AN OVERVIEW OF CITIZEN SCIENCE AND GEOGRAPHIC CITIZEN SCIENCE

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Hi everyone. Welcome this week;s lecture of data politics and society. This week we will focus on Citizen Science and Geographic citizen science.

CITIZEN SCIENCE

"To have a just and sustainable world we need to adopt a new cultural norm, and to be a responsible person on this planet means that we observe our surroundings with intention and we share that we share, see, smell, find…we and our devices become part of a network taking the pulse of the planet"

Caren Cooper

https://www.youtube.com/watch?v=G7cQHSqfSzI

CITIZEN SCIENCE: WHAT IS IT?

Citizen Science is described as:

- "developing concepts of scientific citizenship which foregrounds the necessity of opening up science and science policy processes to the public"

(Alan Irwin, 1995)

Irwin, A. (1995). *Citizen Science: A Study of People, Expertise and Sustainable Development*. Routledge. ISBN 9780415130103.

- CS as projects in which non-scientists, such as amateur birdwatchers, voluntarily contributed scientific data

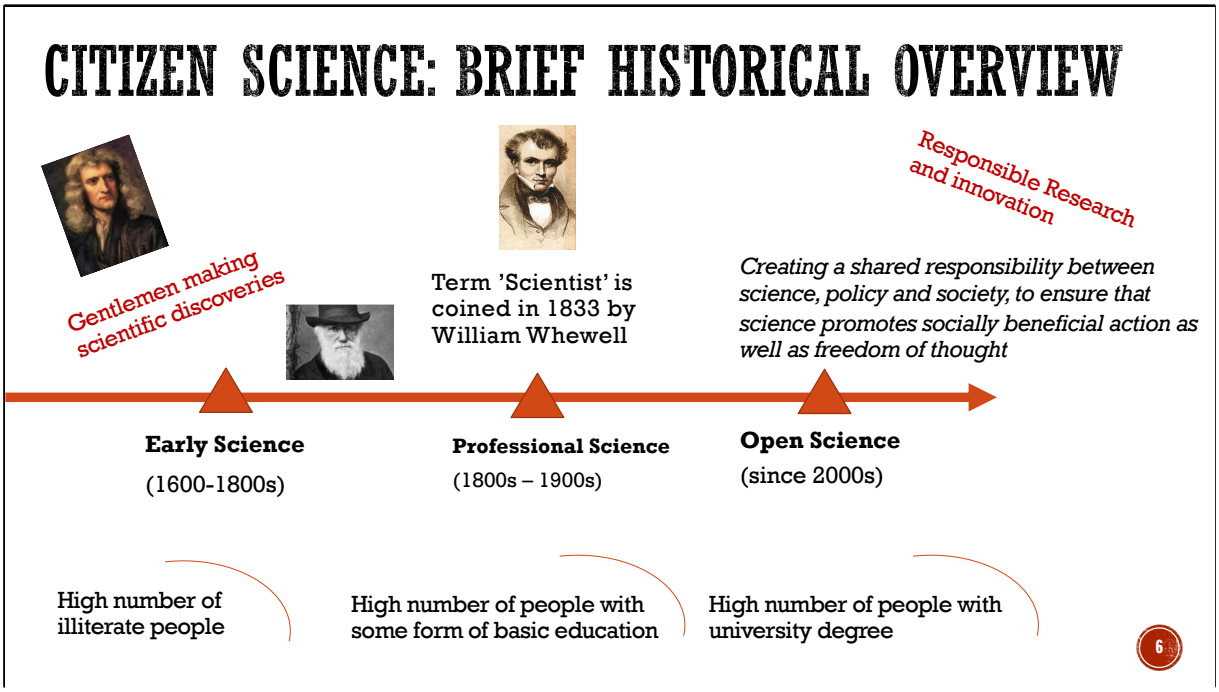
Rick Bonney, 1996

Bonney, R. (1996). Citizen science: A lab tradition. *Living Bird* 15(4): 7–15.

CITIZEN SCIENCE: DEFINITION

The scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions

Oxford English Dictionary, 2014



Looking at the early period between the 16 and 18 hundreds, the main societal characteristics of the western world in terms of literacy, was that there was a significant higher number of illiterate people compared to those who were well educated. To give an example In 1650 in England only 50% of men and only 10% of women knew how to read and write. During this period citizen science takes the form of gentlemen science; due to the fact that science professionalization did not exist and during this period science was mainly practiced as a hobby of the rich, who were called gentlemen, or gentlewomen, and who used their own private resources to fund their investigations. And we have examples such as Isaac Newton's and later on Charles Darwin's scientific discoveries here.

Towards the middle period, is when the term scientist is coined and with it slowly comes the professionalization of science. Here we see a higher number of people finishing some form of basic schooling. During this period, we have examples of what we know as today's citizen science; i.e., scientists – not necessarily though from the academic community as we know it today – work with members of the public to collect data and observations, but citizen science is not called as such of course. It is driven by a recognition of those leading the investigation that the public – which now have higher educational skills – may contribute to a scientific investigation which

cannot be done otherwise. During this period, we do have examples also of women leading such investigations –outside professional scientific bodies of the time - such as Florence Nightingale.

From the 1940s onwards we start to see major scientific projects, investments, the opening of laboratories etc. and during this period ordinary people are mainly excluded from participating in scientific research, or they are being involved in environmental monitoring. Moving slowly from this period to the next we saw some profound changes in the way science it was initiated and in terms of how it operated and managed; especially with respect to science-society relationships. For example, during this period we have controversial techno-scientific debates around topics such as nuclear weapons and the political changes that led to the commercialisation and the industrialisation of scientific research as well as incidents of scientific fraud that caused public suspicion. These gradually lead to the reformation of science-society relationships; e.g., efforts of scientific bodies to improve public's understanding of science, although these were mostly unsuccessful in terms of re-establishing public trust and support.

In the third period that we are going through now, illiteracy (at least in the western world) does not almost exist, and most people have some form of basic education, even a university degree. In this context - and together with the emergence of a more dialogic mode of cooperation and negotiation in science, which aims to understand and integrate public wants, needs and values in scientific practice – there are calls for 'Responsible Research and Innovation (RRI).

A more recently coined term from the policy context, that of open science (OS), proposes that science is co-created with members of the public; policy documentation and guidelines suggest that this can be achieved with methods such as citizen science.

EARLY EXAMPLES OF CITIZEN SCIENCE

Painting of Hanami in Goten-yama around 1847 (Credit: Tokyo Metropolitan Library)

National Audubon Society's annual Christmas Bird Count

Citizen's Acid Rain Monitoring Network.
https://pubs.acs.org/doi/pdf/10.1021/es00064a603

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Among the longest running and widespread Citizen Science projects are those designed to engage the public in the observation and recording of phenological events. The practice of studying natural cycles is as old as human history. For example, the timing of plant growth and animal behaviour was used by our ancestors for hunting and gathering. Therefore, although citizen science is a relatively new term, people have been participating and contributing to "scientific research" for years.

The oldest known phenological series ever recorded is that of cherry (*Sakura*) flowering at the Royal Court in the former Japanese capital of Kyoto. Data on these series stretch back to 705 and (probably) represent the oldest written biological record.

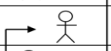
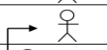
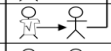
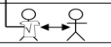
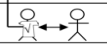
The first recorded example of the use of the term is from 1989, describing how 225 volunteers across the US collected rain samples to assist in an acid-rain awareness raising campaign.

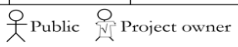
Birding is one of the oldest and most-familiar forms of citizen science. In fact, one of the oldest citizen-science projects is the annual Christmas Bird Count, in which an

experienced birder leads a circle of volunteers as they collect information about local populations of birds. This Bird Count activity began in **1900,** and it is but one example of a long-standing tradition which has persisted to the present day.

Butterfly counts are another example, with schemes starting in the UK and North America in the mid 1970s.

CITIZEN SCIENCE TYPOLOGIES I

	Traditional Science	Citizen Science				
		Contractual	Contributory	Collaborative	Co-created	Collegial
Question						
Study Design						
Data Collection						
Data Analysis and Interpretation						
Understanding the results						
Management Action / Publication						
Geographic scope of the project	Variable	Narrow	Broad	Broad	Narrow	Narrow
Nature of the people taking action	Scientists	Public	Scientists	Scientists / Public	Scientists/ Public	Public
Research priority	Highest	Medium	High	High	High	Medium
Education priority	Low	Medium	High	High	High	High



Haklay based on Shirk et al.'s (2012) five models of **public participation in scientific research** (PPSR).
Image is from:
Haklay, M. (2021). Geographic Citizen Science: An overview. *In: Skarlatidou, A. and Haklay, M (eds) Geographic Citizen Science Design: No one left behind.* London: UCL Press.

Shirk, J.L., Ballard, H.L., Wilderman, C.C., Phillips, T., Wiggins, A., Jordan, R., McCallie, E., Minarchek, M., Lewenstein, B.V., Krasny, M.E. and Bonney, R. (2012). Public participation in scientific research: a framework for deliberate design. Ecology and Society 17(2): 29.

- **Contractual:** When a community group engages scientists (either paid or pro-bono) to research issue that concerns them;
- **Contributory:** Most common type of citizen science projects; led by scientists, where volunteers mainly collect data;
- **Collaborative:** Led by scientists who set the questions, volunteers collect data but also analysing or understanding the results (e.g., in air quality studies) and taking part in any subsequent action (e.g., advocacy);
- **Co-created:** Volunteers involved in setting up research questions, data collection and analysis, but scientists still have control over project goals, design methods and analysis.
- **Collegial:** Bottom-up projects carried out with or without the involvement of scientists. Here scientists may simply provide expert advice.

CITIZEN SCIENCE TYPOLOGIES II

Level 4 'Extreme Citizen Science'	• Collaborative science – problem definition, data collection and analysis
Level 3 'Participatory Science'	• Participation in problem definition and data collection
Level 2 'Distributed Intelligence'	• Citizens as basic interpreters
Level 1 'Crowdsourcing'	• Citizens as sensors

Haklay, Mordechai (Muki). 2013. 'Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation.' In *Crowdsourcing Geographic Knowledge: Volunteered Geographic Information (VGI) in Theory and Practice*, edited by Daniel Z. Sui, Sarah Elwood, and Michael F. Goodchild, 105–22. New York: Springer.

SOME CITIZEN SCIENCE CHALLENGES

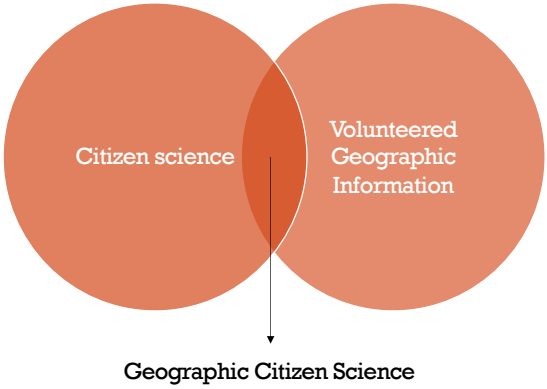
- Data Quality with an emphasis on scientific protocols
- Volunteers: Motivating, Retaining and Rewarding participants
- Lack of evidence to demonstrate citizen science impacts (Evaluation)
- Digital Technology Design and User Experience aspects
- Data Management Issues
- Training
- Ethics and Data protection
- Disciplinary Differences and Policy issues
- …

Hush City App

CAPTURING OUR COAST

GEOGRAPHIC CITIZEN SCIENCE: VGI & CITIZEN SCIENCE

Geographic citizen science: the scientific work undertaken by members of the general public where the data generated has a deliberate and explicit geographic aspect and follows specific protocols or processes.



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Not all VGI is geographic citizen science, and not all citizen science is geographic.

A citizen science project that is concerned with recording an environmental observation by taking a geotagged picture with a smartphone is clearly producing VGI – this is one of the most common examples of geographic citizen science. Also, a project that engages volunteers to map the location of all water sources in an informal settlement in the open digital database of OpenStreetMap is carrying out a systematic collection of facts, and therefore it can be considered as citizen science (and therefore geographic citizen science). On the other hand, we have activities which clearly fall outside the conditions of geographic citizen science – such as when VGI is not concerned with recording information in a systematic and objective way – for example, Opinions regarding a restaurant that are recorded in TripAdvisor cannot be considered citizen science. In addition, VGI that is done without an intention of producing scientific outcomes or purpose falls outside geographic citizen science. Finally, when a citizen science project is not concerned with the geographic location of the observations, it will not be classed as VGI. For example, a Zooniverse citizen science activity which involves classifying galaxies is not geographic citizen science.

GEOGRAPHIC CITIZEN SCIENCE

February 2021 - Open Access
https://www.uclpress.co.uk/products/125702

EXTREME CITIZEN SCIENCE

https://www.youtube.com/watch?v=z3d_UsYgt1c

Extreme Citizen Science | ExCiteS | is

a philosophy of situated, bottom-up initiatives which take into account the local needs, practices and cultures to work with broad networks of people to design and build new devices and knowledge creation processes which can transform the world.

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We have defined Extreme Citizen Science (ExCiteS in short for the research group at UCL) as a philosophy of situated, bottom-up initiatives which take into account the local needs, practices and cultures to work with broad networks of people to design and build new devices and knowledge creation processes which can transform the world.

Extreme Citizen Science & Sustainability

- Citizen science: the activity where amateur volunteers participate in data collection (occasionally also in processing and analysis).

- Western beliefs about techno-scientific innovation, top-down approaches which exclude communities from the broader sustainability agenda and debate are highly problematic.

  "People are integral to how their environments are shaped and the diversity that these environments support" *(Jerome Lewis, 2018)*

- Using citizen science approaches to collect and analyse Traditional Ecological Knowledge (TEK) – and other mainly environmental data – in collaboration with local communities (and some times in support of local NGOs), to support them address issues important to them and enable them to contribute to the global and local sustainability debates.

Working with indigenous communities

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- Extreme citizen science initiatives rely on communities identifying and defining the initial problem themselves. Two are the two key components of the extreme citizen science methodology and our approach to engaging indigenous communities, which always initiate a participatory design process: i.e., negotiating a Free, Prior and Informed Consent (FPIC) process and establishing an open and iterative community protocol.

Free, Prior, Informed Consent (FPIC) process

Informing people about planned activities and impacts, positive and negative, prior to them being affected by them; discussing together risks and mitigation measures and decide if they want to be involved.

- The FPIC process aims to inform “the affected persons about planned activities and their impacts – both positive and negative” verify “that the information provided has been understood, before explicit consent can be negotiated” . The consent is free and informed highlighting the importance of free will and the ability of communities to refuse an intervention. The consent should be also negotiated prior to them being affected by any external actions. This is a challenging and long process, which further sets the foundations for local capacity building.

Establishing a Community Protocol

An iterative process defined by local team which includes discussing and building a plan for:

a. Project Functioning Information;
b. Technological and Methodological Support;
c. Data Sharing protocols.

- To sustain the project over its lifetime, we always work towards establishing a community protocol that formalizes the solutions collectively agreed by the community participating in the work.
- The first part of the protocol consists of questions and answers about the functioning of the project such as:
  - Who collects the data?
  - When will they go to collect data?
  - How will they collect the data?
  - How will they check the data?
  - With whom will they share their data?
  - Who is responsible for the equipment?
  - What risks are there when collecting data?
- This is then followed by a session on the technical and methodological support, another about the logistics support and, finally, one on the data sharing protocols, because the communities themselves decide who owns their data and whether they want to even share them with anyone else.

- It is important to understand that this is an iterative process defined by the local team. Further changes, such as inviting new members and defining new roles, are decided by the local team and need to be documented in the Community Protocol.

Participatory (Interface) Design & Evaluation

- Community engagement does not stop with the FPIC and community protocols. Most of the people we work with are very different from the average smartphone or any technology user in the western world. People are low-literate or non-literate, they don't know how to read, write or sometimes draw, they never used a map before, perhaps they have never owned a smartphone or cell phone device. They do not necessarily have electricity to charge the equipment, they have never had any experience having to all of sudden deal with multiple devices, multiple chargers etc.

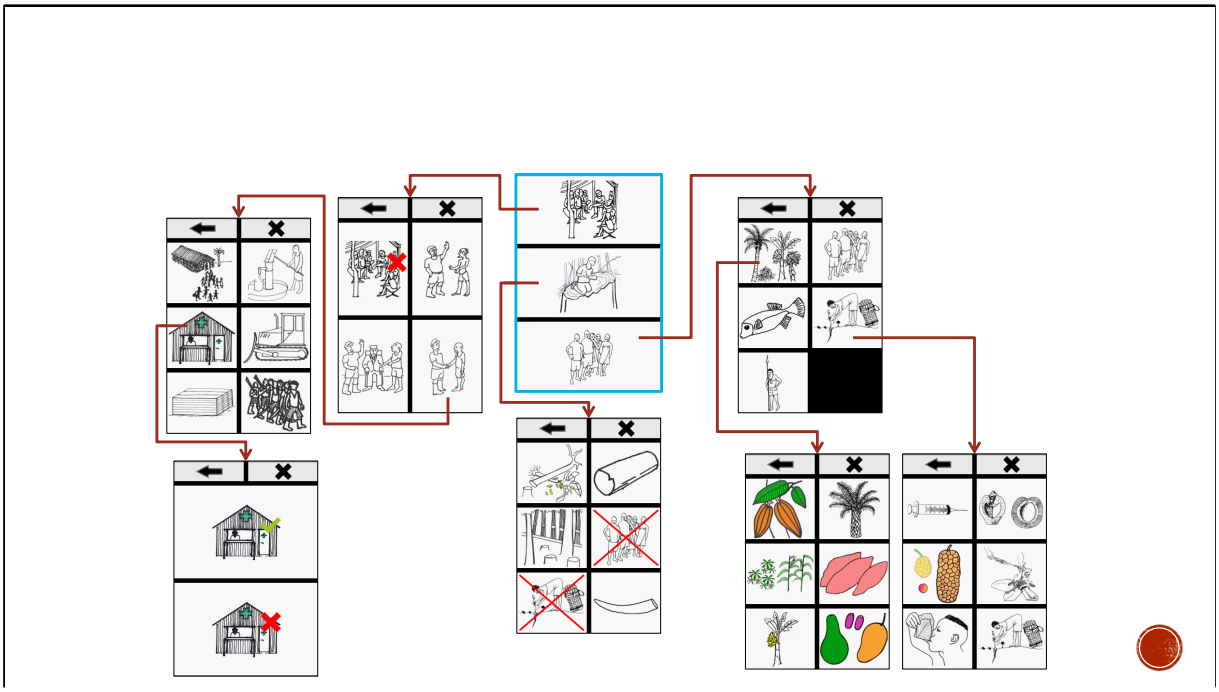
- To lower or eliminate any usability barriers we follow also a participatory design for the interface design and the evaluation of the proposed technological intervention. In this context we also build on knowledge from the fields of HCI4D and ICT4D (Human Computer Interaction for Development; Information and Communication Technology for Development).

- One example to demonstrate how this process starts, is with the development of pictograms which are used to collect data. Depending on their educational background and other skills these may be codesigned with the community and the research team, or may be developed by the researcher and then they are shown to the community to check whether their understand what each icon means.

Tools: Overview

Sapelli Collector

- Sapelli is an Android-based **mobile data collection and sharing platform** designed primarily (yet not exclusively) for non-literate or illiterate users with little or no prior ICT experience.
- Sapelli uses a decision tree, hierarchical architecture in a pictorial-based interface design



We use in the beginning categorical icons. These are icons that are used to group similar items so that when you have to collect data about say 70 items, you can somehow navigate to find the one you want to map (by grouping similar things together; e.g. if fruits are grouped together, we need an abstract icon to represent fruits; if various seeds are grouped together similarly, we need an abstract icon to represent seeds and so on).

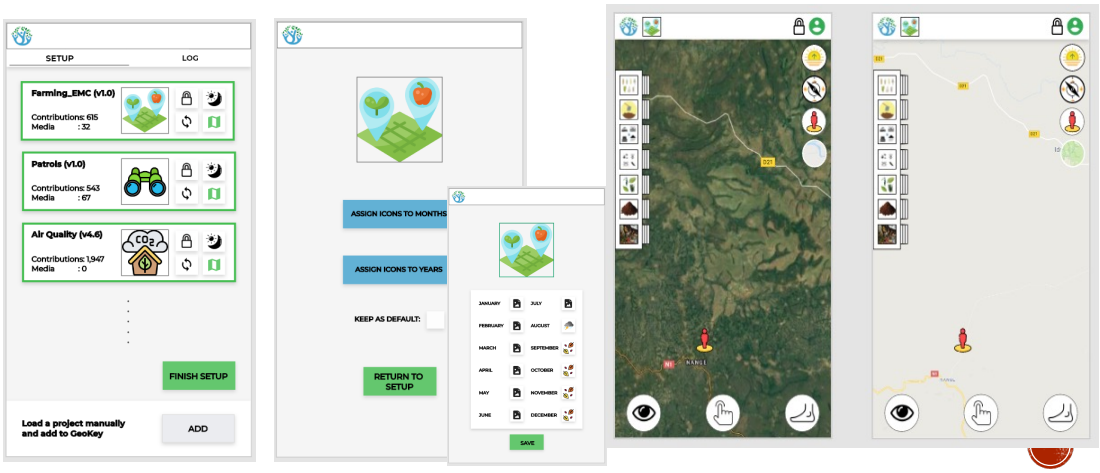
From any category/grouping you select (e.g. fruits), you can access the more specific icons (e.g., pineapples, bananas) to find the data item (in the leaf node of the decision tree) for which information is about to be collected.

Tap&Map – Data Collector

- Designed to overcome interaction barriers (in the use of hierarchical decision trees, touch screen interfaces etc.)
- Tap&Map is a smartphone application accompanied by a set of cards equipped with near field communication (NFC) technology. Each card has an icon printed on one side of the data items that are collected.

- Tap&Map was designed to overcome interaction barriers (in the use of hierarchical decision trees, touch screen interfaces etc.)
- It is a smartphone app accompanied by a set of cards, which are equipped with near field communication (or NFC) technology. Each card has an icon printed on one side to show the data item for which data are being collected.
- In the process of tapping&mapping, it is essential that the user stands as close as possible to the actual location of the physical object being mapped, so that the device reads and records its accurate location through its GPS sensor.

Sapelli Viewer – towards an "Intelligent Maps" interface



Sapelli Viewer is a smartphone app which enables people to view the data they collect using satellite imagery on the background.

EXTREME CITIZEN SCIENCE CASE STUDIES

Congo-Brazzaville: Reporting Illegal Logging and Poaching with the Mbendjele Yaka Pygmies

- Mbendjele Yaka Pygmies of northern Congo-Brazzaville experience for years an unprecedented exploitation of their local forest and natural resources, in ways which are clearly juxtaposed with the indigenous ways of interacting with them. For these egalitarian communities of hunter-gatherers, the forest is not only a source of livelihood, but it is important for their traditions and its spiritual role. In order to support local communities and in collaboration with local Non-Governmental Organizations (NGOs) Sapelli Collector was developed in 2013, and it is used since then with non-literate people, to collect data about illegal logging and poaching in the area

- The vision of local organizations which collaborated in the project is that data collected would provide the necessary evidence to report logging companies' behavior and which would subsequently inform new EU FLEGT (Forest Law Enforcement Governance and Trade) legislation.

Brazil: Fighting illegal land invasions with the Ashaninka

- The Ashaninka live in the Peruvian and Brazilian Amazon rainforest. They number more than 100,000 people and are probably the biggest indigenous population of low-land Amazonia. They fight illegal activities in their territory (mainly drug dealing business in the border), but often struggle to be heard by governmental enforcement agencies, therefore they monitor their land mostly themselves.

- In the beginning of 2000s, their land suffered a serious logging invasion from Peru, leading to issues of hunger. The loggers were both consuming animals and scaring them away, and community members feared meeting an invader if they went hunting and fishing which would even put their lives at risk. This risk is even higher from drug dealing land invasions and there were many community leaders who for murdered. In 2014 four of them killed during the same week.

- The Ashaninka approached ExCiteS, because they were interested in collecting geographic data as proof for these invasions, and make this available immediately to enforcement agencies, speeding up the communication process with them and hoping that in that way they can get an effective and fast response from authorities.

Brazil (Pantanal Wetlands): Natural Resource Management for New Conservation Legislation with Indigenous Communities

Source: wildbrazil.com.br

- The Pantanal is the largest wetland in the world; it boasts a wide and unique biodiversity. Local fishers are directly dependent on the wetland for their daily livelihood. However, the legislation for resource management and consumption in the area followed the scientific recommendations of conservation biologists, which assume that people are fixed in time and space and that indigenous practices (which are very dynamic and flexible) should stop because they are not sustainable. This gradually led into people's physical and economic displacement of indigenous peoples.

- Sapelli is being used with local communities in this area since 2014, who collect data about the use of natural resources and their management strategies. The data collected provided evidence that indigenous practices are indeed sustainable and as a result new legislation recognized local people as a traditional community and this provided them the right to use their traditional practices without the danger of being penalised with fines or even imprisonment.

Namibia: Natural Resource Management and Fighting Illegal Cattle Invasions with the Ju|'hoansi

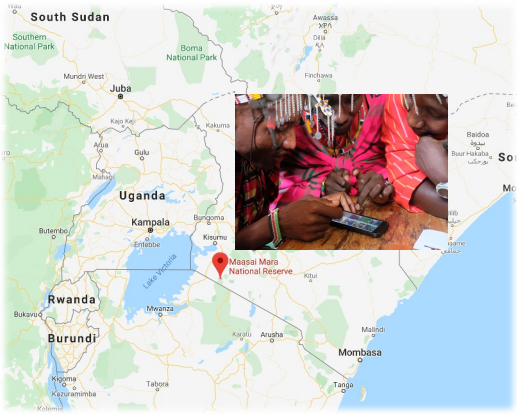
- The Nyae Nyae (Nya Nya) Conservancy in Namibia officially registered in 1998, is an area where the Ju'hoansi (ju-twansi) community hasve hunted and gathered for thousands years. The area came under threat since local communities have come into contact with agricultural economies and especially due to extensive cattle farming in the traditional hunting and gathering territories. As the primary custodians of the Nyae Nyae conservancy the Ju|'hoansi asked for support to enable them collect data which can help fight illegal cattle invasion in their territory.

- A first Sapelli implementation for this purpose was deployed in 2015, while since 2018 the communities use also Sapelli to collect data for the ways they use local community forest resources.

Ghana: Reporting Weather Conditions with Local Farmers

- Agriculture in Ghana is highly influenced by extreme weather conditions and climate variability. Due to lack of scientific data, the national meteorological agency cannot always provide reliable information for weather conditions. Therefore, local farmers rely heavily on their own experiences and intuition, to plan and manage farming activities. They use Sapelli to report weather conditions and share the knowledge between them and this helps them structure their daily activities. The data collected has the potential to further improve scientific weather prediction models in the area by incorporating this form of indigenous knowledge.

Kenya: Collecting Data for Indigenous Plants with the Maasai



- In Kenya, Sapelli is being utilized since early 2019, with Maasai warrior communities. One of the greatest threats they face is the loss of their TEK and the increased deforestation in the Maasai Mara National Reserve. Sapelli is therefore used to assist them in collecting and recording TEK related to indigenous plants and pass that into younger generations. Within a few hours after the initiative was launched there individuals gathered over a hundred data items and since then they've collected thousands of points with information about the medicinal and other properties of local indigenous flora.

Cameroon: Supporting Baka communities Tackle Illegal Wildlife Crime and Animal Monitoring

- Cameroon harbours extraordinary biodiversity ; It is one of the last places on earth where such a diversity of megafauna exists in the wild, but it is being rapidly depleted by the illegal wildlife trade and extractive industries. Many Baka communities feel a great sense of injustice towards external wildlife traffickers pillaging forest resources, and consistently express a desire to be involved in tackling such activity and since 2016 they collect data in an area of roughly 953 km².
- This can be extremely sensitive data and even exposing the contributor's details can put their lives at risk. Therefore, they use Sapelli together with an anonymous ID system and additional password protection features which are used to lock the devices so that no one has access to them.

SEMINAR THIS WEEK

'Whose Land-Whose Map? Land Use Mapping in the Digital Earth Era', by PhD student Marcos Moreu