of participatory mapping methods have been done in conjunction with interventions outside formal planning processes and have focused more on the methods and resulting data and not so much on their influence on planning outcomes. Thus, studies of how these participatory methods fare in real-life planning processes are needed to guide the development of operational methods.

A recent study by FAO has shown that planning practitioners need operational methods that capture and integrate local spatial knowledge with other sources of knowledge and support collaborative decision-making in planning processes (Ziadat et al., 2017). Tanzania offers an exciting opportunity to study the use and outcomes of participatory geospatial methods due to its participatory land and natural resource management policies and rapid digitalization of planning and decision-making processes. In addition, the drive to study the outcomes of knowledge integration using participatory geospatial methods stems from the participation paradox. Namely, the mismatch between the emphasis on participation and knowledge integration for sustainable landscape development and the actual participatory approaches that often do not live up to expectations of inclusive local decision-making in the Global South (Cleaver, 1999; Cooke & Kothari, 2001; Persha & Andersson, 2014; Ribot, Lund, & Treue, 2010; Stringer, Reed, Dougill, Seely, & Rokitzki, 2007). There are signs of this paradox unfolding in Tanzania, especially in land use planning and natural resource management (Hart et al., 2014; Nnkya, 2007; Sungusia & Lund, 2016; Walwa, 2017). My assumption is that it is not only the lack of commitment combined with failure of the policies to transfer decision-making to local communities but also a lack of suitable tools to involve the communities and elicit their knowledge and perspectives in georeferenced forms that explain the mismatch.

In this research, I will use case studies to study the potential of participatory geospatial methods to improve knowledge integration and contribute to more inclusive and informed decision-making. My specific research objectives are to 1) study what local spatial knowledge (LSK) reveals about land use and land use management-related decision-making, 2) study how existing land use planning policies and practices integrate LSK into planning decision-making in Tanzania, 3) develop participatory geospatial methods capable of integrating LSK into formal land use planning, 4) study the benefits and adoption potential of these methods in formal land use planning processes, and finally 5) reflect on the limitations of the geospatial methods in representing LSK and diverse perspectives in these processes.

My case studies are from rural Tanzania—in particular, from two case study areas. Unguja Island, Zanzibar, and Southern Highlands, mainland Tanzania. I conducted the research with a University of Turku Tanzania research team that has well-established cooperation with local universities and authorities in their respective fields. This network of Finnish and Tanzanian researchers and practitioners was fundamental for me to carry out the research and dive into existing planning processes in the country. In order to develop applicable planning methods and assess their usability and outcomes, I used a transdisciplinary approach and collaborated with practitioners outside of academia. This allowed me to gain from

their experiences in land management and planning practice and in using participatory geospatial methods.

The four articles of this dissertation explore both land management and land use planning from the local inhabitants' and practitioners' perspective. From the first field work onwards, I, as a researcher, have found it important to try to understand (within the confines of time and methodology) the logic and reasoning behind people's actions—be they, for example, land use activities of local farmers or planning practices of district authorities. This has prevented me from making unfounded judgements and corrective suggestions. My interest in understanding actions has also been a way for me to start a dialogue in Tanzania.

I respond to the first research objective in Article **I** by looking at local knowledge related to agriculture, the main livelihood of rural populations in the Global South and the largest single use of the world's land surface (UNCCD, 2017: 126). A participatory mapping campaign of a sample of village population and farming household interviews shed light on the land use patterns and agricultural strategies behind them in Zanzibar's Unguja Island. In Article **III**, I respond to the first objective through discussions and mapping exercises with community members around satellite image printouts in Southern Highlands of mainland Tanzania. This reveals local spatial knowledge and perspectives that more comprehensively explain patterns of various land uses in the village. The findings from the Article **I** sparked my interest to study ways in which local knowledge can be elicited for planning purposes.

The policy reviews and discussions with planning practitioners and participants in Articles **II** and **III** answer the second objective. I used literature-based criteria in both articles to systematically assess how the existing policies and planning practices consider local spatial knowledge and capture it in the planning processes in Zanzibar and mainland Tanzania. The policy-practice analyses informed the codevelopment of an improved participatory geospatial method that responds to the third objective in Article **III**. The codevelopment and testing of the method in Southern Highlands was done by our transdisciplinary team of researchers and practitioners from Finland and Tanzania. We developed the method for a formal village land use planning (VLUP) process and tested it together in one village, where I was also able to assess its performance and impact.

The fourth objective I answer with a combination of interviews, group discussions and observations during the empirical method testing as well as a comparison of land use maps produced with or without the codeveloped geospatial method in Article **III**. Further examination of the benefits and adoption potential of participatory geospatial methods I carry out in Article **IV** by interviewing Tanzanian practitioners who have used the methods and by analysing the responses of participants surveyed about their experiences in the mapping exercises. The fifth

objective I respond to with a reflection based on all four articles, literature on the nature of LSK, and work by prominent scholars in the field of critical GIS that I open in Chapters 2.2. and 2.3. Some of the observed shortcomings of the participatory geospatial methods I have already presented in the discussions of Articles **III** and **IV,** but in this summarising account I highlight the ones, which are decisive for ensuring local priorities, inclusiveness and local process ownership are part of participatory planning.

While this first chapter has introduced the wider relevance and objectives of this dissertation, in the next chapter I will explain the theoretical and conceptual framing of my research. First, I shall introduce the concept of place, which I have used to conceptualize the personal relationship between humans and their surrounding landscape, and which underlines the importance of local land users' perspectives in planning for socioculturally and environmentally sustainable landscapes. Then I will explain the concept of local spatial knowledge, and the methodological underpinnings of participatory mapping and planning to capture this knowledge. In Chapters 3 and 4, I describe my study areas and the research approach and methods. In Chapter 5, I present my main findings with a discussion and considerations of methodological and ethical aspects of the participatory research. In the last chapter, I summarise by presenting my main conclusions.

# 2 Theoretical and conceptual framework

## 2.1 Place as a concept to understand human-environment relationships

Entrikin (1991: 5) has pointed out that understanding of a place requires both objective and subjective views on reality. This pluralistic view of place has been advocated in landscape planning and management (Williams, 2014) and in sustainability sciences (MacGillivray & Franklin, 2015). Both fields of study highlight the need to integrate scientific knowledge with the diverse place-based experiential knowledge of land users in order to plan sustainable landscapes. Subjective people-place relationships are considered important in understanding what constitutes human well-being in a place, and how socially and ecologically sustainable landscapes can be achieved under different pressures on land and landscapes (Adger, Barnett, Chapin, & Ellemor, 2011; Lewicka, 2011; MacGillivray & Franklin, 2015; Sebastien, 2020). In sustainable landscape planning, a comprehensive understanding of the landscape and its constituent parts (places) is a necessity in order to account for its various properties, functions and values (Selman, 2012). Landscape can be defined as a holistic socio-ecological system that is perceived by people and has spatial patterns and dynamics that can be studied and identified at different spatial and temporal scales aiding spatial planning (Council of Europe, 2000; Farina, 1998: 1-19; Selman, 2012: 3-4). However, in everyday life, people construct their understanding of their surroundings in smaller entities than landscape through places and connections between places that have meaning to them. Ingold (1993) has illustratively said about this place-landscape relation that places are centres or "nexuses" of human experience and action in the landscape.

In geography, the close and personal relationship between humans and their surrounding landscape has been studied through the concept of place. Place as opposed to the positivist, objective notions of nature or the environment detached from humans as the physical space to be observed (Cresswell, 2014: 15-17; Karjalainen, 1999; Williams, 2014). In this view, the human-environment relationship is considered to be much closer and reciprocal; the place affects us, our

perceptions and actions, and we affect the place by altering it physically or by valuing it differently. As such, places are not mere objective physical entities with coordinates but "sites of concrete human involvement" (Karjalainen, 1999). Tuan (1975) defines place as "a center of meaning constructed by experience". Through our experiences in a place, we infuse meaning, memories and value into that place. Cresswell (2014: 12), while referring to Agnew (1987), posits place to often have a unique location in the form of coordinates and a material form and features as well as ideational characteristics such as sense of place attached to it by people. Sense of place encompasses the meanings and emotional attachment that people or groups of people have towards a place (Relph, 1976; Tuan, 1977). Sense of place has been studied to explain place-related behaviour and attitudes and linked to a strong sense of responsibility for the environment, but also resistance to the behavioural change required to halt environmental degradation (Chapin & Knapp, 2015; Masterson et al., 2017).

In addition to an individual's experiences, place meaning is also constructed through sociopolitical interactions. As elaborated by Rose (1995: 89), "although senses of place may be very personal, they are not entirely the result of one individual's feelings and meanings; rather, such feelings and meanings are shaped in large part by the social, cultural and economic circumstances in which individuals find themselves." In fact, in geography there are two distinct lines of approach in studying place: one focuses on the various meanings individuals attach to place through time and their subjective experiences, and the other looks at the ways in which meanings are constructed through social and political processes, which then influence the meanings that individuals attach to place. The former, the existential-phenomenological approach, is associated with humanistic geography that emerged in the 1970s as a response to positivism, which it saw as reducing place to a location and container of human actions (Williams, 2014). The latter, the relational approach, is associated with radical, post-structuralist geography that critiqued positivism and the phenomenological approach for not paying attention to the sociopolitical processes of place-making (Williams, 2014).

Studying the human-nature relationship from both of these perspectives is crucial as together they allow better understanding of human needs and interests as well as sociocultural processes and behaviour that play out in landscapes. Humanistic geography sees place as an experiential phenomenon (Karjalainen, 1999). Every person thus has their own unique experiences and knowledge of a place, and the depth of knowledge differs based on how well we know the place—for example due to the time spent there (compare, for example, residents' knowledge of a place to that of tourists). Our mental representations of places, i.e. mind-maps, differ, and people describe places differently even if they live in the same household (Jenkins, 2005, 20). Moreover, their descriptions may vary when they explain a place

to different people or at different times of their lives (Jenkins, 2005, 20). Our place experiences are spatiotemporal, as explained by Karjalainen (2004: 232-241), while our time living in a place has created an individual, multifaceted relationship with it. Massey, an influential scholar of the relational approach to place, wrote extensively about the event like nature and multiplicity of places. For her, places are not stable; they are under constant construction as personal meanings and memories associated with them change or are changed through our interaction with the place and the society around us. The multiplicity of a place and the place experiences of people demand negotiation, as we cannot assume collective identities, authenticity nor predetermined coherence of a place (Massey, 2004: 141). According to Harvey (1996: 78-83) the socio-political construction of place meanings happens through modalities such as material practices that modify our environments, social and power relations, and hierarchies, as well as through the discourses in coded language we are exposed to and create.

To summarise, place concept urges the study of material conditions and place-specific shared and individual experiences that shape held meanings, behaviour and well-being of people in a particular planning context. One way to understand and capture this multiplicity of experience and meaning is through participatory approaches that investigate the different understandings of place. Participatory planning processes try to capture these multiple perspectives—sometimes opposing ones—and try to negotiate and reconcile them through collaborative activities. When engaging in planning, it is important also to recognize that planners and policy-makers have their own meanings and spatiotemporal relationships associated with the planning area, which differ from those of residents and other stakeholders (Vilkuna, 1997: 167). Moreover, as social processes, planning situations (Vilkuna, 1997), and the discourses of them influence people's place meanings and their description of them. Planners' relationship with a place is often based on their professional knowledge, views and ways of conceptualizing a place. Planners also use various instruments (surveys, remote sensing and other spatial data, etc.) to understand a place. In a positivist sense, there is an objective environment, which can be empirically studied, but for humans and human well-being our subjective perceptions and experiences are important in that environment. Thus, we have to have tools to capture these subjective perceptions and experiences from residents and other stakeholders in order to integrate them into planning decision-making.

## 2.2 Studying places through local spatial knowledge

Human-place relationship and humans' understanding of their environment are expressed and exemplified in forms of knowledge, which have been termed, for example, local knowledge (LK), indigenous knowledge, traditional, or experience-

based knowledge. Pascual et al. (2017) define local knowledge (LK) as "a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment." Local knowledge is acquired through experience and can concern all aspects of life and natural phenomena in a specific place, including its material objects and intangible meanings. It may be developed and held by individuals or entire communities, who share it through stories and everyday interaction (McCall & Dunn, 2012). Scientific knowledge (as a positivist notion) has since Greek antiquity been separated from so-called practical everyday knowledge and considered in an ideal form to be universal, explanatory, and proven to be true by a standard method (Hirsch Hadorn et al., 2008: 20). Local knowledge on the other hand, often does not meet the positivist criteria or lend itself to standardization (Turnhout, Bloomfield, Hulme, Vogel, & Wynne, 2012). Nonetheless, it has usually been, like scientific knowledge, acquired through empirical evidence via observation, experimenting with different underlying conditions and openness to incorporating new, even contradictory knowledge (McCall, 2009). In this view, we can think of local knowledge and scientific knowledge as being products of the expertise of different sociocultural systems and their ontologies. The importance of local knowledge, values and practices has been recognized for achieving sustainable development goals and land and resource management policies globally (Pascual et al., 2017; Turnhout et al., 2012; UNESCO, 2017).

Most local knowledge has spatial aspects. Spatial knowledge can be defined as individually or collectively perceived spatial comprehension of physical features, linkages and dynamics that can be mapped (Pfeffer, Baud, Denis, Scott, & Sydenstricker-Neto, 2013). Thus local spatial knowledge (LSK) refers to local people's mental representations of place and spatial concepts (distance, distribution, etc.), such as knowledge of boundaries and locations and their spatial connections. Spatial knowledge and spatial thinking allow people to understand natural phenomena, patterns and relationships in the landscape but also help them to identify and structure problems, and find and express ways to solve them (Collins, 2018). When LSK is based solely on experience, the mobility and exposure to the surrounding environment of the individual affects its extent. However, usage and exposure to coded, geographical representations of the landscape, such as maps, and interaction with other people and their spatial representations also influences the construction of spatial knowledge of an individual. Thus, LSK is not necessarily consistent, and compared to the actual locations on the ground it may have errors because people's knowledge is not complete and may be incorrect (Rambaldi, 2010). LSK is often not in codified form on paper or in other visual representations (Pfeffer et al., 2013). People are generally, nevertheless, capable of rendering their spatial

knowledge into map-like representations showing connections and relationships between locations. These simple map representations lack scale and can be considered direct representations of the cognitive maps, i.e. mind-maps, of the drawers while they are not confined to cartographic conventions.

McCall and Dunn (2012) have identified three types of local spatial knowledge content. First is the spatial technical knowledge about resources, events and activities that may be a result of generations of experience. It concerns, for example, location of resources and recreational sites, environmental hazards, urban safety and other physical phenomena, some of which outside professionals are unaware of. Second is the spatial knowledge of local actors' needs, interests and values attached to particular places, including, for example, individual land and resource ownership and communal property regimes that are usually misunderstood by external actors. Third is the knowledge of sacred and historical places and cultural artefacts, as well as locations related to cosmological and creation myth explanations that have existential significance to individuals and particular communities. The values and existential significance attached to places by local people has become an important field of study in sustainability sciences, which employs the pluralistic view of place as having both subjective and objective characteristics. The diversity of values of both tangible elements and abstract ideas attached to places is seen as crucial to include in planning for socially, ecologically and economically sustainable solutions to global challenges (Kenter et al., 2019; Rawluk, Ford, Anderson, & Williams, 2019).

The characteristics of local spatial knowledge in terms of precision and accuracy usually differ from the characteristics associated with expert-based spatial information. People's knowledge of boundaries can be fuzzy and indistinct, as boundaries may be overlapping and blurry or vary according to, for instance, gender, age or land use (Rambaldi, 2010). There may also be ambiguity in the meanings of places and in the precision of specific locations (McCall & Dunn, 2012; Rambaldi, 2010). Imprecision or uncertainty is not only the case in local spatial knowledge but applies to location and extent of natural phenomena and objects in general, creating challenges to visually represent them in map form (MacEachren et al., 2005). LSK is also rich in the sense that each individual has their own representations of the environment and its objects. The local taxonomies and classifications of phenomena and objects such as vegetation, soils and land uses may differ entirely from scientific ones, and we ought to reflect on how we represent or misrepresent these different epistemologies in maps (McCall, 2009; Rundstrom, 1995). Finally, human cognitive maps are dynamic in that they evolve through experience and learning, and therefore LSK has dynamic characteristics (McCall & Dunn, 2012). Local knowledge includes details of, for example, temporal changes in resource availability, natural phenomena, human activities, and power. It also incorporates historical events and their influence on the current day situation in communities. The dynamics and

richness as well as the imprecision of local spatial knowledge ought to be considered when local knowledge is elicited and visualized in order to represent it as closely as possible to its actual form.

## 2.3 Participatory mapping and geospatial methods to capture local spatial knowledge

Participatory mapping (PM) is a way to capture and communicate local spatial knowledge and place meanings in a visual and spatially explicit form. PM has been defined by Corbett (2009) as "a map-making process that attempts to make visible the association between land and local communities by using the commonly understood and recognized language of cartography". In line with Brown & Kyttä (2018), I use PM as an umbrella term for different terminology including community mapping, participatory geographical information systems (PGIS), public participation GIS (PPGIS), volunteered geographic information systems (VGI), and participatory three-dimensional modelling (P3DM), all of which have different origins and varying levels of technological sophistication. PM can be done simply by drawing a sketch map in the sand or on a piece of paper or by using various georeferenced media such as topographic maps or remote sensing imagery. Different geospatial technologies are used to collect, digitize, visualize, analyse, combine, store and share the PM data. Some of these technologies enable data management to be done in a participatory manner with stakeholders (see e.g. Zhang, Geertman, Hooimeijer, & Lin, 2019). Mobile mapping technologies and open source spatial data are also used nowadays to carry out PM exercises or mapping as a volunteer activity by citizens on their own time using, for example, OpenStreetMap platform (Goodchild, 2007; Verplanke et al., 2016). In the remainder of the dissertation, I refer to PM applications that produce georeferenced outputs as participatory geospatial methods when I need to distinguish them from non-georeferenced mapping methods.

Several coinciding developments have been attributed to the emergence of PM in the late 1980s and 1990s all the way to the present. The increasing access to affordable hardware and GIS technologies and general move towards collaborative governance have been crucial for the involvement of non-experts in mapping and planning (Elwood, 2011; Pánek, 2016). Partly, PM developed as an approach to data collection and knowledge creation as a response to the social, political and epistemological critique of GIS science and its support of positivism and exclusivity of knowledge (Elwood, 2011; Pickles, 1995; Sieber, 2006; Weiner, Harris, & Craig, 2002). In the Global South and in research with indigenous communities, PM methods evolved through the combination of participatory action research (PAR) methods and geographic information technologies and they came to be seen as a way

to contest prevailing narratives and official maps of territories (Brown & Kyttä, 2018; Sieber, 2006). A general drive for the use of PM was to open possibilities for local non-experts to share their knowledge for decision-making, which had been, for the most part, the domain of expert-knowledge. At the same time questions started to be asked about the possibilities of technological methods to support local people to empower themselves and represent their local spatial knowledge in decision-making processes, a concern that PM practice continues to deal with today (Abbot et al., 1998; Reid & Sieber, 2019). The field of critical GIS, especially, focuses on studying the representation of LSK and epistemologies as well as the social implications, including inclusivity, of PM and geospatial technologies (Elwood, Schuurman, & Wilson, 2011). It is acknowledged that PM can both empower and marginalize the people it involves as participants and that the design of the participatory process defines who ultimately benefits from it (Weiner et al., 2002). Elwood (2009) gives an encouraging account of how participatory geospatial methods are used by community organizations to represent and consolidate the diverse place meanings of community members as a way of representing multiple epistemologies using GIS. Presently, increases in PM applications in the society and interest in the field are shown by recent journal reviews and special issues (e.g. Brown & Fagerholm, 2015; Brown & Kyttä, 2018; Mukherjee, 2015; Verplanke, McCall, Uberhuaga, Rambaldi, & Haklay, 2016) and by the establishment of the International Society of Participatory Mapping (ISPM), which brings together researchers and practitioners globally to share experiences and critically view best practices.

The relationship between local spatial knowledge and PM data is influenced by several factors. Participatory mapping can be done individually or collectively and the data that is gained with each mode capture different knowledge content. While society and communities have inherent heterogeneity through social and cultural groups with varying income, social status, ways of thinking and place meanings, the concerns of different groups and individuals living or operating in a place can differ substantially as well in content and spatial reach (Healey, 1997: 95-126; Leach, Mearns, & Scoones, 1999). The aim of PM often is to capture this diversity of perceptions and needs with a representative sample from the communities or among stakeholders. In individual mapping exercises, local spatial knowledge is collected from individuals and aggregated into one dataset, which represents the diverse knowledge among the sample population. In collective mapping exercises, the participants reach a consensus through discussion and produce a shared representation of the mapped landscape, which limits the richness of LSK that is captured in the resulting spatial data. Raymond et al. (2014) have noted that instrumental, individual-based valuations and deliberative, collective valuations of the landscape represent different types of knowledge and their outputs cannot thus be considered capturing exactly the same human-nature relations in the area. The

knowledge content that is captured in PM is also influenced by who defines the mapped phenomena and how they are visualized. Rambaldi (2005; 2010) has emphasized the importance of participatory legend making in order to use locally accepted and relevant map items, taxonomy of and symbols for the physical, biological, and sociocultural features of the mapped landscape.

Furthermore, as noted in the previous chapter, the accuracy and precision of LSK may differ from that of expert-based spatial knowledge. The same level of spatial accuracy and precision cannot be assumed nor required from the PM data as from spatially precise ground survey data. Nonetheless, some issues are possible for people to map with high precision and accuracy, such as a boundary of fenced farmland, and some remain vague, such as places of aesthetic or spiritual value. Moreover, local people may view official spatial data to be inaccurate from their experience-based perspective. Consideration of accuracy and precision become important when the PM data is integrated with other spatial data, used to communicate with authorities and other outside actors, or used in spatial planning and decision-making (Corbett, 2009; McCall & Dunn, 2012). Amongst the various PM methods, the ones that enable the level of spatial certitude or ambiguity needed in a particular situation can be chosen (McCall & Dunn, 2012). Participatory geospatial methods that use cartographic protocols and capture LSK in a georeferenced form enable, for example, the measurements of distance and area sizes that are needed in spatial planning. The discussion between participants and practitioners on data accuracy improves the confidence with which PM data can be used for spatial decision-making (Forrester & Cinderby, 2011).

## 2.4 Participatory land use planning and local spatial knowledge

Participatory mapping methods are increasingly used to provide information in collaborative spatial planning processes (Jankowski, Czepkiewicz, Młodkowski, & Zwoliński, 2016; Kahila-Tani et al., 2019). Land use planning, the same as any spatial planning, is a very information-intensive process where spatial information is crucial to inform value judgements for land use and infrastructure allocation and different risk prevention measures. There are numerous definitions for and aims of spatial planning, while each country has its own planning system that governs how planning is to be done and the planning practices also differ between planning institutions within countries (Healey, 1997: 72-75). Regardless of the planning system, spatial planning is a process that aims to control and improve the spatial distribution of people, land uses and resources. Contemporary planning theory, in both the Global South and North, recognizes multiple sources of knowledge, including expert and local spatial knowledge, and seeks to engage with various stakeholders, managing

their multiple types of knowledge and building a planning consensus (Pfeffer et al., 2013; Rydin, 2007). Thus participatory planning involves various stakeholders in the planning process and often defines them as those individuals, groups and organizations who are affected by or can affect planning decisions (see original definition by Freeman, 1984). The reasons for integrating LSK in planning decision-making through participation and PM have been classified into instrumental, normative and substantive arguments (Fiorino, 1990). In the instrumental view, participation creates trust and acceptance of the decisions and hence commitment to plan implementation. Normative arguments suggest that participation is a democratic right and that the wider society will benefit when participation reduces marginalization of people (Reed, 2008). Finally, substantive arguments highlight the increased quality of decisions and equitably distributed benefits when various perspectives and knowledges are incorporated into decision-making.

Planning processes follow certain steps and on each step, stakeholder participation and local spatial knowledge can have a role and influence the outcomes. Sharifi et al. (2002) define three stages of the planning process that are similar to the three-stage framework of Arciniegas and Jansen (2012) and based on Simon's (1979) rational decision-making model. In the first stage, the prevailing situation is described or a problem is identified and objectives for planning formulated. In the second stage, different alternatives or solutions are generated, and in the third stage their impacts are evaluated based on which decision or choice is made between them. This framework describes a planning process simplistically, but in most planning cases the same overall steps are identifiable. McCall and Dunn (2012) also add to these stages an action phase where the plans are implemented and monitored. Stakeholders may participate in all the process stages or in some of them, depending on the stakeholder engagement plan, which is often made by the planners or facilitators in line with the given planning policy. The level of participation may differ at each stage. The level of participation varies based on the degree of stakeholder involvement that has been categorized by scholars in different ways (see e.g. Arnstein, 1969; Davidson, 1998; Goetz & Gaventa, 2001). On one end of the spectrum, participation can be seen as one-way communication where planners inform the participants on the decisions, and on the other end of the spectrum it can be seen as empowerment of the target population when decision-making has been devolved to them. PM can be used at each stage to support participation and to elicit LSK—for example, to collect information or opinions from stakeholders on land use, to analyse and visualize the impacts of alternative land use decisions, to assist in land allocation discussions and knowledge integration, and to document plan implementation and land use changes for monitoring purposes (Arciniegas & Janssen, 2012; Jankowski, 2009; McCall & Dunn, 2012). The selection of PM methods and level of participation aimed at in a given planning stage depends on

several factors, including the capacity of the stakeholders to participate, relationships between the actors (accord, trust, antagonism), and the nature of the issues under discussion (their complexity, social implications, technical knowledge needed, etc.) (McCall & Dunn, 2012; Reed, 2008). Furthermore, the objectives as well as resources of the planning process affect how stakeholders are involved and ultimately the emphasis given to the empowerment of participants in the decision-making.

## 2.5 Principles to guide assessment and development of participatory processes

Ever since collaborative governance and participatory approaches in research and development started to emerge in the global agenda in the 1980s, the limits of and rationale for participation have been subjects of scrutiny (notably Cleaver, 1999; Cooke & Kothari, 2001; Rahnema, 2010). Codes of conduct and good practices have been developed to assess the quality of participation and guide the design of participatory processes. In the previous chapters, critical issues to consider in PM and spatial planning were raised. In the following, I will discuss some guiding principles for participation in general through the core values of public participation identified by the International Association for Public Participation, IAP2. The values represent those aspects of participation that the association deems to be shared across national, cultural and religious boundaries (IAP2, 2014).

IAP2 assumes the normative premise for participation that is (I) the right of those affected by decisions to be involved in the decision-making processes and highlights that (II) people's views and knowledge will, in effect, influence decisions. The desired level of participation is not defined by the core values, as different levels of engagement can be appropriate and decisions can be made in collaboration between planners and participants depending on the situation (see e.g. Davidson, 1998). However, influence on decisions denotes active involvement and, as such, empowerment in decision-making. Many proponents of participatory decision-making view empowerment as fundamental to participation (Reed, 2008; Richards, Blackstock, & Carter, 2004). And it is also the main objective in many PM applications in the Global South (see Chapter 2.3 and e.g. Corbett et al., 2006; McCall, 2011). For planning to be an empowering exercise for participants or communities, they must have ownership over the entire process and the process must support local agency, decision-making capacity and autonomy in resource management and include process evaluation criteria that they view as important. Influence on decisions also requires that participants' contributions are communicated in a form and language understandable to everyone involved in decision-making. The PM methods should thus be developed keeping in mind how to ensure the PM data can be utilized in discussions and planning decision-making. The opportunity for

participants to develop new options and ideas is also important during exploration of different planning alternatives (Tippett et al., 2007).

Next on the IAP2 core values list are that (III) participatory processes ensure sustainable decisions by recognizing the needs and interests of all stakeholders and that (IV) the stakeholders are actively sought out and facilitated to participate. The role of the planner or facilitator is thus to ensure equal opportunities for participants to share their knowledge, sometimes supporting the marginalized to express their views and to provide specialized advice for all to consider (Abelson et al., 2003; Reed, 2008). Managing power imbalances and dominant knowledge holders' influence is also crucial (Rydin, 2007). Furthermore, identification of the people or entities that are affected or have an interest in the decision and selection of participatory methods that do not hinder participation are prerequisites for the participatory process (McCall & Dunn, 2012; Rowe & Frewer, 2000). The level of technological sophistication of the PM methods should thus suit the capabilities of the participants. (V) Participants need to be involved in designing how they participate, which means that they have to be involved in the early stages of any participatory planning process. Early engagement and ability to influence what knowledge contents are sought increases participants' ownership of the process and its outputs (McCall & Dunn, 2012). (VI) Participants are provided with all necessary information to participate in a meaningful way and (VII) they are also informed in the end how their input affected the decision. For stakeholders to participate, timely and comprehensive communication is important, but so are awareness raising and capacity development that levels opportunities among stakeholder groups to actively engage in the activities and improves understanding of issues under discussion (Rambaldi, 2010; Tippett et al., 2007). The transparency of decisions and accountability of decision-making will enhance trust towards the planning process among stakeholders and those who were not directly involved (Blackstock, Kelly, & Horsey, 2007; Laurian & Shaw, 2009).

# 3 Research context and study areas

Tanzania has some of the Africa's most progressive policies on participatory natural resource management, planning and customary land ownership, especially in the rural areas (Wily, 2002). In the early 2000s, after a decade of decentralizing policy reforms, effectual participatory governance and local economic empowerment in the natural resource sector were seen as answers to rural poverty reduction together with conservation of Tanzania's natural resource base (Kallonga, Rodgers, Nelson, Ndoinyo, & Nshala, 2003). Under the current policies village communities, through elected representatives, have right to plan and manage their land within the village administrative area. The success of the participatory policies is, however, questionable in the country, as the policy synergies and implementation have largely not materialized, leading neither to the anticipated benefits to local communities nor de facto decentralized governance (Hart et al., 2014; Kaswamila & Songorwa, 2009; Lerise, 2000; Ministery of Finance and Planning, 2016; Walwa, 2017). The vast majority of rural areas lack spatial plans and registered communal management rights to forest resources (Hart et al., 2014). The deforestation rate in Tanzania is one of the highest in the world, with an estimated forest area net loss of nearly 500,000 ha per year, and almost two-thirds of the country's drylands are estimated to be seriously degraded (World Bank, 2019). To support rural economic development and halt the loss of natural resource base, national and local administrations feel increasing pressure to expand planning coverage. Information and communication technology is seen enabling advancements in the society and in planning decision-making processes (Ministery of Finance and Planning, 2016). The technological solutions have been claimed, however, to perpetuate power imbalances in Tanzania between those with access to these solutions and those without (Huggins, 2018).

In this dissertation local knowledge and its integration into local-level land use planning and management were studied in two case study areas; Unguja Island of Zanzibar Archipelago (Articles **I**, **II** and **IV**) and Southern Highlands of mainland Tanzania (Articles **III** and **IV**) (Fig. 1). The case study areas in Zanzibar and Southern Highlands exemplify agricultural communities living in multifunctional landscapes with threatened natural resource base due to various land use pressures.

These communities with natural resource-based livelihoods offer opportunities to study local spatial knowledge on their land and natural resource management and relationships with their surrounding environment. On Unguja Island, I conducted the research in two villages, Cheju and Kiwengwa; in the Southern Highlands, the main field research was conducted in Mamongolo village. The villages are in area size approximately 20–40 $km^2$ and have a population of about 1000–3000 inhabitants. Through the Tanzanian practitioners interviewed for Article **IV**, the dissertation also includes experience of using PM methods in the urban context of Dar es Salaam city, Pemba Island of Zanzibar Archipelago and several other communities in Unguja Island and Southern Highlands (Fig. 1). The rationale behind the selection of the case study areas was our team's on-going or longstanding research and development cooperation with local planning institutions in these areas. The case study villages were chosen primarily as they were representative of the socioecological conditions of the larger region. In Article **IV** the case study areas were the ones in which the interviewed practitioners had worked in and the selection thus focused on practitioners' experience with geospatial technologies not on the case study site characteristics.

Unguja Island of Zanzibar Archipelago and Southern Highlands differ topographically, climatically and ecologically. Unguja Island has year-round warm temperatures with bimodal rainfall pattern, and the studied communities live on mostly flat coastal plain (Article **II**). The vegetation on the island has experienced extensive human influence, and it consists of coral rag scrubland and coastal and mangrove forests with several threatened endemic species (Revolutionary Government of Zanzibar, 2004). Southern Highlands consists of plateaus and volcanic mountains that rise up to 3000 meters. The temperatures vary between the lower and higher elevations, with the higher elevations experiencing nighttime frosts. The rainfall patter in the Highlands area is unimodal from November to April (Mbululo & Nyihirani, 2012). The vegetation of the area is predominantly characterized as forest-grassland mosaic, which sustains high biodiversity with numerous endemic species of flora and fauna (Davenport & Markes, 2018).

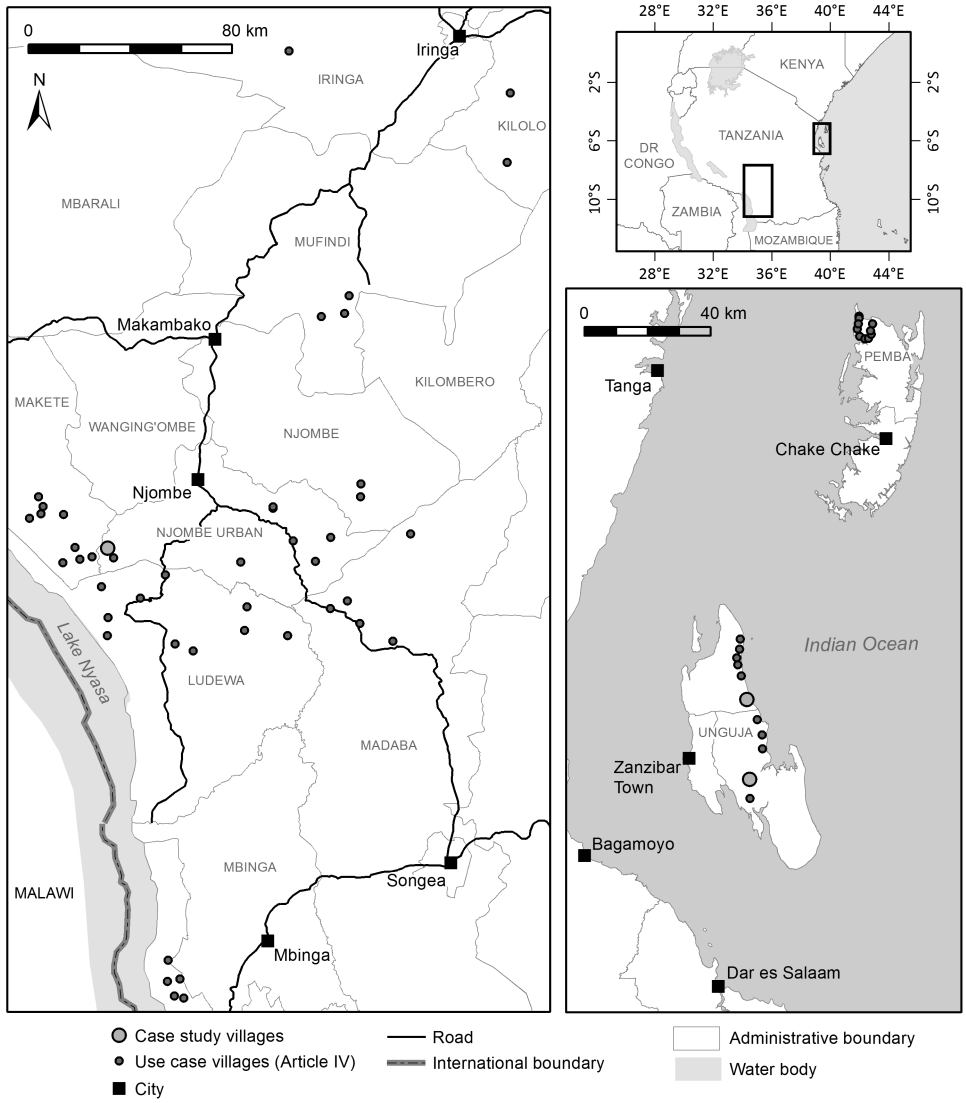


**Figure 1.** Map of the study areas including the villages and Dar es Salaam city where the interviewed practitioners in Article **IV** had used the participatory geospatial methods in participatory mapping.

Based on population estimates Tanzania had a population of approximately 50.1 million in 2016 and is projected to reach 89 million by 2035 (UNDP, 2017). Southern Highlands population is mostly of bantu origin while Zanzibar has also Arab and Indian influence and a distinctive coastal Swahili culture. Tanzania ranks among the countries with low human development, and 30.4% of the population of Zanzibar lives under the basic needs poverty line while the respective figure for Njombe region

of Southern Highlands where the study was conducted stands at 25.7% (UNDP, 2017). Socioeconomically the two study areas are similar with agriculture and small-scale forestry being the main local livelihoods. In Zanzibar, international tourism and in Southern Highlands large-scale commercial forestry and agriculture create economic opportunities but also external pressure on land use (Milder, Buck, Hart, Scherr, & Shames, 2013; Mustelin et al., 2010). The land use planning system in mainland Tanzania differs from that of Zanzibar Archipelago due to different administrative history and Zanzibar's status as a semi-autonomous part of Tanzania. While mainland Tanzania has enacted participatory planning and natural resource management policies, such as the Land Use Planning Act No. 6 of 2007 and the Forest Act of 2002, Zanzibar has recently established a National Spatial Development Strategy (Department of Urban and Rural Planning, 2015), including provisions for local participation, and is revising its land use planning policy. Zanzibar also has a forest sector policy, the Zanzibar Forest Act of 1996, through which participatory land use planning has officially been conducted with communities.

# 4 Research methods

## 4.1 Transdisciplinary mixed methods approach

All the articles in the dissertation have a transdisciplinary element. With transdisciplinary I refer to collaborative research arrangements that involve both researchers and practitioners, subject specialists or other stakeholders (Gertrude Hirsch Hadorn et al., 2008). I distinguish them from research teams that are interdisciplinary and transcend disciplinary boundaries. Similarly, as participatory processes recognize the value of local spatial knowledge in understanding real-world phenomena, transdisciplinary research recognizes the need for practical and non-academic knowledge holders in making research more socially relevant, reflecting the complexities of reality and contributing to real-world problem solving (Gertrude Hirsch Hadorn et al., 2008; Mauser et al., 2013). In transdisciplinary research, the problem identification, structuring and investigation, as well as interpreting and using the results, is done in collaboration with practitioners (Hirsch Hadorn et al., 2008: 35–37). My research work involved practitioners as collaborators in these various phases of the research process. In Articles **I** and **II**, I collaborated with agricultural and forestry experts of the local and national administration to develop assessment frameworks and assess existing land management and planning practices. We also organized seminars at the end of the research to reflect the results together with the practitioners for Articles **I** and **II**. These reflections helped me to ensure my interpretation of the results was in line with theirs and that they have the results accessible for decision-making. In Article **III**, I collaborated with staff of a development co-operation project, a local non-governmental organization and district planning authorities to identify weaknesses in current planning practice, and codevelop and assess an improved participatory geospatial method. We also wrote a practitioners' manual on the codeveloped method. For Article **IV**, I interviewed land use planning practitioners on their views about participatory geospatial methods, which they had used in their work.

I used mixed methods to answer my research questions in three of the articles (**I, III, IV**) in this dissertation. Mixed methods research has been recognized in geography for a long time as a way to study the interrelated relationship between humans and their environment and complex social processes and human behaviour

(Cope & Elwood, 2009: 4–5), which were the backbone of my research interests. Mixed methods research mixes or combines quantitative and qualitative research techniques, methods and concepts in one study and tests findings by triangulating data sources (Cresswell, 2009: 14; Johnson & Onwuegbuzie, 2004). In my research, however, the emphasis was on qualitative methods. In Article **II**, I used a multimethod approach, where several methods are mixed within one research tradition (Leavy, 2017: 164). By using multiple methods and mixing them, I was able to integrate the different forms of knowledge, namely local spatial knowledge with scientific knowledge, and findings based on different research methods in building evidences to explain a phenomenon.

There are three main reasons why I used a mixed methods approach in the research. First is the realization that stems from the humanistic geography tradition discussed in Chapter 2.1 that scientific knowledge will benefit from the place-based knowledge and perceptions of local inhabitants in understanding land management practices and outcomes of participatory processes—hence the qualitative investigation into people's land use practices, planning processes and perceptions. Second is the complexity of natural resource governance, which necessitated a mixed methods approach to offer more information on the phenomenon than qualitative or quantitative methods alone could offer (Cresswell, 2009: 10). For example in Article **I**, I utilized quantitative and qualitative methods sequentially to first study land use within a larger sample of informants, after which I interviewed a smaller sample to better explain the land use pattern. Third is related to the pragmatic underpinnings of mixed methods research and its focus on the research problem. The pragmatism compels researchers to utilise all possible, or the best available, methods to examine and understand the issue (Johnson & Onwuegbuzie, 2004). The case study sites and their local spatial scale meant that there was very little scientific, remote sensing, and census information available on the studied phenomena. I also focused on understanding and not quantifying phenomena, for which qualitative data collection was the best available method to use.

A summary of the qualitative, quantitative and spatial data and methods is presented in Table 1. A generalization of the transdisciplinary mixed methods approach workflow is illustrated in Figure 2. Article **I** integrates scientific explanations of sustainable agricultural practices with local practitioners' experiential knowledge. It also mixes interviews, observations and participatory geospatial methods in revealing land use patterns of the local communities. It uses a smaller sample of household interviews to inform the interpretation of the PGIS and quantitative GIS data from a larger sample of informants. Article **II** traces planning practices through interviews of participants and practitioners and contrasts their perceptions of the planning process with a review of policy documents. Article **III,** with its dual objective of developing a planning method and assessing it, integrates

**Table 1.** Assessment frameworks and research material and methods used in each Article **I-IV**.

| No | Assessment framework | Main research material | Data collection methods | Analysis methods |
|---|---|---|---|---|
| **I** | • Criteria for agroecosystem health | • Interview and observation data<br>• Literature on agroecosystem health and sustainable agriculture<br>• Aerial photographs, land cover pattern map, participatory mapping data and GPS points | • Interviews and observation<br>• Participatory mapping on landscape and field level | • Content analysis using constants comparison<br>• Descriptive statistics, two-step cluster analysis and partitioning rules<br>• Overlay statistics, Euclidean distance analysis and visual spatial data analysis |
| **II** | • Criteria for effective participation and good practice in PGIS | • Interview and group discussion data<br>• Literature on effective participation and good practice in PGIS<br>• Forest Act No. 10 of 1996, Forestry Policy of Zanzibar (CNR 1999) and Community Forest Management Guidelines (MANR 2011)<br>• CoFMA* maps | • Interviews and group discussions | • Conventional and directed content analyses and policy review<br>• Descriptive statistics<br>• Visual spatial data analysis |
| **III** | • Criteria for effective participation and good practice in PGIS | • Interview, group discussion and observation data<br>• Literature on effective participation and good practice in PGIS<br>• Guidelines for village land use planning, administration and management of 2013, Land Use Planning Act of 2007, and Village Land Act of 1999<br>• VLUP** maps and their GIS data | • Interviews, group discussions and observation<br>• Codevelopment and testing of a method | • Conventional content analysis and policy review<br>• Descriptive statistics<br>• Shape index and visual spatial data analysis |
| **IV** | • No predefined assessment criteria | • Interview, group discussion and survey data<br>• Scientific articles, one PhD dissertation and project reports of the studied use cases | • Interviews, group discussions and surveys | • Conventional content analysis<br>• Descriptive statistics |

*CoFMA refers to Community Forest Management Agreement
** VLUP refers to Village Land Use Plan

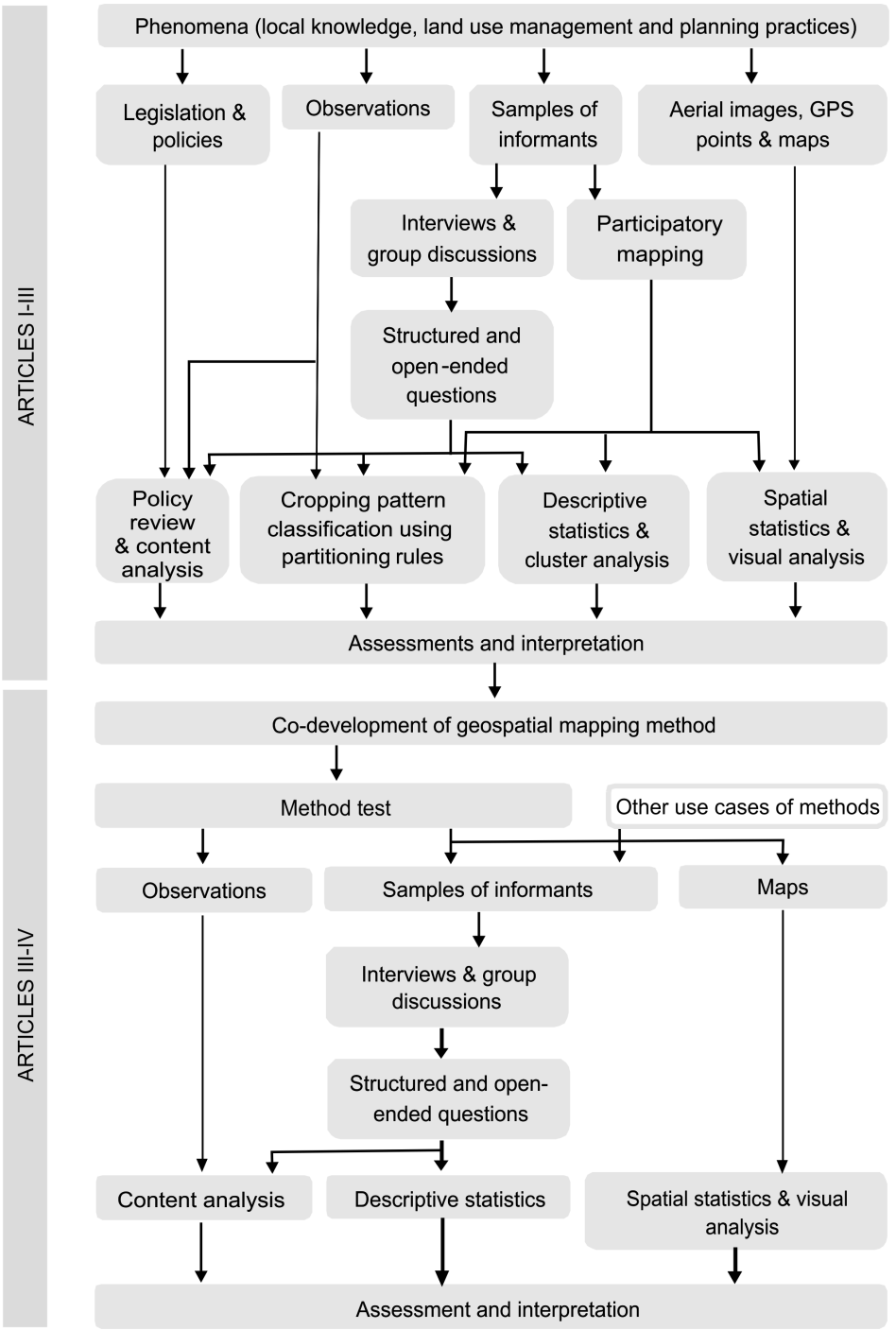


**Figure 2.** Research material and methods workflow. The textbox without solid colour refers to the use cases of participatory geospatial methods, which I studied through interviews of Tanzanian practitioners in Article **IV**.

participants' and practitioners' insights with scientific literature-based ideals of participatory practice and combines quantitative and qualitative evidence from observations, interviews and spatial analysis of maps. Article **IV** has a simpler research design, namely expert interviews and survey data; however, it also relies on knowledge sharing between the interviewed practitioners and the researcher in understanding the studied participatory geospatial methods. Next, I will summarise my research material and methods in the four articles. More detailed description of the material and methods can be found in the respective articles, and considerations on the methodological limitations in Chapter 5.6.

## 4.2 Development of assessment frameworks based on literature

A major component in the research designs in this dissertation is an assessment of land use management or planning practices. In order to frame the research focus and carry out the assessment of the phenomenon under study from a particular perspective I developed a set of literature-based criteria for each study. In Article **I**, the agricultural land use practices and related local farmers' knowledge were studied and assessed based on agroecosystem health concept (see Fig. 3 in Article **I**). In Articles **II** and **III**, the assessment of participatory land use mapping and planning practice as well as policy was based on principles of effective participation and good practice in PGIS (see Table 1 in Article **II** and Fig. 2 in Article **III**). The IAP2 principles summarized in chapter 2.5. were among the main sources of assessment criteria adapted for these two studies. In Article **IV**, however, the assessment of the participatory geospatial method was done through expert interviews without predefined literature-based criteria. A literature review of relevant sources was carried out to develop the assessment frameworks and criteria for the studies so as to ensure some generalizability of each framework and findings. Thus even though the criteria were mainly based on well-known literature of the relevant topic, a pragmatic approach to developing a particular set of criteria for each study was adopted. This increased the relevance of the criteria to the study subject, namely agricultural and participatory planning practices and policy, and the criteria's context sensitivity. For example, in Article **I**, previously published studies on agricultural practices in Unguja Island were utilised to guide the agroecosystem health assessment and investigate already-documented local knowledge of farming.

The criteria formulation followed a step-by-step procedure where each step reaches a more tangible objective of assessment and, finally, a set of measurable or observable criteria (see Van Cauwenbergh et al., 2007 for procedure of agriculture-related criteria formulation and Hassenforder, Pittock, Barreteau, Daniell, & Ferrand, 2016 for procedure of participatory process-related criteria formulation). I

carried out the assessments in collaboration with Tanzanian practitioners, and therefore they were not based only on theoretical literature or the evaluation of the researcher. Assessments that combine theoretical concepts and expert knowledge are an essential part of transdisciplinary knowledge production, which benefits from subject specialists' judgements, prioritization and insights of the topics under investigation (Penker & Wytrzens, 2008). In Articles **I, II** and **III** through interviews and collaborative work, the Tanzanian practitioners were involved in assessing and judging the criteria. In Article **III**, the priorities and improvement needs of local practitioners guided the selection of criteria, and in Article **IV**, the assessment was entirely based on expert prioritizations.

## 4.3 Policy review

Apart from doing a literature review for developing the assessment frameworks, legislation and policy documents from Tanzania mainland and Zanzibar were reviewed as part of the policy-practice assessments in Articles **II** and **III** and for the method development in Article **III**. The main documents are the Forest Act of 2002, the Zanzibar Forest Act of 1996, Zanzibar's Community Forest Management Guidelines of 2011, the Village Land Act of 1999, the Land Use Planning Act of 2007, and Guidelines for Village Land Use Planning, Administration and Management of 2013. I analysed the policy documents for how they recognize and guide participatory practices and use geospatial technologies in supporting participation. In Article **II**, I analysed the policy documents by identifying strengths and weaknesses of the relevant sections of the policy in relation to the literature-based assessment criteria. In Article **III**, I reviewed the existing policy against the assessment criteria but also in order to ensure that our codeveloped participatory geospatial method corresponds to the preconditions set by the policy.

## 4.4 Interviews, group discussions, surveys and observations

Data collection from informants and observations had important roles in studying the relationship between local people, their land uses, and the landscape, as well as people's experiences in planning processes. These qualitative data collection methods enable capturing of individual experiences, behaviours, and opinions and also examination of the social, political, cultural, economic and environmental structures and their effects on individuals (Winchester & Rofe, 2010, 5-8). In Article **I**, I had a stratified sample of farming households which represented different sub-villages within one village, and I interviewed both spouses of each household. In addition, I interviewed a purposive sample of local agricultural experts. In Articles **II**

and **III**, I applied purposive and convenience sampling of informants. The informants had been identified as stakeholders in participatory planning processes and most of them had participated in the land use planning activities. Some of the identified informants were reached through focus group discussions instead of individual interviews. In Article **IV**, I used purposive sampling and interviewed practitioners who had utilized the participatory geospatial methods that I was studying. I also analysed survey responses of participants who had been participating in the mapping exercises. In case study villages, the village leadership assisted in organizing the interviews, group discussions, and surveys and in contacting the informants. On higher levels of administration, the Tanzanian practitioners involved in the research assisted in identifying and contacting the informants. The village leadership and practitioners were provided thorough instructions on the sample characteristics, which were upheld to reduce possible bias in the informant selection.

The interviews were semi-structured, including the interview schedule with open- and closed-ended questions (Dunn, 2010, 110). Most of the interviews and group discussions were done by research assistants in the local language, Swahili. The interviews with practitioners I conducted in English. I am conversant in Swahili; however, to ensure thorough and correct documentation of the informant accounts, I used research assistants in the data collection. I participated in the interviews and group discussions supervising the assistants and occasionally by asking further questions. I trained the research assistants on the research objectives and interview schedules prior to commencing the fieldwork. The research assistants on their part gave valuable input in formulating the interview questions in context-specific form and in the local language. The informant accounts from interviews, surveys and group discussions were transliterated either in situ or later the same day when we went through the written answers together with the assistant. In group discussions of Articles **II** and **III** and in the interviews of Article **IV**, the conversations were audio recorded and later transliterated or transcribed. In the interaction with informants, I emphasized that we create as casual atmosphere as possible and show enthusiasm towards local knowledge and opinions to encourage informants to give us extended accounts of their experiences. The discussions with informants were helped by carrying out the interviews in situ on the farmers' fields and drawing together a sketch map of their fields in Article **I** or sitting around the satellite image that had been used in participatory mapping exercises, on which the interviews and group discussions focused in Article **III**. In Article **II**, I also used a participation matrix, a visual representation of the planning process and level of local participation, which assisted informants in identifying and telling how they felt they had been engaged in the participatory planning exercises. These visual aids during the interviews and group discussions helped the informants and the interviewer to understand each

other, reflect together, and focus the attention around the topic during the conversation (Kindon, 2010, 264).

By combining interviews with group discussions and observations, I was able to clarify and cross-check individual informant accounts, in particular related to land use and planning practices, while I was trying to trace factual human behaviour in the landscape or in a social process. I conducted the observations alone (Article **I**) and with a research assistant (Article **III**) and used a template to structure the observations and to document them. In Article **I**, I observed the environment and land use practices, in particular the agricultural fields of my informants. Whereas in Article **III**, my assistant and I engaged in observing PM exercises in a form of participant observation with the difference that the occasion was staged by us and not part of the daily life of our informants (Watson & Till, 2010: 126-129). During the several weeks of data gathering in the field for each article, I wrote field notes and used them to structure and develop ideas and take note of informal discussions. Furthermore, in Article **IV**, I used available literary sources, such as scientific articles and project reports, to give me background information for interviewing practitioners on facts about their planning practices, a method recommended for conducting expert interviews (Alastalo & Åkerman, 2010). Contrary to tracing factual human behaviour in some of the research I did, most of the interviews and surveys focused on the subjective opinions and experiences of informants and were valuable as such in bringing the diversity of human experience into the study and for answering the research questions.

## 4.5 Content analyses

I analysed the qualitative data from interviews, surveys, group discussions and observations using content analyses in Articles **II, III** and **IV**. The structured, closed-ended responses in interviews and surveys I analysed with quantitative, statistical methods (see Chapter 4.8). I used conventional content analysis; namely, I identified patterns or themes in the text data and coded them into categories that I interpreted directly from the data (Flowerdew & Martin, 2005; Yin, 2011). In each article when analysing the collected qualitative data, I first looked for patterns of meaning and issues that were relevant to the research questions of that particular study and developed initial codes that described these different contents. Then I coded pieces of text in the data with those codes that described the text content. After going through and coding the whole dataset, I reviewed the initial codes and the text items that were coded with these initial codes, iteratively recoding, decoding and subcoding the text as I went through the data again. I also modified the initial codes and identified additional codes at this stage. Then I categorized the codes into larger groupings, or themes, by sorting them into codes that had a similar meaning or

content and seemed to form a theme or a subtheme within a main theme. Finally, I reviewed the themes to ensure they were coherent and distinctive and modified them when needed. These themes and subthemes I described in the results of the articles and provided citations to illustrate some of them.

In Articles **II** and **III**, the assessment criteria that had been developed for the studies and used for designing the interview schedules provided a structure for the content analysis. However, the coding and themes were based on interpretation of the data itself as described above. In Articles **III** and **IV**, I used a qualitative data analysis software, NVivo 11, to carry out the content analysis and store the data transcripts and audio recordings. In the two earlier articles, the amount of data was smaller and thus possible for me to manage and analyse using MS Word and Excel spreadsheets.

In Articles **I** and **II**, I also used other types than conventional content analysis. In Article **I**, I used constant comparison (Corbin & Strauss, 2008: 73-74) to analyse interview data on sustainable agricultural land use practices. I grouped similar opinions as being a collective opinion of the informants and reported differing views in order to show uncertainty of the informants in defining sustainable practices. In Article **II**, I used directed content analysis to analyse the group discussion transcripts (Hsieh & Shannon, 2005). I used the themes I had identified using the conventional content analysis of the individual interview data to guide the coding of the group discussion data. This allowed me to compare the informant accounts from interviews and group discussions but also to note those themes in the group discussion data that were not present in the interview data.

## 4.6 Use of existing geospatial data

Various existing geospatial data were used in most of the studies. In Article **I**, a landscape-level PM campaign of the study village was conducted using the most recent (at the time) digital georeferenced aerial photographs (2004, 0.5 m pixel size), which were mosaicked, printed at a scale of 1:12,000, and laminated (Fagerholm, Käyhkö, Ndumbaro, & Khamis, 2012). A map of land cover patterns of the study village was also used to study the relationship between land use and land cover (Fig. 4 in Article **I**). The land cover pattern map had been produced by interpreting the then-latest digital panchromatic colour aerial photographs from 2004–2005 at the scale of 1:8000 (Käyhkö, Fagerholm, & Mzee, 2015). The land cover classification in the map depicted six categories of open, semi-open and closed land covers. In Articles **II** and **III**, the existing official land use maps, of which production had been facilitated by respective authorities, were analysed visually to assess their quality. In Article **II**, the official maps were also used in interviews with informants to examine their familiarity with the study areas.

## 4.7 Spatial data collection methods

Participatory mapping exercises and GPS point data collection were organized to gather spatial data on land use and land use practices in Unguja Island in Article **I**. In the landscape-level mapping campaign, a sample of village inhabitants, representing all the sub-villages proportionally to the population size and balanced on gender and age was involved in mapping their food services, namely locations of their fields, and additional descriptive information (see further details in Fagerholm et al., 2012). We had a sample size of 7% of the adult population, which was valid for spatial analysis of the mapped data. A laminated aerial photograph of the village acted as the mapping background onto which the informants individually mapped their approximate field locations using wooden beads. The mapped points were digitized into GIS and the descriptive data was linked to the mapped point data in a geodatabase. This PM method using laminated aerial photographs with village informants and the positive reception it received from the informants inspired the participatory geospatial mapping method developed in Article **III** and the suggestions of new practices in Article **II**. In the PM campaign the aerial photograph was printed in scale 1:12,000, which falls between the recommended spatial scale range of 1:5000–1:20,000 that has been empirically found most appealing to mapping participants (McCall & Dunn, 2012).

A field-level PM exercise was conducted also in Article **I** with a smaller sample of households that represented different sub-villages. This mapping exercise yielded non-georeferenced sketch maps of households' agricultural fields including, for example, their structure, crop and tree rotation, and fallow periods. I used these field rotation maps to identify cropping patterns of the farmers in the study village. Field rotation maps or farm visualizations similar to the ones drawn together with informants in this study are part of participatory rural appraisal and participatory action research methodologies (see e.g. Amoroso et al., 2004; Boedhihartono, 2012). They assisted the informants in explaining their land use and its obstacles and helped me in systematic enquiry, documentation and visual analysis of land use patterns. During the field-level mapping exercises, the boundaries of each informant's plots and fields were also located with a GPS device and the GPS points used to show their relative location to land cover patterns in the study village.

## 4.8 Statistical and geospatial data analyses

Descriptive statistics were used to describe the sample populations and analyse the closed-ended questions and quantitative data in the articles. I calculated, for example, frequency distributions and central tendency values for the quantitative data using MS Excel. In Article **I**, in order to identify patterns in the land use

preferences and practices of the informants, I used two-step cluster analysis in SPSS (Chiu, Fang, Chen, J. Wang, & Jeris, 2001) and a more qualitative data classification method, partitioning rules (Gorunescu, 2011; van de Steeg, Verburg, Baltenweck, & Staal, 2010). The two-step cluster analysis can be done on both ordinal and scale variables and it automatically generates the number of clusters. Both of the methods can be illustrated in the form of a classification tree (see Fig. 2 in Article **I** as an example), which helps interpretation and evaluation of the clustering outcome. I used overlay statistics and Euclidean distance to analyse the geospatial data of the participatory mapping exercises of Article **I**. With overlay statistics, I examined the relationship between the agricultural land use patterns and physical land cover patterns in the landscape of the study village (see Fig. 4 in Article **I**). I used Euclidean distance to study the distances between informants' home and field locations; it can be assumed that the distance has influence on some of the variation in land use pattern in the landscape (Fagerholm et al., 2012).

The field location data, which I collected using a GPS device during the field-level mapping exercises in Article **I**, I examined visually in relation to the land cover maps of the study area. This enabled me to illustrate where in the study village each identified cropping pattern is prevalent (see Fig. 6 in Article **I**). I also conducted a visual assessment of existing land use maps to assess the current planning practices in terms of spatial data quality and usage in Articles **II** and **III**. In Article **II**, I obtained and visually analysed the official land use maps, namely community forest management (CoFM) area maps, of the two case study villages in Unguja Island. In Article **III**, I obtained two different sets of official village land use plan (VLUP) maps from the study area in mainland Tanzania. The two sets of maps had been produced with different PM methods and I compared visually their relative spatial data quality and reported the results in a form of descriptive statistics (see Table 2 and Fig. 5 in Article **III**). Amongst the total of 42 maps, I also obtained digital spatial datasets of 27 maps and calculated and compared shape index measures of the polygon data in ArcGIS 10 software (see Appendix C in Article **III**). I chose to indicate geometric complexity of the mapped polygons using the Shape index because the sizes of the polygons in the dataset vary greatly and the index omits the effect of polygon size on the index (McGarigal, 2015).

## 4.9 Codevelopment of participatory geospatial method

The development of the improved participatory geospatial method for mapping in the formal village land use planning (VLUP) process was done in collaboration with practitioners. The codevelopment process took approximately one and a half years, starting in early 2015 and culminating in mid-2016 when the method was tested and

assessed together. Since then the collaborating institutions in Tanzania have adopted it in practice and further developed it. The codevelopment started after a Finnish-funded development cooperation project had identified a need to improve the existing local-level land use planning practice to ensure higher-quality land use plans. The project had funding to invest in the development and partnered with our research team. They were operating in the Southern Highlands area in two regions, Njombe and Iringa, and had established co-operation with planning authorities of six districts. The planning officials from these districts joined in the process as well. We also partnered with a local NGO from Iringa with experience in community development and participatory facilitation.

In February and August 2015, we studied the existing VLUP planning practice through discussions and needs assessment with the district planning officials, whose responsibility is to organize and facilitate the VLUP processes in the villages. We held formal and informal discussions with the facilitation teams and relevant staff of the partnering organizations during two visits to the area. With the partnering organizations, we identified several critical needs for methodological improvements and limitations of the existing practice. Then we started codeveloping the improved participatory method. I used the principles of public participation and related assessment criteria (see chapters 2.5 and 4.2 ) as guiding my own thinking about the requisites for the improved method.

High-resolution satellite image printouts were agreed to be the most feasible background for participatory mapping with villagers. The staff members of the development cooperation project and district planning officials tested and refined the use of the printouts with village representatives in different villages during early 2016. As a team, we also developed the spatial data procedures required to process the satellite image and spatial data. In June 2016, we tested together the codeveloped method during the formal VLUP process in one village, and I led the assessment of its impact and feasibility. Since we tested the methodology in a formal planning process, we were able to assess it in everyday practice that carries the weight of an enforceable plan as an outcome.

The transdisciplinary collaboration was done in an iterative way. We reflected on and adjusted the methodology throughout the codevelopment process in face-to-face as well as online meetings. Reflection on the context and objectives as well as iteration have been emphasized to ensure that transdisciplinary collaboration leads to feasible outcomes (Mauser et al., 2013). In our case, this was a very important part of the codevelopment. I kept in contact with the focal point person of the development cooperation project and staff of the local NGO primarily via WhatsApp platform during the process. It enabled easy communication and sharing of data between us. It also allowed us to timely discuss and make decisions when any issues rose.

# 5 Results and discussion

## 5.1 Local spatial knowledge helps to explain land use strategies, patterns and dynamics in the landscape

Local knowledge elicited through interviews and participatory geospatial exercises with local community members, in Articles **I** and **III**, was instrumental for identifying farming and land use patterns (Fig. 4 and 6 in Article **I** and Fig. 5 in Article **III**). In the exercises, the local informants mapped where they carry out farming or other land use activities and hence generated a map of land use in their villages. Capturing LSK on land use areas and important sites and visualizing them on a map using high-resolution remote sensing images enabled more detailed understanding of land uses and their extent, intensity and multifunctionality in the villages in Articles **III** and **IV** (see e.g. Appendix A in Article **III**). The local knowledge and resulting farming strategies discussed in interviews helped me understand the characteristics and dynamics of the land use that create the land use patterns and forest-farmland conversions (Table 1 and Fig. 5 in Article **I**). Interviewing community members on their land use preferences and spatial knowledge of, for example, favourable edaphic conditions reveals livelihood strategies, which helps explain the land use patterns and spatiotemporal linkages between them in the landscape. In Zanzibar islands, the local farmers cultivate seemingly unproductive land on rocky soil, but its use is part of a strategy to cope with risks through use of different edaphic site conditions and diversified crop production (Article **I**). The interviews also reveal the rationale and resource limitations of the local farmers as well as beliefs, of for example the benefits of trees, that are behind their land use management decision-making, such as slash and burn practices. The local knowledge of community members and professional experts enabled the identification of sustainable aspects of current land use practices, which was useful for making suggestions on more productive and ecologically sustainable land management alternatives (Table 2 in Article **I**).

Eliciting local knowledge with geospatial methods to understand land use and its sustainability is especially helpful in areas such as Zanzibar islands, where agricultural land use has low mechanization, minimal soil cultivation and

agroforestry components that lead to agricultural activities not being easily discernible in the landscape compared to intensive agricultural practices. Participatory geospatial methods can also be applied to identify and map multiple values in the landscape. The mapping of agricultural land use values in Article **I** was part of a campaign that captured a wide range of landscape values in the same community. This study by Fagerholm et al. (2012) shows the spatial extent, diversity and synergies of place-based values that the community members attach to their village landscape (see also Fagerholm, Eilola, Kisanga, Arki, & Käyhkö, 2019). Similar participatory mapping methods have been used in forest dwelling communities, where a whole range of landscape benefits for local livelihoods and well-being were identified and mapped to inform planning suggestions (Ramirez-Gomez et al., 2016). Studying and acknowledging land use strategies and place-based values of the local population can help to ensure that land use planning decision-making does not disproportionately restrict access to valuable natural resources or undermine risk mitigation strategies of community members. The findings from Articles **I, III** and **IV** substantiate the calls for recognizing and integrating multiple knowledge systems and values into efforts striving for sustainable climate and natural resource governance (Díaz et al., 2018; Ford et al., 2016; Norström et al., 2020; UNESCO, 2017). Understanding land use practices and people's rationales behind their everyday land use decisions and strategies requires lengthy research with interviews in the field, something for which formal planning processes often lack resources. Participatory planning involving local community members in mapping land use, identifying valuable land resources and analysing trade-offs between them for community well-being is another deliberative way to evaluate planning alternatives and make decisions about them.

## 5.2 Policies and existing planning practice should focus on capturing and integrating LSK in a georeferenced form into decision-making

My research in Articles **II** and **III** shows that the existing land use policies do not instruct the use of tools that capture LSK in georeferenced form; thus they undermine LSK integration in decision-making as well as spatial accuracy and credibility of the plans. The Community Forest Management policy in Zanzibar does not recognize participatory geospatial methods as tools for land use planning (Table 1 in Article **II**). The Village Land Use Planning policy of mainland Tanzania mentions the possibility of using geospatial data in PM but does not instruct its use. These participatory policies should emphasize and instruct the use of participatory geospatial methods as a way to support participation and integrate local knowledge into decision-making.

Although the planning processes are currently carried out in a participatory manner (Fig. 4 in Article **II** and Table 1 in Article **III**), more inclusive participation methods that support active stakeholder involvement are needed, according to interviewed practitioners and participants. Furthermore, the use of participatory geospatial technologies and data is minimal, if it happens at all, while up-to-date spatial information from the local level is needed for planning decision-making (Chapter 4.5. in Article **II** and Table 1 in Article **III**). Currently, participatory mapping of village land use is done without scale on blank pieces of paper. This hinders the use of LSK and map outputs in planning decision-making and digitization of the mapped LSK (see also Corbett 2009). LSK is captured in georeferenced form for digital map-making purposes in GPS tracking exercises with a few community representatives, but these data are fragmentary and not utilized in discussions with the community during the planning decision-making (Fig. 5 in Article **II** and Table 1 in Article **III**). The planning decisions are made around the sketch maps on blank pieces of paper by the community representatives. Thus, the community members have no means of verifying how their land use delineations on the map relate to the situation on the landscape. In addition, the digitized maps on which decisions are communicated to higher-level administrators are largely drawn by planners based on a few GPS points and little spatial knowledge of the local land use realities and valuable land resources. Due to the lack of up-to-date spatial data, in general at the local level in the country, the mapping exercises usually have to start from the very beginning. Lack of local spatial data is a common constraint for land use planning and titling in African countries (Hessel et al., 2009; Kyem, 2002; Nackoney, Rybock, Dupain, & Facheux, 2013). Geospatial mapping methods would address this need for up-to-date spatial information as well as provide a way for communities to visualize their LSK with more spatial accuracy on maps for decision-making.

The little emphasis on spatial considerations and accuracy in rural planning practice in Tanzania may partly be explained by planners' professional view on the objective of planning. Land use planning has not been seen by Tanzanian urban and regional planners as an instrumental tool to guide sustainable landscape change and land use practices of land users but as a top-down administrative procedure to be carried out by them as professionals (Nnkya, 2007: 53-75). This mind-set can still be identified among planners in Tanzania today, as was observed during the informal method codevelopment discussions with planners. Thus for planners to see relevance in the opportunities offered by participatory geospatial tools and up-to-date spatial information, they must first consider the plans as instrumental tools that have to be endorsed by communities and land users and be based on the existing structures and land rights in the planning area. Moreover, the common belief of planners that communities are unable to engage with technologies and remote

sensing imagery should be countered by sharing experiences of successful community implementation and developing geospatial methods targeted to people who have little experience in using digital technologies.

## 5.3 The developed participatory geospatial method integrates LSK into formal land use planning

I developed in collaboration with Tanzanian practitioners a participatory geospatial methodology that addresses limitations of the existing planning practice and is cost-effective compared to the existing mapping methods (see details of the methodology in Table 1 and Fig. 3 in Article **III**). The codeveloped methodology was developed for and adopted into practice in the formal village land use planning (VLUP) process in mainland Tanzania. The main component of the methodology is participatory mapping using high-resolution satellite image printouts with local community representatives. With the large-scale and detailed satellite image printouts, we address the lack of spatial data quality in the village land use plans, active local participation, and integration of LSK in the decision-making during land allocation planning. The methodology also includes participatory stakeholder analysis and procedures for managing spatial data of the planning process (Table 1 in Article **III**). During the stakeholder analysis, the community leadership and village assembly identify various land user and social groups in their village and select a representative of each group to take part in the planning process. With the GIS procedures, the Tanzanian planning practitioners can systematically process and store the spatial data, such as the satellite imagery and the mapped information. The methodology is part of approximately two weeks of various planning activities that include among others identification of socioeconomic and land related problems, land suitability assessment and preparation of community action plan to address these issues in a village (see further details of the entire VLUP process in Fig. 3 in Article **III**). Towards the end of the process, the community establishes by-laws that regulate the land use in each land use area delineated during the participatory mapping exercises.

There are certain features in the codeveloped PM method that effectively support its use in the formal planning process. First is the high-resolution satellite image of the planning area, usually of the entire village, which the community representatives use in mapping their current land use and then in the discussions of the future land use plan for their village. The satellite image was chosen as the mapping background because it enables mapping of LSK in a georeferenced form, that is compatible with spatial data requirements of formal planning process. The satellite image is printed in scale 1:7,500, which falls into the most natural end of map scale range and is appealing to people, enabling them to easily recognize features of their living

environment in the image, such as their houses and individual trees (McCall & Dunn, 2012). The planning practitioners facilitate and provide technical assistance during the mapping exercises. After the current and future land use sketch maps are drawn on the image printout, they are photographed from the zenith point and the photos are georeferenced in GIS. Then the planning practitioners digitize the mapped features from the photos, rendering the LSK into a georeferenced digital form. We built the method based on the existing planning policy and within the confines of the existing ICT infrastructure in rural Tanzania. It is therefore based on simple enough technology for district planning practitioners to access and a user-friendly mapping medium for community members to use. We balanced the potential mismatch between users' capacities and technological sophistication and the concern over method ownership by Tanzanian practitioners with the requirement for spatial accuracy of the map outputs in formal planning. This balancing between the limitations and advantages of using advanced technologies with local communities has been emphasized by Corbett (2009), for example.

Second, the mapping and planning are done collectively by the selected community representatives. The defined land use areas and resources on the map thus depict the collective understanding and value of land resources to the community. This remark is noteworthy since the collectively mapped information does not represent the diversity of knowledges and human-environment relationships in the same way as when mapped individually by the community representatives (Raymond et al., 2014). Collective mapping was chosen; however, as the mode because it provides legitimacy for the mapping decisions and the formal planning processes require consensus decisions on land allocation. We also preferred collective mapping because it fits more realistically into formal processes as it is less time- and resource-consuming than individual mapping campaigns (such as the one described in Article **I**). The current land use mapping we conducted as focus group exercises, where people with similar characteristics—in this case, marginalized community members and active members of the community with higher socioeconomic status—worked in their own groups to map the current land use in the village. This drew inspiration from the counter mapping (Peluso, 1995) tradition where maps are used to depict different realities existing in a community, such as women's and marginalized groups' resource access and control (Leach et al., 1999; Rocheleau & Edmunds, 1997). We aimed to give the marginalized and the community actives' groups an equal opportunity to represent their land use and property rights in a map form, after which they negotiated and agreed on a joined map representation for the land use planning process. The collective exercises required skilled facilitation to manage dominant individuals and disputes and help provide participants an opportunity to express themselves. Furthermore, as remarked by Rydin (2007), the collective decision-

making during mapping and planning also requires translation between people with different knowledge, meanings, and experiences; conflict resolution; and prevention of powerful interest groups' subversion of collective decision-making. In the next chapter, I discuss how the codeveloped method fares in these.

Third, the LSK content that is mapped using the codeveloped method is based on the policy-stipulated land use categories of the VLUP. We, however, included the possibility for community representatives to identify and map locally relevant land uses and place-based values, in line with the participatory legend-making often emphasized in PM. The participants first list what land uses are present in their village and what issues they wish to map before starting the mapping exercise. These listed map items are categorized into the standard categories based on the planners' advice. In the course of the mapping, new map items are added to the list when the participants realize they are missing. Fourth, the codeveloped geospatial method and the visualized local spatial knowledge are integrated into the official land use planning process and its stages (see Fig. 3 in Article **III**), which to an extent follow the three-stage model of spatial planning process by Sharifi et al. (2002): description, design and decision. We in addition acknowledge the use of the map output and the high-resolution satellite image printouts in the plan implementation and monitoring stage of the VLUP process (Fig. 3 in Article **III**). For this reason, the map outputs are left in the village after the planning process and the digitized maps produced by the district planners are taken back to the communities as laminated prints in size A0 to be displayed in public. Last, the geospatial methodology was not introduced alone into the formal planning process, but it is accompanied by other non-spatial participatory planning methods that we identified as useful for land use planning. These tools assist the planners in actively engaging community members in, for example, problem analysis and future visioning, thus deepening the local knowledge base for planning decision-making.

The codeveloped participatory geospatial methodology was endorsed by the National Land Use Planning Commission (NLUPC) of Tanzania in 2018 and subsequently adopted into use in five districts in the Southern Highlands area. In 2018, we together with NLUPC published a practitioners' manual, which lays out step-by-step instructions for how to use the geospatial methodology in the VLUP process in Tanzania (see Appendix A). The manual was our way to communicate the applied research outputs to the practitioners and policy-makers in an understandable language and in an operational form. It emphasizes the importance of wide representation of land users and social groups in communities and facilitation skills in mitigating power imbalances prevalent among the actors in land use decision-making. It also allowed our team to share their experiences on the lessons learned in applying the developed methods in practice. The entire repertoire

of participatory methods that we codeveloped for the process can be found in the manual, in Appendix A.

## 5.4 Benefits and adoption potential of the participatory geospatial methods

### 5.4.1 Participatory mapping on top of high-resolution remote sensing imagery enhances planning in multiple ways

My research on our codeveloped method and interviews with Tanzanian planning practitioners show that the participatory geospatial methods facilitate inclusive participation, discussion and learning as well as enhance spatial data quality, which together contribute to more informed decision-making in land use planning processes (see Fig. 3). The influence and benefits of the studied methods are detailed further in Tables 1 and 2 and Appendix A in Article **III** and Table 1 in Article **IV**. The participatory geospatial methods were observed to support inclusive accessibility and participation of those in the community who previously had difficulties participating, such as elderly and people with disabilities. This is because the use of high-resolution remote sensing imagery in mapping reduced the need to GPS track land uses in which physically challenged people cannot participate. It also allows these people to visually examine their village environment from an aerial perspective and use the image as a visual aid to express their knowledge. The printout imagery accommodates a larger number of community representatives and those who have no previous experience in participatory mapping to participate in the exercises. A diverse set of community representatives identified through the stakeholder analysis is thus able to participate in the mapping, which according to Fiorino (1990) is a normative benefit to the participatory planning process discussed in Chapter 2.4. and important principle in public participation discussed in Chapter 2.5. Most participants interviewed or surveyed after the mapping exercises in Articles **III** and **IV** state that the use of high-resolution remote sensing image printouts in mapping and planning exercises helped them in the discussions. Similar findings are reported by Haworth, Whittaker, & Bruce (2016) and especially by Aditya (2010) in Indonesia, where printed aerial imagery was identified as the most appropriate tool in planning discussions. The inclusivity of the studied methods is, however, conditional to the quality of facilitation, which is discussed further in Chapter 5.5.

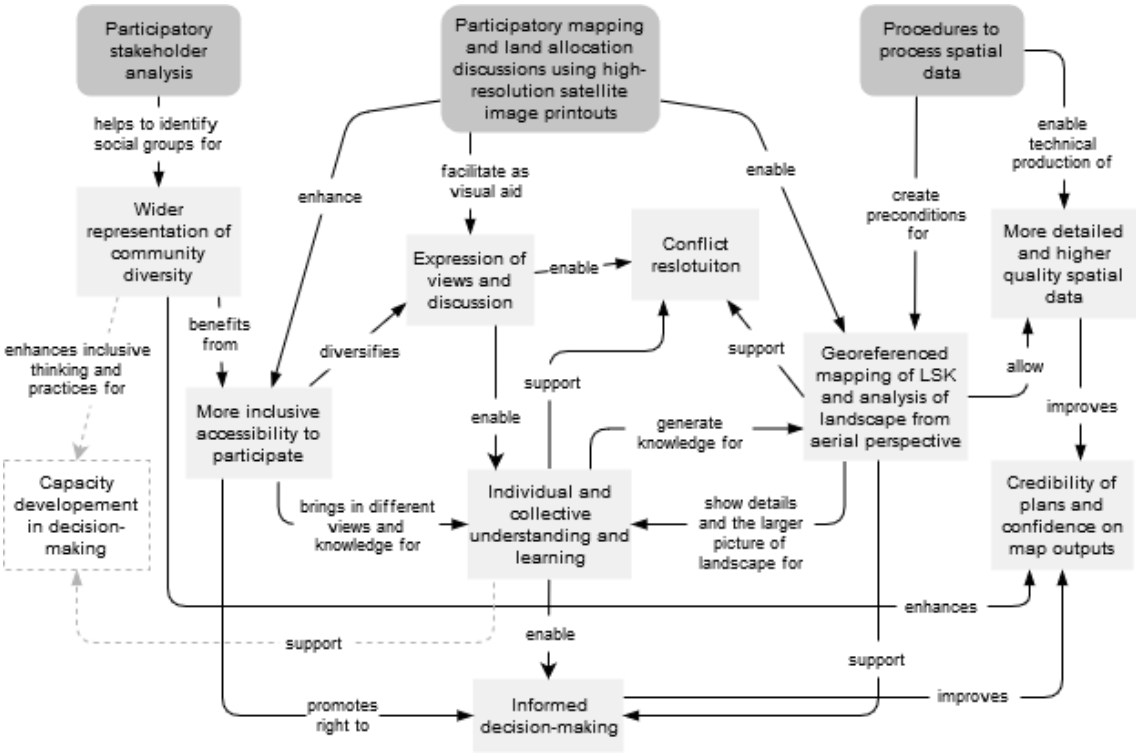


**Figure 3.** The benefits of the codeveloped participatory geospatial methodology for planning process in Tanzania assessed in Article **III**. Similar benefits of participatory geospatial methods have been observed by the interviewed practitioners and participants in Article **IV**. The solid items refer to benefits that were observed in the empirical cases and dashed items refer to benefits that derive from the observed benefits.

In addition to capturing LSK from a more diverse group of stakeholders, the credibility of the land use plans is increased with the geospatial mapping methods, as they improve the spatial quality of the map outputs. The methods produce higher quality spatial data in terms of detail and semantic and geometric accuracy as evidenced by a comparison of maps produced by different participatory mapping methods (Table 2 and Fig. 5 in Article **III**). The interviewed practitioners in Article **IV** see the higher spatial data quality achieved using the geospatial methods as a clear advantage over the existing non-georeferenced mapping methods. The geospatial methods allow them to produce higher quality land use maps with less work in the field and digitize PM information more easily from sketch maps to digital form. In fact, the methods are a way for local community members to express their spatial knowledge in a georeferenced form that is seen as credible in formal planning processes. The area delineations and locations in the official land use maps thus reflect the reality of the local land users as known and experienced by them, without relying on the planners' interpretations of non-scale maps, as is the case with existing

mapping methods. My research shows that the use of remote sensing image printouts in mapping and higher quality spatial information have increased the confidence of planning practitioners on the map outputs. With the remote sensing image printouts, land resources, land use, and tenure arrangements in the villages become visible to the community members and other actors making land allocation decisions. These decisions are also possible to trace and scrutinize in the sketch maps on the image printouts by the larger community, thus increasing the transparency, acceptability and implementability of the land use plans along with the instrumental value of the methods (emphasised by e.g. Blackstock et al., 2007; IAP2, 2014).

The participatory geospatial methods have been observed to assist planning discussions and conflict resolution as a visual aid. The remote sensing imagery acts in the mapping exercises as a boundary object, supporting participants to express their knowledge and discuss. As a boundary object, the imagery creates a common language among the various land users and planners to share and understand different place meanings and values they attach to the landscape. While, as discussed in Chapters 2.1. and 2.2., each individual has their own perceptions of the planning area (e.g. comprehensive or more restricted cognitive maps) and their own knowledge, meanings, and values attached to different places, the remote sensing image helps to visualize them and link them to the objects in the landscape so that others will understand which places are discussed. According to several interviewed practitioners, the creation of a shared understanding using the remote sensing image printouts helps in resolving conflicts and misunderstandings related to land use and village boundaries. Other studies of participatory geospatial methods have shown the methods to similarly enhance communication, awareness of different views, and detection of misunderstandings among land use planning actors (Arciniegas & Janssen, 2012; Fisher et al., 2017).

Moreover, the participatory geospatial methods support individual and collective understanding and learning that enhances participants' decision-making capacity and informed decisions. In our case study village of Article **III**, many local participants were not familiar with their entire village and the mapping exercises with remote sensing image printouts enabled them to analyse and learn more about their village landscape and land uses (Appendix A in Article **III** and Fig. 3 in Article **IV**). The participants seem to have had tacit (unverbalized) knowledge about their environment, which is difficult to articulate and which the remote sensing image printouts helped them to visualize and utilize in the planning discussions. Rambaldi (2010: 8) has suggested that precisely the visualization of tacit knowledge is what makes inherently complex environmental and land use issues clearer to people. Better spatial understanding also indicates improved capacity to find ways to solve problems (Collins, 2018). The increased understanding contributes to the substantive value of the participatory geospatial methods in planning. The

interviewed participants and practitioners in Articles **III** and **IV** perceived that they learned about both the bigger picture and the details of the village landscape, as well as spatial and functional characteristics of the land use through the discussions around the images. These discussions and the sketch map on top of the image as a depiction of the village have therefore influenced people's perceptions of the landscape, its future and the meanings they attach to different places in the village; an outcome of planning as a social interaction noted in chapter 2.1. In simple terms, the remote sensing image gives the participants the possibility to see the landscape beyond their everyday places and form a landscape-scale understanding of it. The exercise is often the first time people see this perspective, which is helpful for them in making land use allocation decisions. In addition, the practitioners in Article **IV** noted that with a better understanding of the village landscape and land use characteristics, they were able to appropriately advise the community about future land use allocation. In other studies, social and environmental learning has been reported to occur through collaborative geospatial mapping exercises (García-Nieto et al., 2019; Gordon, Elwood, & Mitchell, 2016). The use of satellite images has also been shown to induce learning in individual mapping campaigns (Zolkafli, Brown, & Liu, 2017).

The Tanzanian examples in my research suggest that the participatory geospatial methods help to integrate LSK into formal planning processes and more importantly generate normative, instrumental and substantive benefits to spatial decision-making. The benefits of the studied methods on spatial data quality, inclusive and active participation in planning decision-making, and perceived learning outcomes can be expected in settings where the existing planning practice lacks geospatial tools to engage stakeholders and the stakeholders have little exposure to an aerial perspective on their environment.

### 5.4.2 Wider adoption of participatory geospatial methods into practice requires training and supportive organizational environment

The realized benefits of the methods discussed in the previous chapter are a strong indication of the wide adoption potential of these methods into planning practice. The cost-effectiveness in terms of reduced fieldwork in conjunction with increased plan quality makes the methods feasible for adoption into practice. The cost-effectiveness is an important factor for planning authorities who are crippled by limited financial and human resources in Tanzania. However, wider adoption of the geospatial technologies requires support from actors and decisions on higher levels. The results of this dissertation in Article **IV** suggest that there is a need for geospatial skills education of planning students and on-the-job training for planning

practitioners to improve their know-how and confidence required to use participatory geospatial solutions in practice. Capitalizing on and sharing of geospatial skills existing within organizations are also crucial, as exemplified by the experience in Zanzibar Islands, where geospatial tools and expertise were utilized in certain forestry operations but not in participatory planning with local communities (Chapter 4.5. in Article **II**). Several of the interviews with practitioners in Articles **II, III** and **IV** show that access to these technologies can put different districts and communities on unequal footing, since the technologies are not readily accessible to all district administrations due to limited ICT infrastructure, skilled practitioners and awareness on geospatial opportunities. The availability of ICT infrastructure and open source data such as remote sensing imagery is rapidly increasing in the Global South (Amade et al., 2018; Geospatial Media and Communications, 2019). Investments still have to be made to ensure nationwide access to ICT infrastructure in Tanzania before the methods are available to all planners in the country.

Furthermore, awareness raising and advocacy among policy-makers is needed on the benefits of these participatory technologies. Better awareness among policy-makers would assist in enacting land planning policies that guide practice more clearly towards the use of geospatial data and technologies in ways that support local community participation (see Chapter 5.2 above). In addition to the policy shortcomings, the results in Article **IV**, show that the organizational political environment (Avgerou, Hayes, & La Rovere, 2016; Kyem, 2012; Mennecke & West, 2001) in Tanzania is not favourable for the adoption of these methods. The planning organizations should become more supportive of innovation among their own staff. In the planning administration and among decision-makers at district, regional and national level, there is a need for ensuring resources for planning operations and technology use, addressing disincentives of technology adoption in planning organizations and a commitment to participatory governance in general. As long as decentralized land management and participatory planning processes are at odds with the organizational culture and political actors at various levels of governance in the country, there is little that practitioners on the ground can do to adopt participatory geospatial technologies permanently in their practice.

## 5.5 The use of participatory geospatial methods has practical, institutional and epistemological limitations to overcome for inclusive planning

The participatory geospatial methods studied in this dissertation aimed at and were observed to enhance active stakeholder participation and integration of LSK in formal planning processes. However, there remain limitations on how inclusiveness and transformative planning can be achieved with these methods. Some of these

limitations are practical, some institutional and some epistemological, related to the nature of local knowledge discussed in Chapter 2.2 and more extensively by, for instance, Elwood (2006), Reid & Sieber (2019) and Rydin (2007). One common practical limitation of these technological solutions is the unattainable local ownership of the methods, while accessing and processing the spatial data are currently only possible for district level actors with ICT infrastructure and geospatial skills. Due to their user-friendliness and skilled facilitation, participants can understand how to read and use the high-resolution remote sensing image printouts. Nonetheless, the methods can still perpetuate dependence on external experts and social exclusion of local stakeholders (Huggins, 2018; Kyem, 2001). Stakeholders' involvement in designing the participation methods, which is highlighted in the public participation principles (IAP2, 2014), is currently missing and would in part address the lack of local ownership in formal planning processes in Tanzania.

Another limitation is the way in which the map content is defined in the formal planning process. With the codeveloped participatory geospatial methodology in Article **III,** we start with a predefined list of standardized map items and land use categories and ask the participants to identify which are present in their village and if they want to add other content that is not in the predefined list. This forces locals to adopt the standard categories and diverts focus from possible varying epistemologies, place meanings and the valuable land resources for community well-being. It may lead to poor recognition of multifunctionality of landscape and the values attached to the landscape, including conflicts and synergies between them (Olson, Hackett, & DeRoy, 2016; Reid & Sieber, 2019). To address this drawback in the participatory mapping, the defining of map items and typology of land uses could begin from a tabula rasa and give local stakeholders the opportunity to identify their own categories. During the participatory legend making, they can decide on the map semantics and discuss locally relevant issues to map (see e.g. McCall & Dunn, 2012). There are numerous examples of how to facilitate identification and visualization of values and features to map in a more local, self-determined way (Olson et al., 2016; Rambaldi, 2010; Ramirez-Gomez et al., 2016).

In the practitioner's manual (Appendix A), we identify a stage in the VLUP process where a non-scale mind map of village resources and a participatory legend can be made in order to allow community members to define the map items, which are then mapped using the high-resolution remote sensing image printout. This phase is, however, time-consuming and requires mutual understanding among the planners on its importance to the planning process and to the self-determination of the local community. In Tanzania, the formal planning policy and standards do not currently recognize the importance of identifying resource areas of, for example, firewood and building material, nor cultural or historical sites and other socially valuable landscape features other than the mere utilitarian values captured by

standard land use categories. The questions to ask are: does planning miss something crucial regarding local socioecological wellbeing if we ignore these landscape aspects, and how can we reconcile the epistemological differences between scientific and local knowledge in practice in official land use planning processes. The future policy reforms should consider the need for LSK on these local land use characteristics and landscape values in the diverse rural communities of the country in order to recognize their importance to sustainable land use planning.

Standardization in formal planning creates challenge to the representation of LSK in its fuzziness and imprecision while the map outputs have to be generally interpretable and informative. The participatory geospatial methods studied in this dissertation poorly capture and address this ambiguity of LSK. Participatory legend making and discussions with local stakeholders on the map visualizations can be used to address this challenge (McCall, 2003). The geospatial methods allow various visualization techniques to be used to represent the knowledge in a map form (Young & Gilmore, 2017). Planners can decide together with participants how to represent the uncertainty, ambiguity and dynamism present in many socioecological phenomena, including the seasonality of land use, which the farming strategies studied in Article **I** demonstrate, but which is not required to be explicitly mapped in land use planning processes in Tanzania. This helps to mitigate the production of what Kothari (2001: 147) has called the cleaned-up version of local knowledge and experience, which omits important experiential knowledge from the maps and from the decision-making. Moreover, since LSK often differs from expert-based knowledge in its precision and accuracy, it is important to discuss and inform map users on what level of accuracy can be assumed of the maps that are based on the LSK. Currently the planning processes in Tanzania do not define the level of accuracy in the maps and the planning policies provide flexibility in these discussions since they do not state what level of accuracy is expected from the land use maps. Clear definition of the level of exactitude in the map outputs mitigates a false sense of accuracy and precision associated with the maps (Forrester & Cinderby, 2011; Monmonier, 1991), which is especially important when using geospatial methods that usually create an unwarranted expectation of accuracy (McCall, 2003). When different understandings of map accuracy are left to exist among the different actors, problems may arise during plan implementation. For example, when the boundaries of land use areas on official maps are taken as de facto boundaries by investors, and the communities view them as porous and fuzzy.

Despite supporting participation and decision-making capacity of a diverse set of community representatives, our codeveloped methodology and the existing planning processes do not tease out, question and address differences in resource access and disenfranchisement of community members, nor the influence of external process funders (see e.g. Radil & Anderson, 2019). This makes it possible that

community interests are undermined in the planning process and marginalization of some stakeholders continues while their resource claims, experiences and landscape values are not identified, depicted nor considered under prevailing socioeconomic and political circumstances (Bluwstein et al., 2018; Kyem, 2001; Locher, 2016; Orozco-Quintero & King, 2018). The use of participatory stakeholder analysis to recognize different social and land use groups and their subsequent representation in the planning process is an improvement. However, the collective mapping mode we use requires aggregation of the values and features through deliberation and thus excludes some of the diversity of knowledge from the map outputs (Kenter et al., 2019). Which values are included and excluded becomes crucial question and the discussion process and its outcomes have to be guarded against manipulation by more influential actors. Thus the design of the entire participatory planning process should focus more on recognizing local priorities, multiplicity of place experiences and land claims of marginalized groups, as well as local process ownership as discussed in Chapter 2.5. Furthermore, the planning process should be more future-oriented, enabling communities to create future alternatives and address climate change adaptation and nature conservation needs. Here again, it will be essential that the planning process allows local stakeholders to define what is mapped, discussed and communicated to outsiders. In the practitioners' manual (Appendix A) we suggest tools for future visioning that assist community representatives to plan for the future of their village. Spatially explicit tools, such as participatory scenario tools (Bourgoin, Castella, Pullar, Lestrelin, & Bouahom, 2012; Hessel et al., 2009) could also be developed for the design phase of the process. Moreover, spatial decision support systems (e.g. Pelzer, Geertman, & van der Heijden, 2016) can be considered because the geospatial methods capture LSK in georeferenced form, enabling the map outputs to be combined more reliably with other spatial data and analysed to inform decision-making.

Ultimately, there will always be local knowledge, both spatial and non-spatial, that is not captured and visualized in a map form. This local knowledge plays a role in the planning discussions and influences the decisions, provided that the planning process design is geared strongly towards supporting local self-determination and joint reflection on inclusiveness and planning objectives. The formal Tanzanian local-level land use planning process design still has many obstacles but also opportunities to increase inclusiveness and local self-determination, as the above discussion suggests.

## 5.6 Methodological and ethical considerations

The research work in this dissertation entails methodological and ethical issues, such as researcher-practitioner interaction, subjectivity and participatory approach, that

I will next address. Transdisciplinary research with professionals posed prerequisites on the ways of working. It required good communication, trust building and honesty among the actors. We emphasized two-way communication between us as a way to build trust, mitigate misunderstandings and keep everyone informed about problems or changes in the implementation of planned activities. In addition to face-to-face communication during fieldwork, I used email correspondence in the collaboration with Zanzibari administrators (Articles **I** and **III**) and mobile messaging platforms with staff of the development project and the local NGO in mainland Tanzania (Article **III**). The shared fieldwork experiences and mobile messaging built more levelled collegial relationship between us. Nonetheless, working culture and organizational hierarchy differences became evident and unravelled through time. My experience working in Tanzania since 2008 and being part of a research team helped in coping with the differences. I utilized available project documents and other secondary data in communication with the professionals and expert interviews in order to get further insights into the events and practices in Tanzania. This was, however, limited since systematic documentation of activities and events is not a standard procedure in the district-level administration and even in international development projects that I worked with.

The criteria-based assessments of land management and planning practices have their limitations in what is possible to capture, generalize and indicate for conclusions. Two of the clear weaknesses in the assessments are that the criteria were selected for each case study amongst a multitude of variables found in literature and that the criteria are indirect. For the assessment in Article **III**, we held discussions among the collaborating professionals to define the criteria based on each of our interests and objectives for the research. This made the assessment more transparent and relevant to each collaborating institution but limited generalizability of the results. The influence of the co-developed participatory geospatial method on spatial data quality was examined in terms of criteria for semantic and geometric accuracy and through a comparison of map outputs produced by existing non-georeferenced and geospatial mapping methods and interviews of planning practitioners on their perceptions of data quality (in Articles **III** and **IV**). The positional accuracy of the mapped spatial data was not empirically examined due to limited resources for obtaining reference data from the ground. Therefore, the claims made on increased data quality achieved by using the geospatial methods only partially cover the aspects of spatial data quality (cf. Morrison, 1995). Further research could include field validation of the positional accuracy and precision of the mapped features as well as test the effects of using remote sensing imagery on the participants' perceptions of the mapped features. Questions such as the following come to mind: how the land use area delineations on the map match with the patterns of land use in the real

world, to what extent the features visible on the remote sensing image influence the land use area delineations mapped by the participants and what level of positional accuracy in the maps is meaningful to the map users. Future work on the participatory geospatial methods could include examination of the interpretation rules of the participants and development of checks that can be made with them during the exercises to ensure adequate positional accuracy of the resulting spatial information.

The purposive sampling, which is based on the researchers' discretion, is always subjective and has a risk of bias in that the sample may not be representative even though it is potentially broad otherwise. In Articles **II-IV**, I studied a fairly small number of people who participated in planning activities and chose to have samples that represented different administrative levels and professional backgrounds, leading to underrepresentation of women. In the village-level interviews of the same articles, I emphasized representation of different social groups and gender. In Article **I**, we had a stratified sample from the entire village community. The local leadership who selected the informants based on the sample requirements may potentially have had an influence on the sample representativeness despite the instructions on sample composition. The influence of village leadership in the selection of the informants is a common risk in Tanzania (Fagerholm, 2014). Members of the leadership, for example, have the up-to-date register of village inhabitants and are the only ones apart from possible organizations working in the villages who can reach and summon people to meetings. In Article **III**, the participant selection of the VLUP process was ultimately endorsed by the village assembly, which reduced the potential bias caused by the leadership.

The sociocultural setting and interaction that are part of qualitative data collection and analysis call for reflection (Vilkuna, 1997). For example, during interviews, informants might have wanted to hide negative aspects of their experience, or in discussions, the group composition may have distorted individual accounts. To counter this effect on the dataset, I conducted observations and combined group discussion data with individual interview data. I also obtained an informed consent from the informants before interviews, group discussions and observation and the informants participated in the research voluntarily, in part building confidence among us. The content analysis and interpretation of the data and results was influenced by my own knowledge and presumptions as well as sociocultural background as a Finnish person in Tanzania. The subjectivity of my interpretation was especially pronounced as I conducted the analysis alone (Creswell, 2009: 173-201). I was able to arrange a feedback meeting to discuss the research findings with local practitioners and some of the informants of the studies in Articles **I** and **II**. This subjected my interpretations of the findings to their examination and helped me to reflect my understanding and interpretation. My

knowledge of the study context also extends beyond the research topic and is based on my extended time periods in Tanzania since 2008 as a student, volunteer and researcher and my three-year work assignment in Nairobi, Kenya, from 2013-2016.

There were several ethical issues I reflected on throughout the research work. The overarching topic of my research, land, is a politically and economically sensitive resource in Tanzania (Locher, 2016; Sungusia & Lund, 2016; Walwa, 2017). In addition, research and development related to participatory methods and decision-making processes have consequences for how the topics are approached, how informants are engaged and what impacts the research can have in the studied communities. My research did not directly touch on topics such as land or forest ownership and power relations. However, the study of existing land use planning process in Article **II** and the study in Article **III** as an action research with the aim of introducing and studying the effect of participatory tools certainly revolved around and questioned the status quo of decision-making in the villages. Potentially the research thus had unintended negative effects in the community despite the positive development intentions associated with the participatory approach. For this reason, in all the study villages, the village leadership was first consulted, made to understand the research objectives and asked for their consent to carry out the research. In the villages where the codeveloped method was tested and subsequently used in Article **III**, the communities participated voluntarily, namely informed consent was elicited from village leadership and village assembly, and some villages opted out from the project. We also tried to be as clear as possible on the effects of the research and conscious not to raise expectations of benefits to the community or individuals. In addition, research permits were obtained from the respective authorities in Tanzania, and regional and district authorities of relevant sectors were informed and given an opportunity to take part in finalizing the research designs. Despite the consent for and interest in the research, our presence in the study villages, and interaction with informants, participatory exercises and study findings may have had negative effects on the communities or members of the communities. This might have happened, for example, when group discussions exposed views that are not openly spoken about, causing a later conflict. The effects of these encounters are, however, difficult to know, since internal events in the communities are nearly impossible to follow up without continuous presence in the villages, and contact with the study communities has not continued longer than one or two years after the fieldwork.

Throughout the research, I have been aware of the limitations on the knowledge that can be gained and the depth of the analysis, as well as the outcomes that the research can bring. Informants' accounts, their sincerity and thoroughness, are affected by the researcher-informant interaction, topic sensitivity and what there is to lose or gain for the informant in telling a certain narrative. I remained wary of

drawing conclusions from single individual accounts for this reason in the data analysis and write-up. The longest time I stayed in a study village was less than two months, which has left me with the impression that there are so many socioecological factors underneath what I got to observe that I need to be cautious of what I can conclude. For example, are there institutions, in the form of organizations or rules of behaviour, that were not identified in the research and that in the end control how land is used? Were participants as comfortable as they seemed to express their actual views? Ethnographical methods and collaboration with social scientists in the research team could have given me more tools to investigate these aspects. Furthermore, participants and practitioners are not necessarily the best actors to evaluate the level of participation in collaborative processes. Participants may construct a sense of empowerment or influence on decisions during participatory planning exercises even though their actual influence is not substantial (see e.g. the halo effect described by Leach & Sabatier, 2005). Apart from interviews with participants on their involvement, my observations of the participants' interaction with and around the satellite image printout during PM exercises in Article **III** were important for assessing the participation. Individuals may gain a sense of empowerment, which I was witnessing during the PM exercises, but there is no guarantee that it lasts or stretches into human relations beyond that situation. Power to influence decisions can be granted to marginalized community groups during the research engagement but this does not indicate that the empowerment is long-lasting and the power balance in decision-making has changed in the community. Adoption of participatory geospatial methods is at best a step towards inclusive local decision-making in land use planning, but empowerment of community members is a longer and more multifaceted process.

# 6 Conclusions

In this dissertation, I have studied the opportunities of participatory geospatial methods and transdisciplinary method development in diversifying the knowledge base for planning sustainable landscapes at the local level. I have looked into land users' local spatial knowledge that stems from their daily relationship with the landscape and the value it has for spatial planning in complementing remote sensing and other expert-based information. I have also analysed to what extent LSK and participatory methods are included in formal planning processes in Tanzania, where decentralized policies seemingly allow involvement of local communities in natural resource management. The emphasis of this dissertation was then given to the methodological development of participatory mapping for the formal planning process, and studying the methods' impact on capturing LSK and facilitating planning discussions. Based on my empirical findings and reflection on existing literature, the main conclusions of this dissertation are as follows:

- **Existing participatory land use policies may not recognize the importance of georeferenced local knowledge required in sustainable landscape planning as is evident in the Tanzanian policies studied in this dissertation.** While the Tanzanian policy emphasis is on ensuring local community involvement and capacity in decision-making, the quality of geospatial data used and produced with communities during the decision-making is not emphasized. Visualizing community members' LSK and place-specific values in a georeferenced map form enables more detailed understanding of the landscape patterns, multifunctionality and spatiotemporal dynamics needed for informed landscape planning. Without this geospatial information and understanding of the landscape, the credibility and implementability of the planning outputs are reduced. The plans may also disproportionately restrict access to valuable natural resources or undermine priorities and livelihood strategies of the communities.
- **Participatory geospatial methods capture LSK in a form that improves the quality of local-level land use plans**. These methods provide fine-scaled spatial information about the planning areas, which represents the perceptions and realities of the local community members. As such, the methods have significant

advantages over existing practice from the point of view of a Tanzanian practitioner. The observed benefits to plan quality and the methods' cost-effectiveness motivate their wider adoption into planning practice.

- **The use of participatory geospatial methods enhances local decision-making capacity both through spatial learning and by visually facilitating planning discussions.** The high-resolution remote sensing imagery in participatory mapping acts as a tool for comprehensive examination of the community's living environment. It extends their spatial comprehension from singular places that have meaning to them as individuals to a larger picture of the entire village area. This larger perspective supports the participants in making decisions on land use allocation and environmental conservation.
- **Adoption of participatory geospatial methods and inclusive planning practices are largely influenced by the organizational political environment and entire planning process design.** Though geospatial technologies are not readily accessible in all planning contexts, commitment to participatory governance at the different levels of administration and among other planning actors would provide better support for practitioners to apply these methods. Furthermore, participatory design of the planning process with local stakeholders, which is currently not the mode of design, should be adopted in order to enhance inclusiveness and empowerment in decision-making in line with principles of public participation.
- **The research builds evidence of the feasibility and usefulness of participatory geospatial methods in rural communities with little previous exposure to digital technologies.** In particular, high-resolution remote sensing imagery can be used to map various topics with the local stakeholders, such as landscape values. The image can also be used to facilitate discussion among the participants about topics such as resource access and environmental change as well as land conflict resolution for which the image proved to be beneficial in my case study examples. The transdisciplinary collaboration with planners in codeveloping the method ensured the method's feasibility in formal planning, while its assessment against commonly held principles of public participation guides further method development. Particular attention should be given to the possibility of local stakeholders to define the content and semantics of the map in order to capture diverse perspectives, various place meanings and local priorities that participatory planning and sustainability sciences call for.
- **Participatory mapping and geospatial tools should be considered as a medium for discussion and collaborative action, if we anticipate to use them for integrating LSK into formal planning processes.** Together with other forms of participatory tools highlighted in our practitioner's manual, geospatial

tools help to convey the LSK from stakeholders to planning practitioners in a map form but also through verbal means as a visual aid for discussion. The interaction around the map during PM exercises brings other benefits to the planning as well: social and environmental learning and trust toward the planning process and its outputs.

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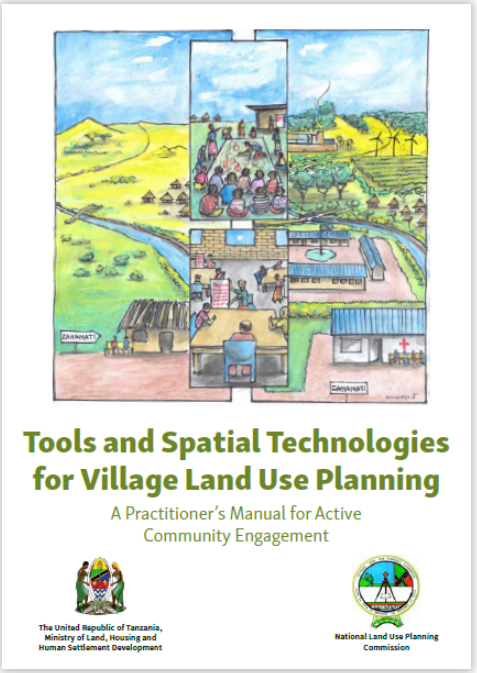
# Appendices

**Appendix A.** Description and table of content of the practitioner's manual that is part of the dissertation work.

## Tools and Spatial Technologies for Village Land Use Planning: A Practitioner's Manual for Active Community Engagement

*National Land Use Planning Commission (NLUPC), 2018. 112 p. Dar es Salaam, Tanzania*




This manual is an annex to the "Guidelines for Participatory Village Land Use Planning, Administration and Management" (3rd edition), that guides the process of village land use planning (VLUP) in Tanzania. The manual focuses on instructing a participatory mapping method that uses freely available high-resolution satellite image printouts with village residents during mapping activities. It also introduces several participatory rural appraisal tools for analysing the current land and socioeconomic situation in the village. Altogether, the manual provides detailed instructions on 17 practices and tools, all of which are tailored to facilitate VLUP activities. The practices and tools are optional and, when necessary, can be modified to suit the village context and available resources.

The step-by-step instructions of participatory tools in this manual will help planning practitioners to actively engage community representatives and collect more detailed spatial information of the village land use. The tools were designed based on the experiences of VLUP facilitators working in the Southern Highlands of Tanzania to address common challenges in the planning process and to ensure high quality planning. This manual has been written for facilitators of the VLUP process, including district PLUM teams, to guide, standardise and inspire planning activities. It is also written to help village representatives, and district- and regional-level administrators grasp the participatory planning approach, manage their expectations, and monitor the quality of VLUP work.

The manual is an outcome of the transdisciplinary collaboration that is part of the dissertation. It also includes excerpts from findings of the research to illustrate benefits of the participatory geospatial method. While the research findings on method assessment are published in peer-

reviewed journal articles, the manual contains description of the method and its use in a more detailed and practice-focused manner. Additionally it includes description of other tools that resulted from the collaboration and which were not studied during the PhD research. As an official document, the manual is published by the NLUPC and is attributed to the Commission and Ministry of Lands of Tanzania.

The online version of the manual can be found here:
www.nlupc.go.tz/publications/guidelines

A shorter earlier version can be found here as a project document:
www.privateforestry.or.tz/en/resources/view/participatory-mapping-and-planning-tools-developed-for-village-land-use-pla

And you can also watch the videos produced about the methodology:
https://youtu.be/gf_3RpFAtyE

## Table of Content

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