

Charla M. Burnett  
*Editor*

# Evaluating Participatory Mapping Software



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Charla M. Burnett  
Organizing Together Consultancy  
Lansing, MI, USA

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## Chapter 9

# Terrastories



**Christopher Martin, Rudo Kemper, Colin M. Gibson, Natalie Thornhill, Rohini Patel, and Dawn Martin-Hill**

**Abstract** Terrastories is a free and open-source participatory mapping software enabling communities to build a database of place-based stories and visualize these on a digital map. Co-designed with Indigenous communities, Terrastories leverages a simple interface to serve the focused needs of its targeted users: to map information that is culturally relevant and important to communities. Terrastories allows for uploading information in different multimedia formats and protects the information by granting users different levels of access. Terrastories is easy-to-use, requiring a low level of technical expertise. Knowledge on Indigenous issues, data sovereignty, and ethics are important to guide information gathering methodologies to build a Terrastories map. These concepts solicit novel interpretations of conventional terms such as ‘data accuracy’. A case study is presented in this chapter that outlines how Terrastories is being used by an Indigenous water research program from Six Nations of the Grand River in Canada called Ohneganos Ohnegahdę:gyo.

**Keywords** Counter-mapping · Free and open-source software · Indigenous data sovereignty · Indigenous knowledge · Indigenous mapping · Oral histories · Place-based storytelling

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C. Martin (✉)

Ohneganos Community Mapping Facilitator, Six Nations of the Grand River Reserve, Canada

R. Kemper

Digital Democracy, Springfield, VA, USA

C. M. Gibson (✉) · N. Thornhill · D. Martin-Hill

McMaster University, Hamilton, L8S 4L8, ON, Canada

e-mail: [gibsoc13@mcmaster.ca](mailto:gibsoc13@mcmaster.ca); [thornhin@mcmaster.ca](mailto:thornhin@mcmaster.ca); [dawnm@mcmaster.ca](mailto:dawnm@mcmaster.ca)

R. Patel

Department of History, University of Toronto, Toronto, Canada

e-mail: [pater141@mcmaster.ca](mailto:pater141@mcmaster.ca); [rohini.patel@mail.utoronto.ca](mailto:rohini.patel@mail.utoronto.ca)

## 9.1 General Information

**Name of Application:** Terrastories

**Name of Developer:** Terrastories (open-source steward team)

**Name of Funder:** N/A

**Type of System Software:** Desktop and Mobile

**Type of Programming Language:** Ruby on Rails, JavaScript, React, Mapbox GL JS, Docker

**API Availability:** None

**Features:** Interactive map, sidebar with stories and other media content, Indigenous taxonomy filters to sort through content, administrative backend to edit stories and set them as restricted, granulated permissions for viewing and editing stories per username, multiple communities per Terrastories server

**Cost:** Free software plus cost of hosting and hardware

**Type of Data Collected (Geographic and Descriptive):** Custom background map (provisioned via Mapbox GL JS), stories, speakers, places, and multimedia content.

**Overview:** Terrastories is a free and open-source participatory mapping and storytelling application for Indigenous and other communities to map, protect, and share stories about their land. It can be used by individuals or communities who want to connect audio or video content to places on a map. It is designed to be user-friendly and interactive, letting community members freely explore and engage with information contained in the map without needing any technical background.

Terrastories began when a team of geographers from the Amazon Conservation Team, along with software developers, identified that there was a need to digitally map a community's place-based oral histories. Located in South America, the Matawai Maroons of Suriname, a community of formerly enslaved Africans who fled into the forests over three centuries ago and reside there today, wanted to map oral histories about when their ancestors first arrived in these lands. The community leaders were interested in having a tool that helps the young people get to know these places, their history, their culture, and who they are as a people. Terrastories was built to accommodate that need, which the team also heard about from other communities across the globe. While Terrastories was built with Indigenous communities and values in mind, it can however be used by any community – or any person – who wishes to map their own place-based oral histories.

At its core, Terrastories consists of an interactive map and a sidebar with stories (see Fig. 9.1). On the map, there are Place markers that are associated with one or more Stories, shown in the sidebar. Users can either activate Place markers to see a popup with more information about that - Place, and to filter the sidebar to only show Stories associated with that Place - or users can activate Story cards to filter the map to only show Places associated with that Story, and zoom to their location. Stories also have Speakers, and it is possible to filter Stories by Speaker, by





Fig. 9.1 Screenshot from Terrastories used during a technical training session at the 2021 Indigenous Mapping Workshop (November 2, 2021)

topic, taxonomy term (which can be Indigenous taxonomies), using a dropdown menu at the top of the sidebar. The entire user interface of Terrastories works in desktop as well as mobile. The interface can also be translated to any language, including commonly spoken ones and translations for minority languages provided by the user.

Users with the right editing permissions can access the Terrastories dashboard to add Stories, Places, and Speakers to the map, customize the interactive map content, and set thematic properties for their community’s Terrastories instance. They can also set Stories as restricted, meaning that one needs to have the right level of access in their credentials to be able to view those Stories. Without that level of access, neither Stories nor Places associated with those Stories will show for that user.

To summarize, Terrastories gives Indigenous communities the ability to focus on the following three key elements of storytelling and knowledge exchange: **Speakers**, **Places**, and **Stories**.

- The *Speaker* category refers to the contributor of the story, knowledge, or resource. Each specific point on the map will include one or more speaker from which the data and information has originated from. Speakers can be both Indigenous and non-Indigenous; any information can be contributed so long as it is tied to the geographical area of interest and is relevant to the mapping priorities of the community leading the development (see Sect. 9.6: Data Accuracy, pg. 200).
- The *Place* category refers to site-specific locations shown on the background map of Terrastories in which Stories are attached to. Assigning a Place to a Story

involves attaching the latitude and longitude of the specific location in addition to adding pictures and a description.

- The *Stories* category refers to the content and knowledge being shared by a Speaker that is tied to a particular Place. This is where a more detailed description of the area can be uploaded as data into Terrastories, alongside multimedia formats such as pictures, audio, and video.

Terrastories can be hosted entirely offline or online, depending on the community's needs and resources. Terrastories is built to be multi-instance, meaning that more than one community can access a singular Terrastories server, but each with their own dedicated space, stories, and map that is only accessible by them. In this way, as a digital tool Terrastories empowers Indigenous and other local communities to map and share Indigenous sites of geographical, traditional, ecological, and cultural significance from anywhere in the world (Kemper, 2018). As a decolonial research tool, Terrastories supports Indigenous Peoples and Indigenous communities to develop their own Indigenous-led and protected repository of community-based Traditional Ecological Knowledge (US TEK Task Team, 2021).

A key design component of Terrastories is accessibility because some Indigenous communities may be unfamiliar with digital technologies and have limited technical capabilities. To promote accessibility, the Terrastories software employs a simple, user-friendly interface that works on computers and personal digital devices like tablets, laptops, and cellular phones – on or offline. This also helps Indigenous communities engaging with the Terrastories platform choose what knowledge or data they want to share publicly and what stories or knowledge they would like to keep private (see Sect. 9.7: Data Privacy, pg. 202).

The development of Terrastories as a program has focused on the needs of the targeted end-users. Core to the Terrastories philosophy is the recognition that the end-users are also the architects of the map they decide to build. Terrastories is community-led in all aspects; designed by community, for community, and community members are the users and stewards of the map they envision and create. Data and information entered the platform acts as a living, community-guided, story-based archive of the land, water, resources, and cultural knowledge integral to Indigenous communities engaging the platform (Kemper, 2018). Ultimately the application acts as a tool to help protect and document tangible and intangible cultural knowledge, while ensuring access to that knowledge from anywhere and at any time.

### **9.1.1 Ohneganos Ohnegahdę:gyo**

Ohneganos Ohnegahdę:gyo (Ohneganos) is a community-led university research program directed by Mohawk scholar Dr. Dawn Martin-Hill in partnership with Six Nations of the Grand River (Six Nations). The Ohneganos team is using the

Terrastories mapping application to develop an Indigenous map of Haudenosaunee<sup>1</sup> Knowledge. Terrastories is paramount to helping Six Nations create a decolonial Indigenous map that compiles and visualizes community data and knowledge on top of a background map of traditional Haudenosaunee territory. Importantly, Terrastories facilitates the sharing of knowledge that is culturally relevant to Six Nations in accordance with Indigenous pedagogies. This is achieved by geolocating and embedding stories, oral histories, and observations that are documented in digital multimedia formats (e.g., pictures, videos, audio recordings, and text) in accordance with specific locations or points on a map.

References to Ohneganos will be made throughout this chapter to help contextualize Terrastories and provide specific examples of its features being used. See Sect. 9.12: Brief Use Case (p. 206) for more information about Ohneganos and details of how the research program is using Terrastories in practice.

## 9.2 Ethics

As a participatory mapping software, Terrastories regularly encounters several general areas of ethical concern and consideration. Six have been described below:

- Community Input
- Local Community Ethics Protocols
- Free, Prior, and Informed Consent (...it is a continual process)
- Validating Individual Permissions Settings
- Legal Ethics (specific to a country or region)
- Ethics Connected to Research within Academic Settings

### 9.2.1 *Community Input*

Community input is a crucial element of ethical consideration for Terrastories. The platform is designed to be community-led, as such, community input throughout the planning, documenting, and building of land-based maps is a vital component of the Terrastories process. In working with Terrastories, communities may decide upon their own input strategies to put in place that reflect their needs. This means the timelines for completing Terrastories projects can also vary depending on how the community approaches its role and the data input process.

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<sup>1</sup>As per King (2007), "...Haudenosaunee is the Seneca word to denote the 'People of the Longhouse' and is sanctioned by the Confederacy of Six Nations to be the word used when referring to the Confederacy. The Mohawk word is Rotinohsonni".

### ***9.2.2 Local Community Ethics Protocols***

Local community ethics protocols refer to the cultural and social ethics established by communities. These ethical considerations are unique in each user case and can manifest in varying ways throughout the life of a Terrastories project. Formalized community ethics protocols are particularly common in Indigenous communities that have been heavily researched in the past or have frequent partnerships with non-community individual or organizational stakeholders. For Terrastories, community ethics are set and guided by the community utilizing the digital platform.

### ***9.2.3 Free, Prior, and Informed Consent***

Consent is also a key ethical consideration at all levels of research, documentation, and land mapping related to Terrastories. The methodology for working with Terrastories recommends treating consent as an ongoing and continual process process, and continually seeking consent from the community through the community's channels identified as best practice for their collective and individual needs. This also involves considering broader policy and ethics connected to research and development in each country or region in partnership with the community.

### ***9.2.4 Validating Individual Permissions Settings***

As an extension of the consent and community input processes, it is possible to ensure that the permissions settings tied to a community's Terrastories map reflect the request of both users and the community guidelines established by the broader community. This means permissions may exist in layers, where the single user has control to establish permissions settings that reflect their individual needs first. This is then followed by the broader settings guided through community consultation and agreement.

### ***9.2.5 Legal Ethics (Specific to a Country or Region)***

Legal ethics refer to a country's or government's ethical considerations connected to data, human research participants, and copyright within a given country or region in which Terrastories is operating. Legal ethics can vary widely from place to place. Terrastories stewards work with partner communities to identify if there are legal ethics that must be considered in each region the platform is being used to collect data within. A basic example of this is adhering to a countries or provinces

copyright guidelines for materials or stories (images, documents, oral stories) that are loaded into the Terrastories platform.

### ***9.2.6 Ethics Connected to Research within Academic Settings***

In some instances, Terrastories use cases have involved partnerships with academic institutions. In such cases, Terrastories projects must also consider the partnering university's ethical requirements for research or data collection with human participants. This is typically assessed through institutional Research Ethics Boards (REBs). Ethical considerations and associated applications are led by project leads who act on behalf of the university (or other academic institution). Notably, in Canada, most government-sponsored research grants require adherence to the Government of Canada's Tri-Council Policy Statement (TCPS2), specifically Chap. 8: Research Involving the First Nations, Inuit, and Metis Peoples of Canada. Review of these guidelines and best practices should be done prior to submitting ethics applications (community or institutional).

## **9.3 Costs**

The Terrastories application is free and open source. However, depending on where you use or host Terrastories, there may be hardware or server costs associated with Terrastories.

### ***9.3.1 Online Hosting***

If you set up your own Terrastories server online, you will be responsible for cloud storage and data service costs. The total cost of this will largely be determined by the size of the media content uploaded to Terrastories, and your data service package. However, this may not need to be very expensive.

For storage, the costs are very low. At the time of writing, AWS S3 Standard costs \$0.023 per gigabyte per month. If the video files uploaded to Terrastories are compressed for web viewing, this is likely to be a very small amount even when considering hours of video footage, only several cents per month.

For data services, the costs vary depending on your needs. At the time of writing, for serving the application using Heroku, there is a free tier that can support several users running the application concurrently and goes into sleep mode after 30 min of inactivity. There is also a hobby tier that costs \$7 per month and can serve numerous users concurrently, never goes to sleep, can support an SSL certificate, and can be hosted on your own domain.

For the online background map, Terrastories uses [Mapbox.com](https://www.mapbox.com), and usage is therefore subject to their pay-as-you-go pricing scheme. At the time of writing, Mapbox has a generous free tier that permits 50,000 monthly loads; afterward, the costs start to accrue at \$5.00 per 1000 loads (see Chap. 2: Mapbox, Sect. 2.3: Costs, pg. 23).

It is recommended to consider the long-term hosting costs for online hosting and set aside funding accordingly. How long (i.e., how many years) do you anticipate for your Terrastories server to be available online? How much might your Terrastories server grow with file content in that time?

Terrastories as a volunteer organization also has their own server available for Indigenous and other local communities to utilize freely. However, if a community wishes to host their own server (i.e., for reasons of data sovereignty), the Terrastories team has guides available that detail how to go about doing so on the website <https://terrastories.app>.

### 9.3.2 Offline Hosting

If you set up Terrastories offline, there will be costs associated with hardware. You can install Terrastories on a local computer, which means that the costs will be the unit price of that computer. You can also install Terrastories as a “Field Kit”, or a mini-computer that automatically generates a Wi-Fi hotspot through which other devices can load Terrastories.

At the time of writing, the following equipment is recommended for a “Field Kit” setup:

- Intel NUC i7 Performance-G Kit (NUC8i7HVK): \$819 (see Fig. 9.2)
- RAM for Intel NUC i7: \$73
- Internal SSD Hard Drive for Intel NUC i7: \$88

You may also want to supply a beamer, speakers, keyboard, and mouse if you want to project Terrastories from the minicomputer during a collective workshop setting. For more information, the Terrastories team has guides available that detail how to go about doing so on the website <https://terrastories.app>.



**Fig. 9.2** An Intel NUC i7 minicomputer used for hosting Terrastories offline

### 9.3.3 *Other Costs*

Most communities using Terrastories do not already have their maps and recordings of oral histories ready to be uploaded and published. You may therefore want to consider other costs relating to an oral histories mapping project, such as:

- Equipment for mapping and recording
- Compensation (i.e., incentives or honorariums) or stipends for community members or the project team
- Logistical costs for travel and workshops
- Software for cartography and media editing/production

On the Earth Defenders Toolkit platform, there is a case study of a community in Suriname called the Matawai that built an oral histories mapping project around the use of Terrastories with support from the Amazon Conservation Team. In this case study, some of these other costs are named. The following guide can therefore also be useful as an insightful cost reference.

Matawai: Place-based Storytelling in Suriname – <https://www.earthdefenderstoolkit.com/community/place-based-storytelling-with-the-matawai-in-suriname/>

## 9.4 Technical Level

Terrastories has been directly co-created with Indigenous communities with limited experience working with digital technologies; therefore, it has been intentionally developed to require a very low level of technological literacy to use. By design, there are not a lot of options or tools built into Terrastories. This enables the tool to be easy-to-use and prioritizes its functionality to be effective at one primary task – namely, the visualization of how stories or other multimedia content relate to places on a map. The primary task is complemented by several simple secondary tasks or features, including the maintenance of a database of stories, places, and speakers, and deciding who has access to the data.

### 9.4.1 *Front-End: Using and Administering a Terrastories Community*

Interacting with the Terrastories map and sidebar of stories does not require any technical skills and can be demonstrated to non-technical users with ease on both mobile and desktop platforms. Building, editing, and maintaining the Terrastories database, along with setting up user and story permissions, can both be done using the Administrative Menu (see Sect. 9.7: Data Privacy, pg. 202) and does not require any technical capacity. However, this latter task may require users to consider and

implement several best practices around ensuring that the database does not become unwieldy, or accidentally granting permissions to restricted stories for users who should not have that heightened level of access.

There is one slightly technical aspect to working with the administrative back-end – namely, that places are put on the map using latitude and longitude coordinates in a decimal degree’s format. Currently, a user must enter those manually into a field, rather than being provided with a user interface to “pin” the stories directly on the map. This has caused some issues for users who either (a) do not have a way to access location coordinates, or (b) have them in a different format such as degrees, minutes, and seconds (DMS), or a projected Universal Transverse Mercator (UTM) format.

### 9.4.2 *Back-End: Setting Up Terrastories*

Setting up Terrastories for a community may require some expertise and external support. There are several components to consider here.

- *Cartography.* A major feature of Terrastories is the interactive map on which the storied places are populated. This interactive map can be customized according to community needs and can be served via Mapbox Studio or any other tileserver that works with Mapbox GL (such as TileServer GL). If you need to customize your map, or use a map offline, somebody with cartography and geographic information system (GIS) skills needs to help create and style the map and ensure that it is accessible wherever Terrastories is being hosted.
- *Hosting.* Some technical computer skills may be required, which will vary depending on whether Terrastories is hosted online or offline. There are step-by-step directions for both online and offline setup, but they involve interacting with interfaces that may feel unfamiliar or complex to a non-technical user (e.g., Amazon Web Services, Heroku, Docker, and command line). However, anyone with a background in server administration, software development, or mesh network/offline software will be able to work with these processes, and even more advanced computer users (e.g., someone experienced in GIS) will likely be able to follow the instructions without any issue.
- *Language.* It is possible to translate Terrastories to any language, whether they are commonly spoken languages, minority languages, or Indigenous languages. A community or user can provide their own translations for all the Terrastories content, starting with an existing translation (such as English, Spanish, Portuguese, or Japanese) as a basis. You can then add that language using Terrastories’ localization tools, and it will be available as an option at the login screen (see Fig. 9.3).





Fig. 9.3 Terrastories translated in the language of the Matawai Maroons of Suriname

### 9.4.3 Training and Capacity-Building

Using Six Nations as an example, while the Ohneganos mapping project is still in its infancy, strategies for familiarizing community members with Terrastories have been successful through virtual workshops (e.g., Haldimand Tract Workshop and Indigenous Mapping Workshop 2021) and from being featured on the research program’s vodcast (i.e., Ohneganos: Let’s Talk Water). Additionally, time and resources have been dedicated to giving Ohneganos team members the technical skills needed to give community members positive experiences with the mapping application and provide further front- and back-end training. See Sect. 9.12: Brief Use Case, pg. 206 for more details.

## 9.5 Inclusiveness

By nature of its design, Terrastories functions to enable communities to map their own oral storytelling traditions, which places decisions for inclusion, distribution, and access to information on the community itself. This form of empowerment is linked to decolonizing geography and counter-mapping (Hunt & Stevenson, 2017) because Indigenous and other communities are structurally underrepresented decision-makers in dominant representations of global maps. In the case of Terrastories, these communities are instead centered as both architects and users of the maps they design and create.

For inclusion of decision-makers, and participation in decision-making processes, is determined by the interplay of the Terrastories technology and the community engaging with the software. In terms of primarily technological concerns, Terrastories will require certain technical support during processes like initial

set-up and map customization (see Sect. 9.4: Technical Level, pg. 197). However, these do not inhibit decision-makers and community leadership from participating in initiating or customizing their maps. Terrastories has been designed to be accessible on both desktop and mobile applications, as well as offline and online, which enables users to participate, adapt, and inform the map-building process without limitations based on internet access or device preference. This is a significant technological feature that addresses issues of digital divisions with respect to access to modern information and communications technologies between rich and poor regions globally, as well as rural and urban regions locally.

As a participatory mapping platform, Terrastories has been designed to encourage all community members to provide input during the map-building process and it does so in an inclusive and culturally relevant manner. The interface is user-friendly and interactive, with both auditory and visual features, and allows people without technical backgrounds to engage with the development and use of Terrastories maps. Furthermore, Terrastories can be translated into any language, including minority and Indigenous languages, ensuring that the user base in a community is not restricted by language. Accounting for language variation can also address factors like generational differences in commonly spoken languages in a community. The language feature can also serve to enhance maps for users when it is relevant to tie place-based traditional knowledge to specific linguistic names.

Lastly, decisions regarding which members of a community can directly input data and access data (when information is not entirely open access) will be autonomous decisions made by the community developing the map. For Ohneganos, Six Nations chose to have Ratikararò:roks (Story Gatherers) work with Haudenosaunee Knowledge Keepers, leaders, Elders, and other knowledge holders to record and document oral stories, sacred sites, and traditional knowledge. The level of access to the information gathered will depend on the nature of the information, which is governed by the local decision-makers leading the project.

## 9.6 Data Accuracy

Terrastories was not designed with conventional notions of ‘data accuracy’ in mind. For instance, one core function of Terrastories is to be a platform that maps the oral histories that are shared through storytelling. Stories are not often characterized as being ‘right’ or ‘wrong’, which has implications in relation to data validation, verification, and accuracy. Stories and oral histories are complex, often symbolic, and metaphorical sources of information, that may contain subjective or qualitative data reflective of the beliefs, viewpoints, and lived experiences of the individual sharing the story (Cunsolo Willox et al., 2012).

Oral stories, histories, and interactions with the environment are all examples of traditional knowledge. In the context of Indigenous communities and cultures, traditional knowledge, empirical knowledge, and spiritual knowledge make up three

core components of Indigenous Knowledge (Dei et al., 2000). Described by Daes (1994),

...the heritage of an indigenous people...[is] a complete knowledge system with its own concepts of epistemology, philosophy, and scientific and logical validity. The diverse elements of an indigenous people's heritage can only be fully learned or understood by means of the pedagogy traditionally employed by [the] peoples themselves. (pp. 2–3)

Definitions and understandings of data accuracy must therefore be reinterpreted within the context of a mapping platform that services Indigenous Knowledge about the natural world as opposed to Western Scientific environmental knowledge; the latter referring to the dominant and colonial knowledge system which typically prioritizes empirical knowledge, objective truths, and quantitative data over and above all else. For Terrastories, 'data accuracy' is better understood as the systems in place that consider if the stories and oral histories being shared are representative or in agreement with a community's general understanding of the land and culture. As noted in the excerpt by Daes (1994), systems of validity and stewardship of Indigenous Knowledge can only be understood by Indigenous Knowledge Keepers and thus are the communities' to dictate.

One example of a mechanism commonly adopted by Indigenous communities to validate knowledge transferred orally is called "relational accountability" (Wilson, 2008). Central to relational accountability is attribution – describing details about the source of the story or knowledge being shared (i.e., where, who, when etc.).

As a platform, Terrastories thus cannot (and should not) have the power to dictate the accuracy or validity of the knowledge or 'data' being shared, nor should the small group of often non-community support administrators. However, with a solid understanding of data accuracy within the context of Indigenous Knowledge, Terrastories does have systems, functions, and recommended processes in place to facilitate information screening to promote data accuracy. For instance, principally – and by design – as a decentralized knowledge platform Terrastories relies on the community to upload knowledge and information, which upholds the principle of ensuring the community (and its members) have the power to manage the information being contributed to the map. In practice, that means that, if community members have concerns with data or information that has been uploaded to the platform, they can raise their concern with the administrators and mapping support team and arrange for a dialogue to discuss the concern with the initial contributor. This way, members of the Terrastories community simultaneously act as sources of data (knowledge holders), users (learners), as well as stewards (knowledge keepers) on the platform. The Terrastories mapping community that is formulated creates an ongoing, dynamic, and recursive verification process for all information existing on the Indigenous map, which helps to materialize Terrastories core philosophy of being community-led.

Another interpretation of 'data accuracy' within the context of Terrastories is related to relevance. This interpretation does not invalidate the stories or oral histories being shared but helps to ensure the data and information contained within the stories are relevant to the goals and scope of the map, as prescribed and outlined by

the community. Depending on the nature or purpose of the Terrastories map being created, some data and information may fall outside of the map's scope. Hence, the community may decide to (perhaps temporarily) exclude some stories shared or data collected. This community-informed screening procedure is achieved through the process of manually uploading all data and information to Terrastories. Input access is restricted to the number of users delegated as Admins and Editors (see Sect. 9.7: Data Privacy, pg. 202) who, upon reviewing the content, are tasked with uploading the data and information collected based purely on relevance (i.e., the nature of content, not the content itself). Restricting input access to a small number of mapping coordinators, as well as requiring all data that is input to be screened manually, is a rigorous (though labour intensive) process that ensures quality control and quality assurance with respect to data accuracy.

To summarize, the community ownership and vetting process described earlier is a secondary validation process that takes place after the primary screening of information that occurs as a first step before information is uploaded to Terrastories. These are the systems, functions, and recommended processes in place to help ensure 'data accuracy', as reinterpreted within the context of Indigenous Knowledge.

## 9.7 Data Privacy

Indigenous communities that use Terrastories to build maps own and control the data and information that is uploaded. Terrastories was designed with Indigenous data sovereignty; free, prior, and informed consent (FPIC); and the principles of ownership, control, access, and possession (OCAP) in mind (see Sects 9.2: Ethics, pg. 193 and 9.12: Brief Use Case, pg. 206). However, many Indigenous communities do not have the digital infrastructure or technical capacity to manage the required databases and servers on their own. Due to this limitation, the administrative back-end of Terrastories has been designed to be flexible to accommodate the specific needs of the communities that Terrastories is serving.

Communities decide who can access a community space by assigning credentials to permitted individuals. In practice, these decisions are made by a body, such as a community mapping steering committee, who create user profiles (i.e., usernames and passwords) for each community member granted access to the Terrastories map (for Ohneganos, this is the Ohneganos mapping team, under the direction of the community leads). However, different levels of access and permissions are granted to users at the profile creation stage. Table 9.1 below describes the different 'roles' that can be assigned to each user and the associated permissions/restrictions (at the time of writing). In the future, it will be possible to define user permissions at a more granular level (i.e., per individual profile).

Permissions are necessary because some information uploaded to Terrastories may be privy to a small number of community members (e.g., Knowledge Keepers). Restrictions may allow (or inhibit) some users from viewing and/or editing data and information. In some circumstances, the community may decide that some

**Table 9.1** Terrastories user roles and associated permissions

Role	Description
Admin	No restrictions. Can access the <i>Administrative Menu</i> to create new user profiles and change <i>Theme</i> settings (background images, logos, custom map settings). Can add, edit, and manage all information uploaded.
Editor	Cannot access the <i>Administrative Menu</i> to create new user profiles or modify <i>Theme</i> settings (see ‘Admin’). Can add, edit, and manage all information uploaded.
Member	Cannot access the <i>Administrative Menu</i> (see ‘Admin’) or add, edit, and manage all information uploaded. Can only view data and information granted access to ‘Members’.
Viewer	Cannot access the <i>Administrative Menu</i> (see ‘Admin’) or add, edit, and manage any information uploaded. Can only view data and information granted access to ‘Viewers’. This is the most basic level of access, typically reserved for non-community members, providing access to publicly available information or data the community decides as being privy to the public.

knowledge and information is open to the public. In that case, they may either make available a general ‘Viewer’ login for the public or use a new feature in development at the time of writing, which will provide public access to the community’s space on a Terrastories server without needing to login, while still providing an option for community members to login to access information that has been hidden under various levels of restrictions.

## 9.8 Analytical Capacity

As a visualization tool for mapping oral histories or other stories about places on an interactive map, Terrastories does not have any analytical capacities, strictly speaking. Terrastories may be used in an analytical way for a participatory decision-making process; for example, by overlaying Indigenous knowledge as expressed through stories over maps that show environmental impacts to show how Indigenous landscapes are being affected by extractivism. This kind of analysis would be extrapolated by users by looking at the map, and there are no inherent analytical capabilities built into the tool. However, this speaks to the ways in which Terrastories can be used in tandem with other applications as covered in this volume – the data and maps collected and compiled as a Terrastories background map may have been produced using sophisticated analytical methodologies, in applications such as Mapeo (see Chap. 3, pg. 41), Mapbox (see Chap. 2, pg. 21), QGIS, or ArcGIS and Survey 123 (see Chap. 8, pg. 169).

There are several user tutorials, videos, and practical guides compiled on the Terrastories website on the How It Works page: <https://terrastories.app/how-it-works/>. These tutorials do not require any technical expertise, and there is a live online demo to experiment with.

## 9.9 Visualization Capacity

Once places, speakers, and stories have been added to Terrastories, they can be interacted with and sorted in several ways:

**Through the Map View** One way to access the stories is by navigating the map and clicking/pressing on storied place markers. These appear as markers on top of the interactive map. Doing so will open a popup of that place with optional items like a photo, a description, the type of place that it is, and the region where it is located. It will also filter the stories on the sidebar to only those that are associated with the place. This can be useful for users who want to start exploring the map and learning about the history associated with different areas.

**Through the Sidebar** The other main feature of the Terrastories front end, alongside the interactive map, is the sidebar where the stories are located. A user can also click/press on a story card (before or after viewing any media content), which will trigger the map to travel to the place(s) associated with the story. This can be useful for users who are interested in stories but have not yet learned where they took place.

**Using the Filters** On the sidebar, there are also filters that allow the user to sort/filter through both storied place markers on the map, and story cards in the sidebar. There are filters for speaker, region, topic, community, and type of place. These all function similarly – for example, you may use the speaker filter if you only want to view the stories shared by one speaker, and any places associated with those stories. Or you may choose to filter stories/places by type of place. All these filters will utilize the metadata provided by the community, and can therefore reflect community knowledge, categories, and taxonomies for how they think about stories and places. An Indigenous community may choose to have their own worldview and cosmology reflected in how they categorize types of places, opting for both natural categories (such as river, rapid, mountain) and cultural categories (such as specific categories of sacred or spiritual sites).

For Terrastories users with permissions to access a community’s administrative back-end (see Fig. 9.4), they may also filter through the community data by Speaker, Story, and Place and there are search options available to help them find particular data.

## 9.10 Openness

Terrastories utilizes the MIT Open Source License (<https://opensource.org/licenses/MIT>).

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the “Software”), to deal in the

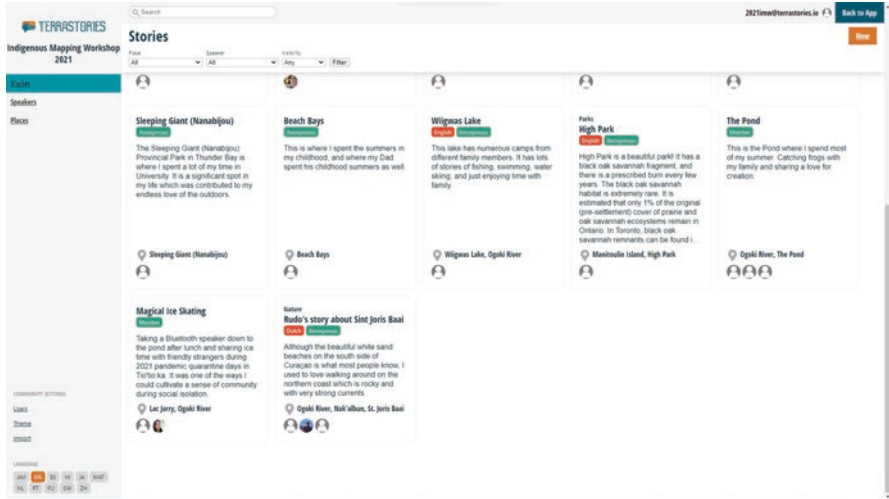


Fig. 9.4 Screenshot from the administrative menu of Terrastories used by a technical session at the 2021 Indigenous Mapping Workshop (November 2, 2021)

Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

As an entirely open-source application, Terrastories can be hosted on your own server, or hosted offline. Terrastories is built in alignment with principles of Indigenous data sovereignty, which in terms of hosting means that the data can be stored in a location of your choice.

Exporting or backing up data will depend on the hosting environment. Some environments (like AWS/Heroku) allow for easy and regularly scheduled backing up of data. It is also possible to do an export of the whole Terrastories database via Rails, but this is a more technical task. Terrastories developers are planning on having an export option made available from within the Terrastories user interface sometime in the future. It is, however, already possible to batch import data into Terrastories from within the user interface.

For more information on the technology stack architecture of Terrastories, see Fig. 9.5.

### 9.11 Accessibility

Terrastories is an offline-first application, which means that it can be hosted online or offline entirely without any limitations of core functionality. As a web application, Terrastories can be loaded onto any platform (Mobile, Microsoft Windows,

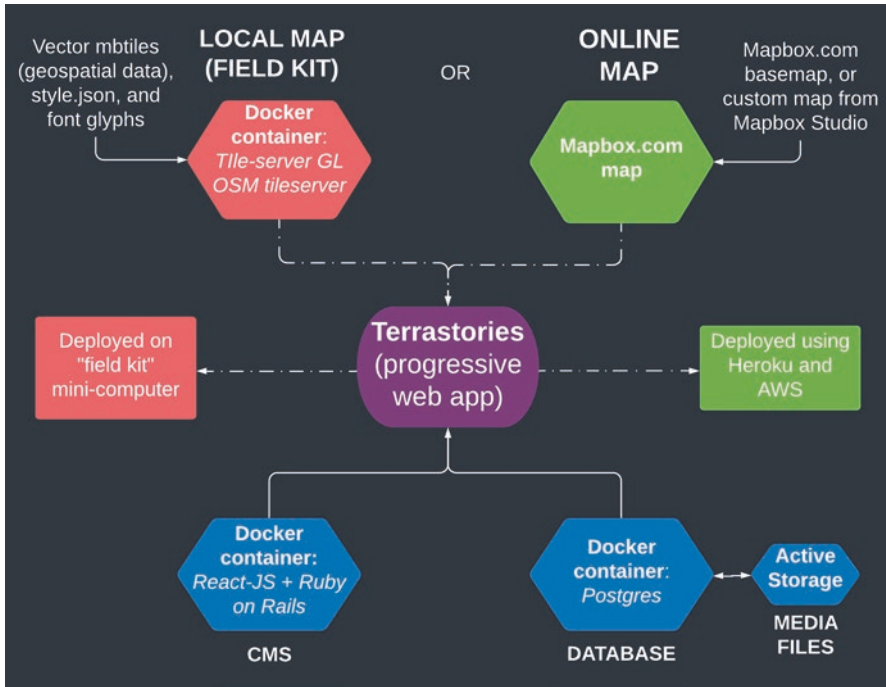


Fig. 9.5 Terrastories technology stack architecture (as of June 2020)

Mac, Linux), and the application is designed to be responsive, meaning it will render well on any platform including mobile phone (see Fig. 9.6).

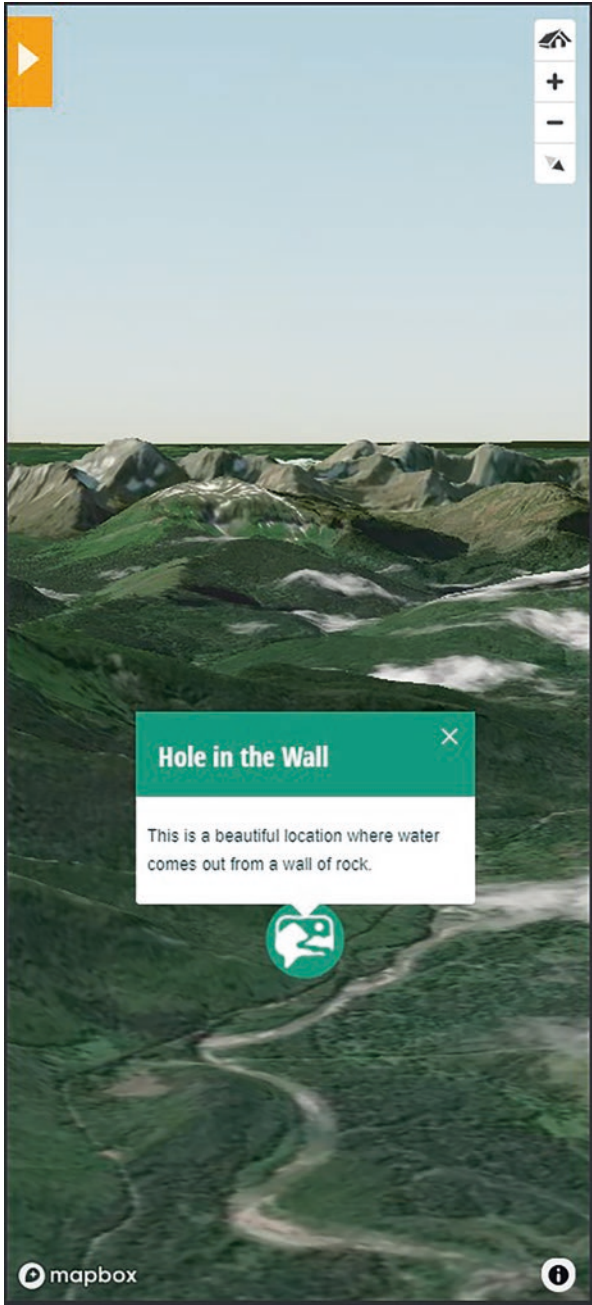
The application can be translated into any language, and text content is relatively minimal to allow the maps and media recordings to serve as most of the interface. At the time of writing, a near-term roadmap objective is to provide a place name pronunciation option where users can upload a recording of somebody pronouncing a place name out loud.

## 9.12 Brief Use Case

In Winter 2020, Ohneganos Ohnegahdę:gyo approached the Terrastories Stewards Team – a volunteer team composed of open-source developers and community engagement facilitators – seeking to use the Terrastories platform as a decolonial research tool that could support the broader goals of Ohneganos (see <https://www.ohneganos.com/>).

Ohneganos is a research program comprising two subprojects, Co-Creation of Indigenous Water Quality Tools and Ohneganos – Indigenous Ecological Knowledge, Training, and Co-Creation of Mixed-Method Tools. With the support of





**Fig. 9.6** Screenshot from mobile view of Terrastories used during a technical session at the 2021 Indigenous Mapping Workshop (November 2, 2021)

Six Nations Elders and Indigenous and non-Indigenous academics, both project teams connect scientific water testing and measurements to Traditional Ecological Knowledge (TEK) and Indigenous oral traditions about the lands and waters at Six Nations. Collectively, the community-led projects conduct research from the perspective of acknowledging and embracing the culturally relevant spiritual, social, and ecological significance of the lands that support the community of Six Nations (Kemper, 2018). Within this context, the Terrastories platform (and other complementary tools, such as Mapeo), support Ohneganos and the community of Six Nations in the decolonization and Indigenization of their geospatial water data. Terrastories facilitates the community's ability to layer this data with oral stories and sites of significance that are vital to the community's well-being (Kemper, 2018).

### ***9.12.1 Living Archive of Haudenosaunee Knowledge***

Digitizing Indigenous maps help to make them more engaging, interactive, and allows for them to reach a wider audience. The Terrastories digital map being developed by Six Nations will become a key component of the Ohneganos data platform and learning portal. Information that will be included in the map may include historic, sacred, or cultural sites of significance; changes in habitat and animal movement patterns; current locations (and historical changes) of culturally and/or ecologically significant plant and animal species (including extinctions such as pawpaw trees, Indigenous bees, fungi, etc.); and various other environmental data and ecological indicators. Importantly, all data will be tied to Indigenous place-names for land areas and water features. The data may be quantitative or qualitative geospatial data and, as a result, has been (and will continue to be) collected in a variety of ways, including through oral storytelling (i.e., open-ended interviews), by searching through secondary data and existing public and community resources, and through primary research being conducted by Ohneganos.

The Indigenous place-names that will be researched place emphasis on the semantic conceptualizations of the local landscape and waters, which demonstrate deep cultural ties to geographic location by connecting language, history, and spirituality. A descriptive placename and its meaning, together with its spatial conception, can become the context for 'knowing and learning' and ensures the Indigenous language is meaningfully connecting people to ecological ways of being. All of the data tied to Indigenous placenames helps to preserve Indigenous Knowledge for future generations. Therefore, in addition to producing an Indigenous map, the practice of Indigenous mapping has been an excellent learning opportunity for our project partners and the Indigenous youth that are participating. This supports the project's overall objectives of providing Indigenous Knowledge training, developing interactive educational resources, and promoting capacity building by fostering youth engagement and developing academic accreditation pathways.

### ***9.12.2 Ohneganos Mapping Team Structure***

The Ohneganos mapping team is overseen by the research program’s Principal Investigator, Dr. Dawn Martin Hill, and led by the Ohneganos Community Mapping Facilitator, Christopher Martin. Rudo Kemper, a Lead of Mapping and Earth Defenders Toolkit at Digital Democracy, is a Terrastories expert who has been hired to serve as a Project Advisor to support the implementation of Terrastories for Ohneganos and Six Nations.

### ***9.12.3 Ethical Considerations***

Ohneganos addresses ethical concerns associated with the use of Terrastories through implementation of best practices and innovative solutions. Five strategies used by Ohneganos are listed and described below:

- Community-led Research
- Indigenous Data Sovereignty
- Ratiká:raton’s (Storytellers) & Ratikararò:roks (Story Gatherers)
- Ownership, Control, Access, and Possession (OCAP)
- Credits and Attribution Licenses

#### **Community-Led Research**

The Ohneganos Terrastories project at Six Nations was initiated by the endorsement and support of the Haudenosaunee Confederacy Chiefs Council (HCCC). The HCCC has provided direction for the project, including identifying what local and historical knowledge exists about local landscapes, and what local and Indigenous Knowledge should be mapped to contribute towards Indigenous sovereignty, cultural revitalization, and climate resiliency. As the Terrastories project continues to develop at Six Nations, the formation of an Indigenous community-led Advisory Group composed of Haudenosaunee Elders, Knowledge Keepers, and Leaders could further guide the direction of the mapping at a more granular level. This group would help provide feedback on an ongoing basis and direct the focus of the Terrastories data collection at Six Nations. For instance, by identifying what types of knowledge is integral to incorporate into the platform (helping to define the scope), and how the data will be managed and curated throughout the project and after the project ends (and by whom).

Future community input will range from Haudnosaunee Elders, Knowledge Keepers, and Leaders, to Six Nations youth and other community members in Six Nations. For example, while Elders, Knowledge Keepers, and Leaders can provide central guiding considerations, oral histories, and other knowledge, Indigenous youth – such as students at the local language immersion school, Kawenní:io/ Gawęń:yo – can provide input into Terrastories mapping by engaging in technical

training, embedding stories, and inputting ecological data. Community input must be undertaken in systematic conjunction with practices of continual consent.

### **Indigenous Data Sovereignty**

The Terrastories community at Six Nations is protected using server/domain credentials. Administrators uploading knowledge into the platform can make data publicly available or restrict its availability by assigning restrictions/permissions, rendering the information only accessible by user credentials with a heightened level of access. To protect data entered and shared within the Terrastories platform, the Ohneganos mapping team will support the project's leadership (e.g., the Advisory Group) in establishing their own series of user restrictions. This system ensures the data remains protected while also enabling all community members of Six Nations to access their cultural knowledge via the Terrastories application from anywhere in the world, at any time.

For the Ohneganos project, all data entered directly into the Terrastories platform is hosted on a Terrastories AWS S3 Cloud bucket, physically located in Columbus, Ohio. In addition, data is stored with McMaster University in Hamilton and with the Ohneganos Team's Google Drive. Eventually, through community consultation, the data connected to the Terrastories project at Six Nations will be fully hosted by the Six Nations of the Grand River community within a community-selected and governed digital repository. As the project evolves, the data will be centralized to ensure the community of Six Nations retains complete control over their intellectual property.

### **Ratiká:raton's (Storytellers) & Ratikararò:roks (Story Gatherers)**

For Ohneganos, the Speaker function (or input category) in Terrastories (as described in Sect. 9.1: General Information, pg. 190) is very important because it credits the Knowledge that is being given to us from the Ratiká:raton's (Storyteller). This helps ensure 'data accuracy' through relational accountability (see Sect. 9.6. Data Accuracy, pg. 200).

Those engaging with the Ratiká:raton's, the Ratikararò:roks, are also an essential and integral part of the Ohneganos Terrastories project at Six Nations. Ratikararò:roks are involved in listening, recording, documenting, collecting, and mapping a wide array of stories and information about Traditional Ecological Knowledge tied to the people, lands, and waters at Six Nations. Importantly, Indigenous community members participating in the project as Ratikararò:roks consider a series of culturally-based ethics and research protocols as a component of their role in the project.

To ensure both Ratikararò:roks and Ratiká:raton's feel safe, respected, informed, and protected while participating in knowledge sharing, the Ohneganos mapping team put together a document titled: A Ratikararò:roks Training Guide for the Stewardship of Haudenosaunee Ecological Knowledge. The training guide introduces the project and a series of culturally relevant ethical, cultural, and spiritual guidelines unique to the Haudenosaunee and Six Nations Ratikararò:roks.

The guide identifies the following nine principles, which all act as vital ethical considerations for Ratikarà:roks, as well as any community member engaging with Terrastories at Six Nations:

- Cosmology and Traditional Law
- Language
- Integrity & Honesty
- Respect
- Reciprocity
- Quality of life
- Protection of Indigenous Knowledge
- Acknowledgement of Traditional Protocols
- Intent

*Ratikarà:roks* (Story Gatherers) and all community members who use Terrastories at Six Nations are asked to engage these principals when documenting knowledge about the community of Six Nations through the application. The training guide, which outlines the principals in greater detail, is available for free through the Ohneganos project website (see <https://www.ohneganos.com/indigenous-mapping>).

### **Ownership, Control, Access, and Possession (OCAP)**

All stories and data gathered at Six Nations from Ratiká:raton’s (Storytellers), community members, and project participants for use in the Terrastories map are protected under the principles and guidelines of The First Nations Principles of Ownership, Control, Access, and Possession (OCAP) (Schnarch, 2004).

OCAP refers to rules for how First Nations<sup>2</sup> data and information can be collected, used, shared, or stored. OCAP acts as a resource to help Indigenous communities navigate sovereignty over their data and govern the information they provide or collect for research or projects about their communities, Nations, or Peoples (FNIGC, 2021). OCAP asserts that Indigenous communities own all data and control any data collection processes in their communities, especially those concerning their cultural knowledge (FNIGC, 2021). They alone have the right to decide how this information is disseminated, shared, and who has access. Lastly, possession refers to the data being physically stored on servers within communities. Currently, the Ohneganos Terrastories mapping team is in the planning stages of navigating project needs in relation to OCAP (see Indigenous Data Sovereignty, pg. 204).

### **Credits and Attribution Licenses**

In the context of Ohneganos, Terrastories will also provide opportunity for Ratiká:raton’s (Storytellers) to apply creative commons licensing to their posts or

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<sup>2</sup>In Section 35 of the consolidated Constitution Act of 1982, Canada legally groups Indigenous people into three broad categories. As per Section 35.(2), “In this Act ‘aboriginal peoples of Canada’ includes Indian, Inuit, and Metis Peoples of Canada” (Government of Canada, 2013). The “Indian” category is now commonly referred to as “First Nations”.

traditional knowledge (TK) licensing as a component of credit attribution. TK contributed to the project will follow the TK Licenses concept, where appropriate. TK Licenses are based upon Creative Commons licensing (see <https://localcontexts.org/licenses/traditional-knowledge-licenses/>). Where TK licensing is not appropriate, Creative Commons attribution will be applied (see <https://creativecommons.org/licenses/>). This form of licensing allows Ratiká:raton's (Storytellers) to indicate how their data and stories can be used and by whom. TK licensing provides a mechanism for granting culturally relevant attribution to contributed data and stories. This process within the Ohneganos Terrastories project is still unfolding and will be guided by the individuals who are contributing data to the project in partnership with project stewards, project advisors, and the community of Six Nations.

#### ***9.12.4 Training and Capacity Building***

Terrastories does not require a high degree of technical literacy to use (see Sect. 9.4: Technical Level, pg. 198). However, as a participatory mapping software, it does require collaboration and community buy-in, direction, and engagement. Additionally, to make best use of Terrastories, it is important to have a solid understanding of the social and environmental issues that drive the Terrastories guiding philosophy. Thus, education and capacity building is required to help familiarize communities with Terrastories. Some of the preparation work that has been performed by Ohneganos to-date has been offered in the form of the following four workshops:

- Kawenní:io/Gawení:yo Workshop and Youth Training
- Haldimand Tract Workshop
- 'Train the Trainers' Workshop
- Indigenous Mapping Workshop (IMW2021)

For more information about these workshops, visit <https://www.ohneganos.com/>.

#### ***9.12.5 Mapping and Data Collection Methodologies***

Introduced earlier, one of the ways in which community members have been engaged in the project is through Ratikararò:roks (Story Gatherers) talking and exchanging knowledge and resources with Ratiká:raton's (Storytellers). To address ethics considerations, all participants are asked to provide written or oral consent before sharing their knowledge (see Sect. 9.2: Ethics, pg. 193). In terms of how this knowledge may be shared, several effective methods have been applied to gathering community knowledge, stories and resources.

One of these methods is through simple one-on-one conversations. The Ratiká:raton’s (Storytellers) share their perspectives during a recorded interview which is then assessed for relevance by the Community Mapping Facilitator (i.e., the Ohneganos lead Administrator) and suitable components are then embedded into the Terrastories map (see Sect. 9.6: Data Accuracy, pg. 200). Aspects of the interview may be transcribed to text or kept as audio or video files. In either case, the knowledge is referenced to locations using Terrastories. As noted, the Ratiká:raton’s (Storyteller) is credited through the Speaker feature on Terrastories.

Another method of accessing knowledge is through receiving resources (e.g., physical or digital data or files) from Ratiká:raton’s (Storytellers) to embed into Terrastories (see Fig. 9.7). These resources may contain stories, historical knowledge, and or any other type of relevant data.

A final method proven to be effective at gathering data for Terrastories is the Firelight Group’s Direct-to-Digital method. Using this data collection methodology, Ratikararò:roks (Story Gatherers) and Ratiká:raton’s (Storytellers) use a digital map to place information on a map together and in real-time. Readily accessible mapping programs such as Mapeo or Google Earth can be used as a visual aid to help prompt the memories of Ratiká:raton’s (Storytellers) and can be pinned and described at the time of discussion for review and input into Terrastories at a later time. For a detailed description of the Firelight Group’s Direct-to-Digital method, see [https://firelight.ca/wp-content/uploads/2016/04/Guide\\_FirelightGroup\\_DirectToDigital\\_20JAN2016.pdf](https://firelight.ca/wp-content/uploads/2016/04/Guide_FirelightGroup_DirectToDigital_20JAN2016.pdf).



Fig. 9.7 Screenshot from Terrastories used by Ohneganos to map Haudenosaunee traditional knowledge and information around the Six Nations of the Grand River reserve

## 9.13 Comments and Recommendations

The following six recommendations offer advice, suggestions, and insights for anyone considering using Terrastories for the purposes of Indigenous map-building. These important reflections, derived from implementing Terrastories in practice, are lessons learned from the Ohneganos mapping team.

### ***9.13.1 Focus on Learning About Implementing Terrastories, How to Use the Tool Is Easy***

Terrastories is a relatively uncomplicated software that has been carefully designed to incorporate important nuances that address unique ideas surrounding Indigenous ethics, Indigenous Knowledge, and Indigenous sovereignty. It is not a highly technical or esoteric software to use (by design), but it does require a solid understanding of social and environmental issues within the context of Indigenous communities in order for users who may be supporting partner communities to take the right approach following inclusive and participatory methodologies. As such, it is recommended for users of Terrastories to become familiar with issues related to social and environmental justice within the context of Indigenous issues. A solid knowledge base in these areas is necessary to understand the various goals of Terrastories, what it is trying to achieve, and, therefore, how to use it properly and as intended.

### ***9.13.2 Terrastories Is Primarily a Data Visualization Tool, Not a Data Collection Tool***

The primary purpose of Terrastories is to visualize stories about places on an interactive map. Depending on your use case, you may first need to start by putting together the background map that is used by Terrastories. For some use cases, a publicly available basemap such as OpenStreetMap or Mapbox Satellite is sufficient, but for many communities (especially Indigenous communities), it is important to show a custom map that shows the territory from *their* point of view, with landmarks and place names not found on publicly available maps. The creation of a custom map involves tools and processes outside of Terrastories. If data needs to be collected or mapped, a tool such as Mapeo or QGIS could be suitable. If you already have data and need to design a custom map, Mapbox Studio will allow you to do that. Similarly, for gathering and preparing information such as recordings of oral histories, this will need to take place outside of Terrastories, and it may be beneficial to have a process for storing, editing, and organizing multimedia content using other tools as well.



### ***9.13.3 Carefully Plan How to Gather, Add, and Manage Data***

To accommodate a wide range of approaches in how stories are shared by communities across the world, Terrastories is designed to be very flexible in structuring the Speakers, Places, and Stories data. A Place can have numerous Stories, so that more than one community member can add their own story, which may be unique or a different version of an existing story. Similarly, a Story can be related to multiple Places, and can have multiple Speakers. Depending on the community and use case, it may make sense to utilize a particular structure; for example, limiting stories to only have one speaker. It is up to you to implement this, and so it is good practice to consider how you want your Terrastories data to be structured in advance of starting a project, so you know what kind of data to collect and how to facilitate information gathering with the community.

### ***9.13.4 Ethics Are Central, and Ongoing***

Plan out how you are going to engage and address ethical considerations from the onset; the underlying concepts behind the ethics are complicated and can be difficult to implement in practice. We recommend taking time to do this in advance of moving forward on a community-led mapping project to avoid ethics concerns or complications while the project is in operation. Much of this work relies on the participation, interest, and enthusiasm of the community leading the project and obstacles or roadblocks (such as ones arising from unresolved ethical issues) can significantly derail momentum that accumulates during the map-building process.

### ***9.13.5 Plan for Safekeeping Your Data for the Long Term, in a Responsible Way***

When working with Terrastories, you will likely be gathering invaluable community stories and data, so we recommend having a solid plan for safekeeping that information on a very long-term basis and taking into consideration protocols for protection and data sovereignty (e.g., OCAP). While Terrastories is an excellent medium for visualizing recordings of place-based oral histories, it is not recommended to consider Terrastories as the primary repository where those recordings are kept. Instead, we recommend working with an archival entity that is well-equipped for setting up an archive where these recordings are stored indefinitely, who then work in accordance with your protocols for data protection, sovereignty, and permissions. For Indigenous data, a member institute of the Digital Endangered Languages and Musics Archives Network (DELAMAN) may be an appropriate entity to collaborate with, or there could be a local archive that is familiar with specific community

protocols. Regardless of where you host Terrastories (e.g., online or offline), you should always have a backup of the data somewhere where it is not likely to be compromised or lost.

### **9.13.6 Information Gathering Is the Greatest Challenge: Be Innovative**

Collecting data and information for Terrastories takes time and involves human interaction. Developing relationships is key that often requires interacting with community members, especially when Terrastories has a central map-building team. Working during the COVID-19 pandemic was a major obstacle the Ohneganos mapping team had to overcome. Employing data collection methodologies in a virtual space, such as over video conferencing software, was one way the team was able to collect data for Terrastories while abiding by public health restrictions. Such strategies may also be useful for map-builders working with remote communities. Social media is also an effective way to communicate and recruit community members to the project. As a participatory mapping software heavily reliant on community engagement - the more outreach, the better. Ultimately, there are lots of opportunities for new ideas; work with communities to identify methods and approaches.

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