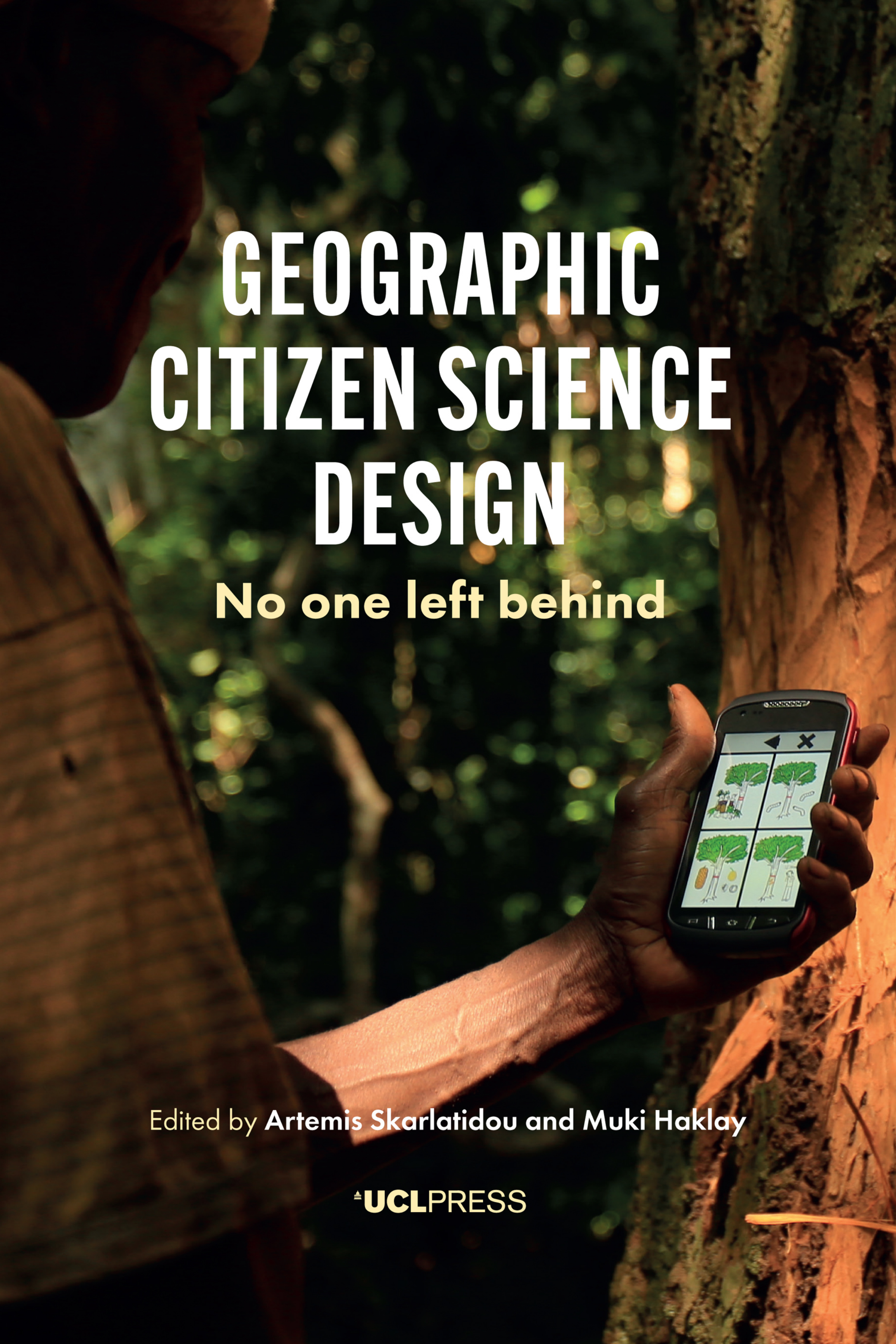

GEOGRAPHIC CITIZEN SCIENCE DESIGN

No one left behind

Edited by **Artemis Skarlatidou and Muki Haklay**

UCLPRESS

Chapter 14

Representing a fish for fishers: geographic citizen science in the Pantanal wetland, Brazil

Rafael Morais Chiaravalloti

Highlights

- The creation of strictly protected areas in the western border of the Pantanal wetland, Brazil, has led to the physical and economic displacement of local people.
- A geographic citizen science programme was implemented to support local people to represent their customary practices, and to encourage practitioners to incorporate local people's needs better in the conservation agenda.
- Time spent with local people to gain rapport is a fundamental step in the implementation of a successful geographic citizen science programme.

1. Introduction

Conservation biology explores ways and means to protect the environment better. It is a scientific discipline that emerged in the early 1960s, and it focuses on 'actions that are intended to establish, improve or maintain good relations with nature' (Sandbrook 2015, 565). Since then, however, the understanding of 'good relations with nature' has changed. It has become increasingly obvious that conservation interventions should include local people's needs in order to meet their goals (Mace 2014).

In many cases, however, conservation practices still face significant challenges in addressing local people's needs. In freshwater fisheries, for example, the majority of management practices proposed and implemented by conservation biologists do not consider fishing strategies that are essential to livelihoods (Chiaravalloti 2017). Common conservation interventions in freshwater systems are based on the idea that people are fixed in time and space (Chiaravalloti 2017), but inland fishers commonly adopt specialised dynamics of use with high mobility; that is, they use a variety of methods of production/extraction at different times and places, including periods of intensive use in response to seasonal abundance, and are flexible to shifts in livelihoods (Abbott and Campbell 2009). Forcing people to live in different ways from those of their customary strategies can lead to physical and economic displacement (Abbott and Campbell 2009).

This chapter focuses on a salient but not extensively studied case of inland fisheries, taking a conservation biology approach to the Pantanal wetland in Brazil. This wetland region is approximately 160,000 km^2 in size, and covers parts of three countries in South America (Brazil, Bolivia and Paraguay). It is not only unique in terms of biodiversity, but also it offers several examples of the previously mentioned mismanagement practices of inland fisheries. This chapter aims to demonstrate how a geographic citizen science application and a participatory mapping approach were successfully used to support local people to represent and communicate their customary strategies of natural resource use and management in a scientifically valid form (Chiaravalloti 2017). The main goal is to explore the extent to which these tools can help practitioners to truly incorporate local people's perspectives in the conservation agenda and to reshape local conservation approaches.

2. The Pantanal and its protected areas and peoples

For the past 50 years, local fishers in the Pantanal region have been under constant pressure to stop fishing, with decision makers, environmentalists and local businessmen accusing them of overfishing in the region (Alho and Reis 2017). As a consequence, several strictly protected areas have been established in the region, restricting the use of natural resources. The first one was set aside in 1971, the Biological Reserve of Caracará, covering an area of 800 km^2. In 1981, the Federal Government replaced the Biological Reserve with the Federal National Park of the Pantanal (Parque Nacional do Pantanal), expanding the protected area to 1,300 km^2. In the early 1990s, with support from the non-governmental organisation (NGO) The Nature Conservancy, three additional large farms were converted into privately owned protected area (called a Private Reserve or Reserva Particular do Patrimonio Nacional; Tocantins 2011). Later on, in 2005 and 2006, two Private Reserves were aggregated, leading to the establishment of the environmental group Protection and Conservation Network for the Amolar Region (Rede de Proteção e Conservação da Serra do Amolar). This is a partnership among all protected area managers, which includes the federal agency for protected areas, NGOs and local Forest Policy agents. The partnership's aims are to monitor resource use along 310 km of linear river distance and adjacent channels and to ensure strict conservation measures for 2,620 km^2 of protected areas in the western border of the Pantanal (Bertassoni et al. 2012).

It is important to point out that local fishers claim that the protected areas in the western border of the Pantanal physically and economically displaced them from their original settlements. According to local people, the first displacement took place in the 1980s, soon after the establishment of the National Park, with recorded incidents of torture and violence perpetrated against them. The second displacement occurred in the 1990s, when the three Private Reserves were created. There are still remnants of their former houses in the area. In fact, the spatial organisation of Settlement 1,[1] which is the closest to the protected areas, is a direct consequence of these displacements. After the second displacement, three different extended families were clustered in a region which covers 0.2 km^2 and is surrounded by rivers, locally called 'the island' (Chiaravalloti, Homewood and Erikson 2017). This spatial pattern of occupation (i.e. where more than one extended family live together) does not exist in any other community in the western border of the Pantanal (Figure 14.1).

When the protected areas were established, several restrictive laws were imposed upon local fishers. During the 1980s and 1990s, for example, legislation forbid the use of fishing nets in the Pantanal (Catella et al. 2014). At the same time, a new fishing tourism business emerged in the region and rapidly came to dominate the local economy – generating an estimated US$150 million per year (Girard and Vargas 2008). By 1999, in the southern Pantanal (the only region where they record annual data), a total of 59,000 tourists per year came to fish in the region (Catella et al. 2014).

In the face of these new restrictions, local fishermen were driven to seek alternative livelihoods either locally or in nearby cities, with many starting to work in fishing tourism as guides to fishing spots (i.e. *piloteiros*) or as bait suppliers (Catella et al. 2014). The small lungfish Tuvira (*Gymnotus spp.*; 2–42 cm) became the most important bait, and the Pan-

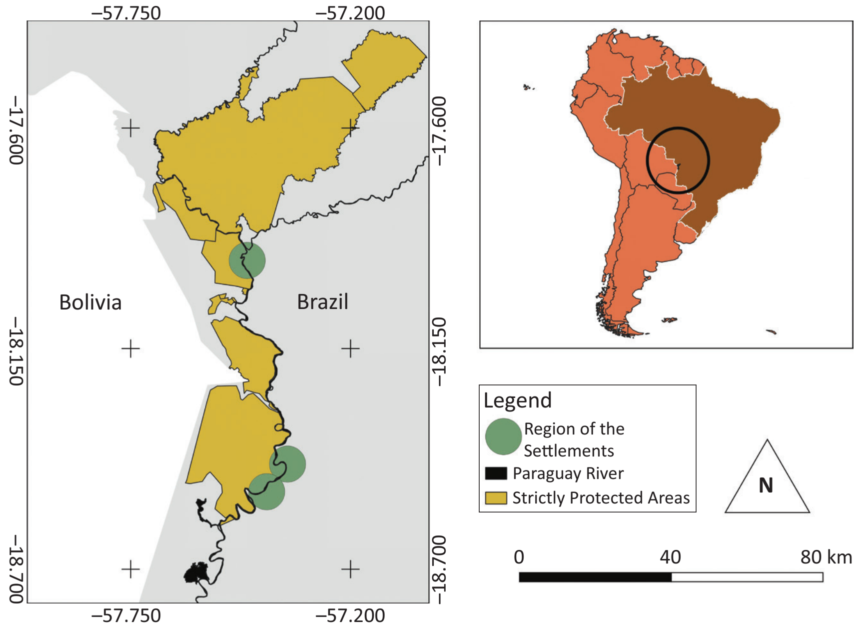

Fig. 14.1 Current location and extent of protected areas and human settlements. Inset: location of the Pantanal in South America (top right). Credit: Map created by Rafael Chiaravalloti 2019.

tanal crab (*Dilocarcinus pagei*; 5–10 cm) became the second most important, representing 50.1 per cent and 34.2 per cent of the total bait catch, respectively (Moraes and Espinoza 2001).

Suddenly, tourist numbers started to decline. By 2006, tourists in the southern Pantanal dropped to roughly 15,000 people per year (Catella et al. 2014). Local companies claimed that there were no tourists because fish stocks were depleted, reviving accusations of local, small-scale commercial fishermen overfishing. They therefore supported tougher enforcement on fishing quotas, especially with respect to some large fish species, and restrictions on certain types of fishing gear and practices, especially those used by local people (Catella et al. 2014). As a consequence of this, commercial fishermen in the Pantanal today may only practice hook-and-line fishing, and those who continue to gather bait may only do so in southern Pantanal (Catella et al. 2014).

In 2013, several managers of protected areas, scientists and policymakers published a book titled *Biodiversity and Human Occupation in the Pantanal Mato-grossense: Conflicts and Opportunities* (Franco et al. 2013).

The book endeavours to provide a scientific argument for the severe restrictions imposed on local people and their subsequent displacements. Based on one week of fieldwork, they first support the argument that local people were overfishing. Then, they argue that fishers in the western border of the Pantanal appeared after 1974, when a great flood covered part of the region, leading to a number of ranch workers moving to the riverside and switching their livelihood to fishing. Finally, they discuss the concept of 'traditional people', and argue that most of the so-called traditional communities should instead be called 'rural poor' due to their lack of distinctive difference from 'non-traditional people'. The authors argue that the rural poor should not be receiving any public benefits that are given to traditional people in accordance with the Brazilian National Policy of Traditional Peoples and Communities (Chiaravalloti 2019). The book gained so much popularity that policymakers began using its conclusions to propose new environmental legislation for the Pantanal. In fact, many of the fishing bills in the 2010s were proposed 'as a way to address the problem pointed out in the book', as one of the local policymakers commented.

In order to prevent further physical and economic displacements, a local NGO which focuses on human rights and conservation, Ecologia e Ação (ECOA), began to publicise conflicts in the area and support local people in better organising themselves. In Settlement 1, the NGO helped local people to establish a formal association and managed to force the local municipality to build a new school and install public telephone infrastructure. As part of the scientific board of the NGO, I started to get familiar with the conflict and was invited to support them with scientific information and evidence about the socio-ecological dynamics of the area.

For those who were working in the Pantanal, it was clear that Franco et al.'s (2013) conclusions were based on their own views about the region, with little supporting empirical evidence (Chiaravalloti 2016). Their claim that fishers were outsiders was fabricated. First, non-indigenous families have been established in the western border of the Pantanal for more than 150 years, deriving from intermarriage between ex-slaves, Paraguayans and local indigenous families (Da Silva and Silva 1995). Moreover, living across the flooded areas, they carry out different professions but have a primary focus on fishing, with some recorded as selling salted fish in Corumbá city during the early nineteenth century (Silva 1986). In other words, fishing has been part of the local non-Indian people's livelihoods for well over 150 years.

Despite these long-standing patterns of residence, at the time, there was still little to no understanding of the sustainability of local people's current fishing practices. Furthermore, there was little sustained analysis of whether the activities of local people do indeed jeopardise the local ecology. This later became one of the primary research questions for my doctoral research, from which this book chapter draws.

3. Mapping the sustainability of fishing

In order to explore natural resource use in the western border of the Pantanal, we used mapping tools that could support collecting geographic data of local people's activities throughout the year. It is important to understand that we did not want to evaluate the ecological sustainability in Pantanal, which would require a different approach based on a long-term ecological study (Cooke et al. 2016). Rather, drawing upon Ostrom's (1990) argument on the sustainability of common property regimes, we hypothesised that local people's embedded rules should ensure the sustainable use of resources. Therefore, the main goal was to uncover local people's resource use strategies, customary use and common property regimes.

At the time, it was clear that people had to go fishing far from their settlements. We did not know how far they were going, if they were going in groups and whether their fishing grounds had physical overlaps with the protected areas' boundaries. Answering these questions, which all have a strong geographic element, could help us evaluate the presence of customary practices, such as the existence of clear boundaries between families or communities.

It was decided to focus on Settlement 1, where currently there are 23 families living in the area and the total population is approximately 100 people. Most of the adults know how to read but cannot write. Most people younger than 20 years of age have attended school, but still have low confidence in writing. Fishing is the main livelihood for more than 90 per cent of households in the settlement (Chiaravalloti 2019).

The tool that was chosen to support the mapping of local people activities was Sapelli. Sapelli is based on extreme citizen science practices and philosophy, and enables local users (regardless of literacy levels) to collect georeferenced data such as boundaries of territories and sites of importance for specific resource use in scientifically robust and locally relevant presentational forms using handheld Global Positioning System (GPS) units and pictogram-driven software. In principle, the tool enables the recording of qualitative data such as human well-being, customary governance and/or natural resource use in a scientifically robust way (Lewis 2012). The mobile app that we used in this study was based on a decision tree logic. People are guided in making a sequence of choices until they reach the final data item in the decision tree for which data are being collected.

In order to build the first Sapelli prototype for the Pantanal case, a preliminary pilot study took place with fishers from Settlement 1 (in July–August 2014). The main goal was to understand all types of resource use that local people carry out in the region, and this information in turn would inform the development of the relevant Sapelli decision tree. The technical development of the decision tree was supported by Gill Conquest, former PhD researcher at the UCL Extreme Citizen Science research group.

The first decision tree included information about all types of activities where people make use of natural resources in the Pantanal; that is, fishing, gathering bait, hunting, harvesting wild rice and collecting wood, straw, fruits, honey and drinking water. People were also asked to record the presence of *dequada*, which is a period of the year when thousands of fish die due to the flooding of vegetation and increase in water temperature. Figure 14.2 shows a zoomed in version of the decision tree from the preliminary pilot, and Figure 14.3 shows a screenshot of the application used during this time. In the last branch of the decision tree, local people were asked to voice record both the name of the place and the number of people who were with them during that specific activity. All decisions (fishing, gathering bait, etc.) were communicated using relevant pictograms, as shown in Figure 14.2.

After reaching the final step of the decision tree, the application automatically searches for a GPS signal. The data collected included the location, day and time, and the selected activity the user was carrying out.

Exploring research questions that require the acquisition of qualitative data, such as customary practices, needs the establishment of a level of trust between the researcher and the interviewees so that accurate responses can be collected. First, participant observation was used as a way to understand local experiences better and to build rapport. This saw me being involved and helping with all daily activities that local people commonly engage in, for example gathering bait, fishing, logging and attending different kinds of meetings and celebrations. Living with them therefore allowed me to build a bond with local fishers, and gradually show and demonstrate the significance of using Sapelli to collect the project's data. Second, semi-structured interviews (SSIs) were also used to gather additional data and to build a better understanding of local peo-

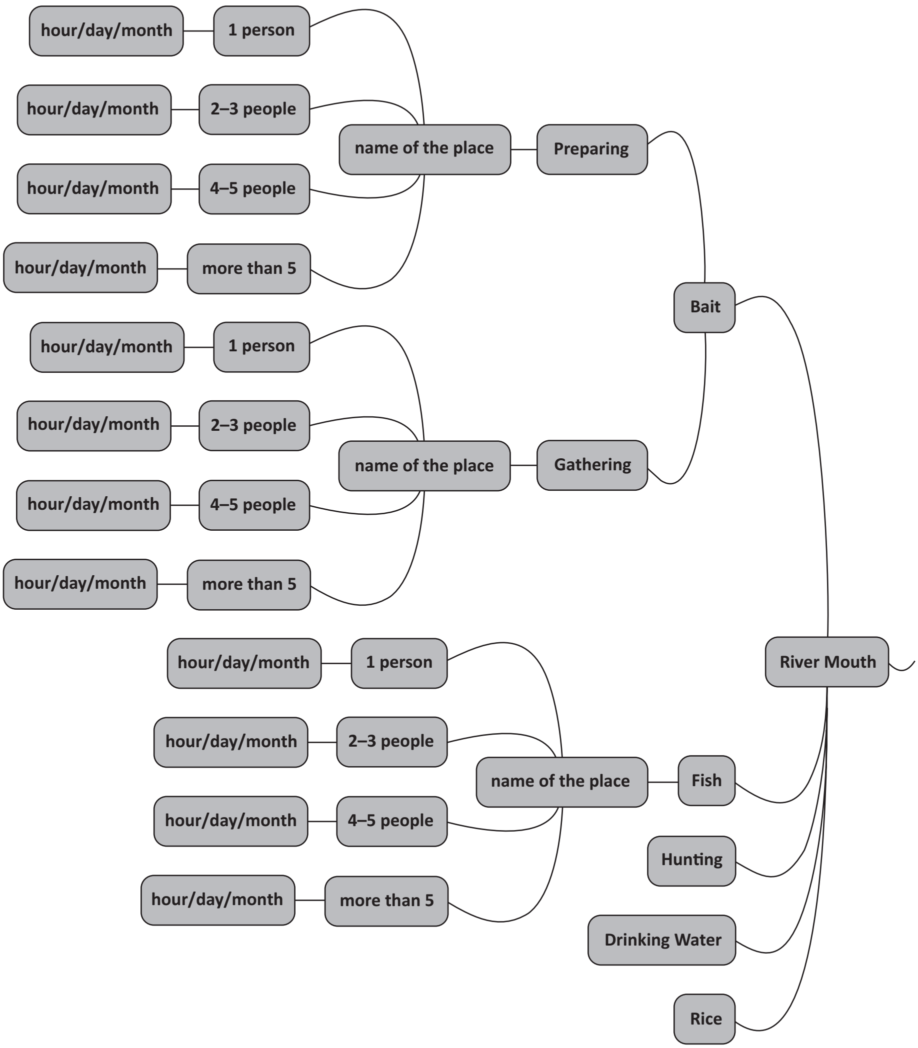

Fig. 14.2 Part of the first decision tree built for the project. It zooms into specific decisions made regarding resources from 'water'. Another part of the decision tree (not shown) dealt with resources related to 'land', such as wood and honey.
Source: author.

ple's resource management and use from both a historical perspective and a more contemporary perspective.

Finally, paper maps of the region were printed using the new Brazilian collection of RapidEye satellite images which have a five-metre

Fig. 14.3 Screenshot of the first version of the mobile app. The example shows the branch focused on recording the presence of *dequada* and its extent (large or small). Credit: Sapelli platform UCL Extreme Citizen Science research group (ExCiteS).

resolution on a 1:20,000 scale, and which cover the whole western border of the Pantanal region. They were printed on laminated paper, on which people could draw and edit their drawings. These paper maps were used in a similar way to the Sapelli data-collection application for adding geospatial information that concerns their daily activities. All SSIs were carried out using the paper maps, as shown in Figure 14.4. Through the use of these maps, we were also able to increase the number of people who engaged in the study.

It should be noted that before the project commenced, several ethical consents were sought. First, University College London Anthropology Department Ethics Committee approved a risk assessment and ethics methods procedure, and authorised the research to proceed with fieldwork. Then, following the Brazilian 'Rules of projects for research that involves human beings' (Resolution number 466 from 2012), the project was translated into Portuguese and submitted via a separate ethics application to the National Research Ethics Committee. Then, local NGOs and research institutes located near the study site (such as ECOA, Embrapa Pantanal, UFMS, Acaia and Instituto Homem Pantaneiro) were contacted, and the project was explained to improve their awareness of the purpose of the research and of the form the data collection was going to take, as well as possible outcomes of the project. The same approach was carried

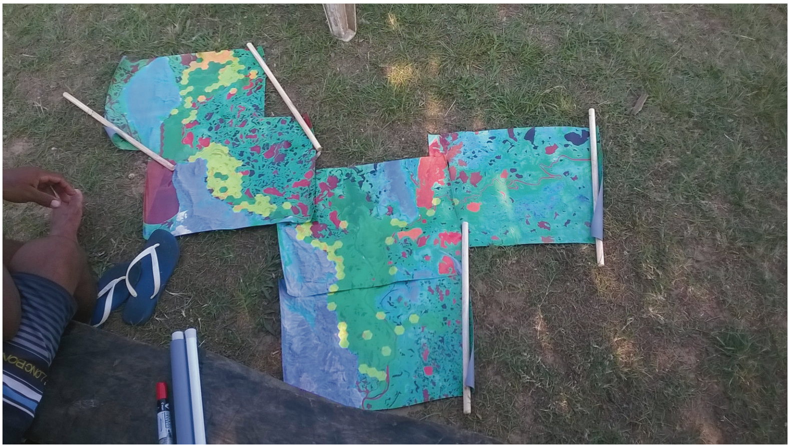

Fig. 14.4 Photo of a fisher showing locations and types of natural resource use in the region. Credit: Photograph taken by Rafael Chiaravalloti.

out with community leaders. This process was followed by individual informed consent from all participants who were interviewed.

4. Interacting with the Sapelli tool for gathering natural resource use data

The Sapelli interface developed for local people in the Pantanal to collect data on their daily activities was installed on Samsung Galaxy XCover smartphones. They are sold as being waterproof and resistant to harsh environmental physical conditions. Given the tough conditions of the Pantanal wetland, they were considered suitable for this case study.

Step 1: Identifying people to pilot test the tool

In the first meeting with local families living in Settlement 1, after explaining the project and obtaining their individual informed consent for data collection, it was decided that each day, a different family would use the mobile phones to record their daily activities. At the time, we had four mobile devices to use in the Pantanal. The first two weeks of data collection were set as a pilot test to explore whether people had any difficulties using the application. I offered to go with them in their daily activities so that I could provide technical support when needed.

This was the first challenge that I encountered: not all families were comfortable in taking me with them during their activities or in using the mobile phones without any support. Although it was made clear that all data would be kept confidential, people were afraid that I was going to use the information on locations of fishing grounds to inform outsiders and rangers when they were using restricted areas, which could result in fishers receiving a fine of up to R$1,000 (c. £200). During the individual informed consent, it was made clear that people would be able to review the data collected, and agree whether it should be used for publication. All community members agreed to share the data after they were collected. In my opinion, that was due to the majority of the fishing grounds being outside the limits of the National Park, as well as because they understood the importance of showing their territory, using maps, to policymakers and local managers in order gain rights of tenure and use of resources.

The second challenge was related to mobile device use. People were worried about using the mobile devices for fear of breaking or losing them, even though it was made clear that they would not be held responsible for any damage. It was also not possible to charge the phones, since there was no electricity in the settlement, and most families did not have power generators. From the total of 23 household families who were interviewed and invited to use Sapelli, only three agreed to use it.

Step 2: Adapting the decision tree

In order to test the use of Sapelli fully, I established the following protocol. Each day, I would follow a different family who had agreed to use the mobile phones to collect data. Each family was therefore supported for one out of every three days that they used the device. However, some families did not leave their houses for many days, and when they did, on several occasions they did not take the phones with them. During the two weeks I spent accessing the usability of Sapelli, I nevertheless collected enough data to understand the interface design changes needed in order to improve its usability.

The first interaction barrier encountered was related to the complexity of the initial decision tree. For each new record, people had to navigate across seven or eight interface selections in order to record a single item in a specific geographic location and to collect the necessary information about this particular natural resource use instance. It is not

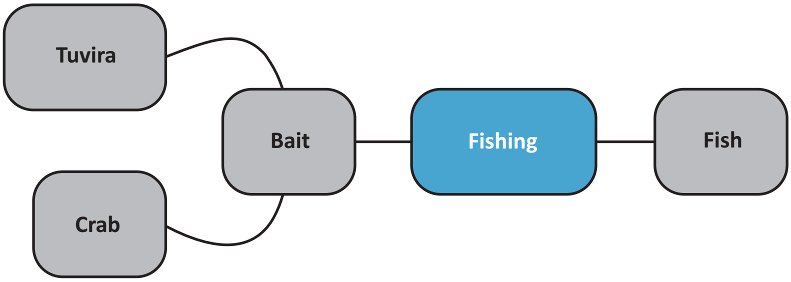

Fig. 14.5 Final decision tree used for the Pantanal version of the software. Source: author.

easy using a mobile phone on a small boat (or canoe) full of fish or bait and fishing gear. Moreover, the data-collection time actually meant that they had less time to spend doing the activity (e.g. fishing). Finding the right balance of using the application without severely distracting them from pursuing their livelihood was of utmost importance. After initial pilot tests, it was collectively decided that the number of choices or steps they had to make across the decision tree should be reduced.

The first change which was applied to the decision tree referred to the way people carried out the activities. For instance, after choosing 'collecting bait', people would be prompted to identify how they were collecting bait (either 'inside the river' or 'from the boat'). It was decided that not collecting these data would not influence the effectiveness of the main research goal concerned with natural resource use, and therefore it was decided to remove this step from the decision tree.

People were still not comfortable using the updated Sapelli version. They thought it was still too complex. So, it was decided that the main focus of the data-collection activity should be changed. Instead of looking at resource use in general, we decided to concentrate on collecting data about fishing and gathering bait only. Although this was a big change in terms of the underlying research and the purposes for which it was being conducted, we decided that collecting data about fishing activities easily and accurately was a higher priority. As a consequence, a new version of Sapelli was developed which had a much more simplified decision tree, and which, as Figure 14.5 shows, included no more than three steps before reaching the end of the tree. Information about the other activities that we had to remove from the initial Sapelli versions (e.g. harvesting rice, collecting honey or clean water etc.) was then collected via interviews and participatory observation.

Fig. 14.6 Figure of a crab initially used to represent the 'gathering crab' in the software (left). Final figure used to represent 'gathering crab' (right). The image is a scientific illustration of *Dilocarcinus pagei* – exactly the same species that local people collect as bait.
Source: Pixabay.com

Step 3: Adapting the pictograms

After reaching community consensus on the data-collection process in the new Sapelli version, another major interaction barrier emerged. The first version of Sapelli was built using pictograms. That decision was made due to emerging research from other contexts that suggested that people with low literacy skills find it easier to understand pictorial design (Lewis 2012). Interestingly, our experience contradicted those previous findings.

Local people in the Pantanal did not particularly agree with the use of pictograms. First, they thought that the cartoon symbols did not accurately represent the fish or bait they were seeing. Although I pointed out that the pictograms were a way to represent a general concept of fish or bait, they argued that it would be better to have a visualisation which resembled the actual species for which data were being collected. This was one way they felt they could verify the accuracy of the data they were collecting. The pictograms were therefore replaced with scientific illustrations of fish and bait, as shown in Figure 14.6.

Step 4: Replacing the mobile devices

During the pilot test period, two out of four mobile phones broke, leaving only two mobile devices to use during the data-collection process, which is illustrated by Figure 14.7.

Fig. 14.7 Sequence of photos showing the same fisherman recording his natural resource use in the Western Border of the Pantanal. In the first two frames, he is fishing, and in the second sequence, he is gathering bait. Credit: Photographs taken by Rafael Chiaravalloti.

Step 5: Data collection

After defining the content of the decision tree and the final pictograms with local people, we invited two families who had participated in the initial pilot tests to use the remaining two mobile phones to collect data on their fishing or gathering bait activities. Both families collected data over a period of five months, from July to November 2015.

Step 6: Results of the data collection

Combining the results of the participatory mapping using the satellite imagery, participant observation and the use of Sapelli, we managed to uncover a deep understanding of natural resources customary use in the Pantanal region. The georeferenced data collected throughout the year showed that people do not spend more than a week on the same fishing or gathering bait ground. They move to a new site when the fishing return diminishes (Chiaravalloti 2017). Because the flood pulse keeps moving from north to south, people have to move their fishing sites regularly. Throughout the year, this process creates a rotational fishing system. Moreover, it was observed that several families go together either to fish or to gather bait. This increases the chance of finding a good fishing ground.

This fishing system is very similar to mobile systems used by other communities around the developing world – practices hailed as displaying sustainable management for non-timber forest products (Assies 1997), grazing (Kothari, Camill and Brown 2013), fishing (Berkes 2006), agriculture (Sunderlin et al. 2005) and bushmeat hunting (Kümpel et al. 2009), in line with the biological principles of metapopulation dynamics (Hanski 1998). In principle, and often in practice, mobile exploitation helps avoid exhaustion of natural resources and allows different species populations to recolonise the areas that have been used (Wilson et al. 1994).

Another important aspect that was revealed through the use of Sapelli is the presence of community territory. The data showed that the reciprocity within people from Settlement 1 towards other community members does not extend to people from outside their community. People from Settlement 1 were able to indicate on the maps what they call 'their' area, and demarcate the boundaries which define Settlement 1 resources (e.g. see Figure 14.8). Therefore, each settlement has its own territory, with clear notions as to the numbers of people allowed access, who controls use of specific spots and with whom each person shares information about such spots. Based on the presence of this territory and

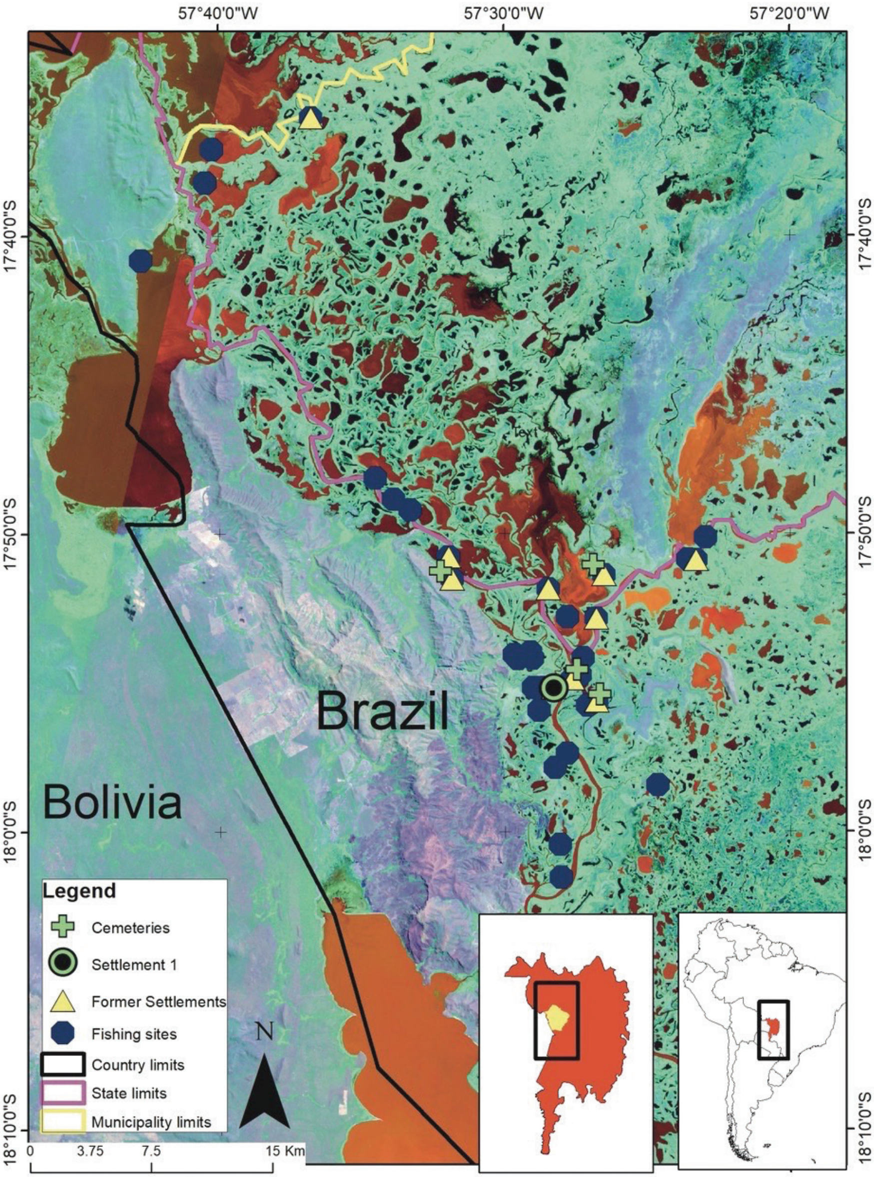

Fig. 14.8 Territory defined by local people from Settlement 1. Inset: location of the Pantanal in South America (right) and location of the study area in the Pantanal (left). Credit: Map created by Rafael Chiaravalloti 2019.

rotational resource use, alongside the existence of hundreds of inaccessible fishing grounds in the region, Chiaravalloti and Dyble (2019) have shown that the local people's fishing activity in Settlement 1 is indeed sustainable. Other authors have shown similar findings, pointing out no signs of overfishing in the Pantanal (Mateus, Vaz and Catella 2011), and highlighting in the western border of the Pantanal an 'excellent degree of biological integrity' (Polaz, Ferreira and Petrere Júnior 2017). Therefore, the evidence that the project has gathered using geographic citizen science has played a fundamental role in deconstructing the picture that conservationists have previously drawn in terms of how local people make use of natural resources in the Pantanal (Franco et al. 2013).

5. Conclusion

Participatory mapping and geographic citizen science are important in allowing local people (regardless of their scientific knowledge) to represent their knowledge, customary habits and management strategies in a scientifically valid way. The case study discussed in this chapter clearly reflects this.

Local people in the Pantanal were accused of squatting in several strictly protected areas and for overfishing local fish stocks. However, Sapelli, in combination with SSIs and participant observation, helped uncover customary practices and a historical precedent, and demonstrate a sustainable use of natural resources. The results triggered a new political environment. Today the local people are recognised as a traditional group, and a new community reserve to protect their livelihoods is under discussion (Chiaravalloti 2019). Given the success of this project, ECOA decided to buy another 10 mobile phones and installed the latest version of Sapelli developed in Settlement 1. They distributed the phones to 10 different families from five different communities in the Pantanal. The main goal of this new geographic data-collection activity is to identify the boundaries of territory and customary use. The project is currently underway, and so there are no results yet from this new project to share with the reader.

Nevertheless, it should be noted that it required months of intensive fieldwork to gain the necessary rapport to convince local people about the importance of using Sapelli to collect this type of data and also to understand how best to design a software solution and interface design which would meet local needs and be able to be used successfully. Therefore, the positive impact this project had on their lives and for sustainability in general was due to a combination of different methods, and, most importantly, the researcher's ability to spend a relatively large amount of time in the field. Under these circumstances, geographic citizen science may have a huge potential to offer in terms of truly supporting a paradigm shift in the context of conservation.

Time, nonetheless, is scarce for the majority of conservation initiatives. Projects tend to be led by large NGOs who hire local organisations for a short period of time to use a framework developed somewhere far from the local reality (Rodríguez et al. 2007). Without investing the necessary time to build rapport, understand user issues and work around technical limitations, geographic citizen science is bound to fail. Given time and a participatory approach to engage with people fully, however, it offers a unique way to support local people and conservation organisations to meet their goals of sustainable development.

6. Lessons learned

- Geographic citizen science has great potential to support better participatory initiatives as part of conservation projects.
- Time spent with local people building rapport and trust plays fundamental roles in the success of geographic citizen science initiatives.
- Other qualitative methods, such as participatory observation and SSIs, need to work together with geographic citizen science to allow effective adaptions to represent local people's needs better.
- People with natural resource-based livelihoods may experience financial loss while collecting data. The length of time required to collect data has to be seriously considered, and compensation should be considered.
- Successful geographic citizen science depends on a change to how conservation initiatives approach local people as a whole. They should focus on real needs instead of silver-bullet solutions.

Acknowledgements

This study was funded by Science Without Borders CNPq/Capes (GA 237737/2012-4), WWF Russell E. Train Fellowship (SW14), Rolex Award for Enterprise and Handsel Scholarship for Wildlife Conservation. I am grateful to Artemis Skarlatidou for the critical review and discussions,

local people who hosted me during field trips and my beloved friend Gil Conquest, who introduced me to Sapelli, helped with the complicate coding and will always be remembered.

Note

1 The real name of the community is anonymised in order to preserve local people's identities.

References

Abbott, James G., and Lisa M. Campbell. 2009. 'Environmental histories and emerging fisheries management of the Upper Zambezi River floodplains', *Conservation and Society* 7: 83–99.

Alho, Cleber J.R., and Roberto Esser Reis. 2017. 'Exposure of fishery resources to environmental and socioeconomic threats within the Pantanal wetland of South America', *International Journal of Aquaculture and Fishery Sciences* 3: 22–9.

Assies, Willem. 1997. 'The extraction of non-timber forest products as a conservation strategy in Amazonia', *European Review of Latin American and Caribbean Studies* 62: 33–53.

Berkes, Fikret. 2006. 'From community-based resource management to complex systems: The scale issue and marine commons', *Ecology and Society* 11: 45.

Bertassoni, Alesandra, Nilson L. Xavier-Filho, Fernanda A. Rabelo, Stephanie P. S. Leal, Grasiela E. O. Porfírio, Viviane F. Moreira and Angelo P. C. Rabelo. 2012. 'Paraguay River environmental monitoring by Rede de Proteção E Conservação Da Serra Do Amolar, Pantanal, Brazil', *Pan-American Journal of Aquatic Sciences* 7: 77–84.

Catella, Agostinho C., Selene P. Albuquerque, Fânia Lopes de Ramires Campos and Darci Caetano dos Santos. 2014. 'Sistema de Controle Da Pesca de Mato Grosso Do Sul SCPESCA/MS – 20 – 2013', *Boletim de Pesquisa E Desenvolvimento* 127: 57.

Chiaravalloti, Rafael M. 2016. 'Is the Pantanal a pristine place? Conflicts related to the conservation of the Pantanal', *Ambiente e Sociedade* 19: 305–10.

Chiaravalloti, Rafael M. 2017. 'Overfishing or over reacting? Management of fisheries in the Pantanal wetland, Brazil', *Conservation and Society* 15: 111–22.

Chiaravalloti, Rafael M. 2019. 'The displacement of insufficiently "traditional" communities: Local fisheries in the Pantanal', *Conservation and Society* 17: 173.

Chiaravalloti, Rafael M., and Mark Dyble, 2019. 'Limited open access in socioecological systems: How do communities deal with environmental unpredictability?', *Conservation Letters* 12: e12616.

Chiaravalloti, Rafael M., Katherine Homewood and Kirsten Erikson. 2017. 'Sustainability and land tenure: Who owns the floodplain in the Pantanal, Brazil?', *Land Use Policy* 64: 511–24.

Cooke, Steven J., Edward H. Allison, T. Douglas Beard, Robert Arlinghaus, Angela H. Arthington, Devin M. Bartley, Ian G. Cowx et al. 2016. 'On the sustainability of inland fisheries: Finding a future for the forgotten', *Ambio* 45: 753–64. https://doi.org/10.1007/s13280-016-0787-4.

Da Silva, Carolina J., and Joana A. F. Silva. 1995. *No Ritmo Das Águas Do Pantanal*. *Nupaub-Usp*. São Paulo: NUPAUB/USP.

Franco, José L. A., José A. Drummond, Chiara Gentile and Aldemir I. Azevedo. 2013. *Biodiversidade E Ocupação Humana Do Pantanal Mato-Grossense: Conflitos E oportunidades*. Rio de Janeiro: Garamond.

Girard, Pierre, and Icléia Vargas. 2008. 'Turismo, desenvolvimento e saberes no Pantanal: Diálogos e parcerias possíveis', *Desenvolvimento e Meio Ambiente* 18: 61–76.

Hanski, Ilkka. 1998. 'Metapopulation dynamics', *Nature* 396: 41–9.

Kothari, Ashish, Philip Camill and Jessica Brown. 2013. 'Conservation as if people also mattered: Policy and practice of community-based conservation', *Conservation and Society* 11: 1–15.

Kümpel, Noelle F., Eleanor J. Milner-Gulland, Guy Cowlishaw and Marcus Rowcliffe. 2009. 'Assessing sustainability at multiple scales in a rotational bushmeat hunting system', *Conservation Biology* 24: 861–71.

Lewis, Jerome. 2012. 'Technological leap-frogging in the Congo Basin. Pygmies and Geographic Positioning Systems in Central Africa: What has happened and where is it going?', *African Study Monographs* 43: 15–44.
Mace, Georgina. M. 2014. 'Whose conservation?', *Science* 345: 1558–60.
Mateus, Luiz, Marcos Vaz and Agostinho Catella. 2011. 'Fishery and fishing resources in the Pantanal'. In *The Pantanal: Ecology and sustainable management of a large neotropical seasonal wetland*, edited by Wolfgang J. Junk, Carolina J. Da Silva, Cátia N. Cunha and Karl M. Wantzen, 621–47. Sofia, Bulgaria: Pensoft.
Moraes, André S., and Luizio W. Espinoza. 2001. 'A captura e a comercializacao de iscas vivas em Corumba, MS', *Boletim de Pesquisa* 21: 38.
Ostrom, Elinor. 1990. *Governing the Commons*. Cambridge: Cambridge University Press.
Polaz, Carla N. M., Fábio C Ferreira and Miguel Petrere Júnior. 2017. 'The protected areas system in Brazil as a baseline condition for wetlands management and fish conservancy: The example of the Pantanal National Park'. *Neotropical Ichthyology* 15.
Rodríguez, Jon P., Andrew B. Taber, Peter Daszak, Raman Sukumar, Claudio Valladares-Padua, Suzana Padua, Luis F. Aguirre et al. 2007. 'Environment: Globalization of conservation: A view from the south', *Science* 317: 755–6.
Sandbrook, Chris. 2015. 'What is conservation?', *Oryx* 49: 565–6.
Silva, Miguel Vieira. 1986. *Mitos e Verdades Sobre a Pesca No Pantanal Sul-Mato-Grossense*. Campo Grande, Brazil: FIPLAN.
Sunderlin, William D., Brian Belcher, Levania Santoso, Arild Angelsen, Paul Burgers, Robert Nasi and Sven Wunder. 2005. 'Livelihoods, forests, and conservation in developing countries: An overview', *World Development* 33: 1383–402.
Tocantins, Nely. 2011. 'Do Mar de Los Xarayes Ao Complexo de Áreas Protegidas Do Pantanal Mato-Grossense', *Revista Do Instituto Histórico E Geográfico de Mato Grosso* 1: 17–27.
Wilson, James A., James M. Acheson, Mark Metcalfe and Peter Kleban. 1994. 'Chaos, complexity and community management of fisheries', *Marine Policy* 18: 291–305.

Little did Isaac Newton, Charles Darwin and other 'gentlemen scientists' know, when they were making their scientific discoveries, that some centuries later they would inspire a new field of scientific practice and innovation, called citizen science. The current growth and availability of citizen science projects and relevant applications to support citizen involvement is massive; every citizen has an opportunity to become a scientist and contribute to a scientific discipline, without having any professional qualifications.

Geographic Citizen Science Design takes an anthropological and Human–Computer Interaction (HCI) stance to provide the theoretical and methodological foundations to support the design, development and evaluation of citizen science projects and their user-friendly applications. Through a careful selection of case studies in the urban and non-urban contexts of the Global North and South, the chapters provide insights into the design and interaction barriers, as well as on the lessons learned from the engagement of a diverse set of participants.

Looking at the field through the lenses of specific case studies, the book captures the current state of the art in research and development of geographic citizen science and provides critical insight to inform technological innovation and future research in this area.

Artemis Skarlatidou is Senior Research Associate in the Extreme Citizen Science (ExCiteS) group at UCL. Her research interests include Risk Communication and Human–Computer Interaction (HCI) and User Experience aspects (e.g. usability, aesthetics, trust) of citizen science applications, geospatial technologies and their spatial representations for expert and public use.

Muki Haklay is Professor of Geographic Information Science at UCL. His research interests include public access, use, and creation of environmental information; and citizen science He is the co-director of UCL Extreme Citizen Science group (ExCiteS) and co-founder of the social enterprise Mapping for Change.

Cover image:
© Gill Conquest, ExCiteS

Cover design:
www.ironicitalics.com

UCLPRESS
Free open access version available from
www.ucl.ac.uk/ucl-press

ISBN 978-1-78735-614-6
90000
9 781787 356146