Digital Innovation with miniSASS, a Citizen Science Biomonitoring Tool

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Date
27/10/2023

Work package
Work package 3

Partners

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Digital Innovation with the Citizen Science Biomonitoring Tool miniSASS

Abstract

The mini stream assessment scoring system (miniSASS) was developed as a citizen science biomonitoring tool for assessing the water quality and health of stream and river systems. A miniSASS survey involves sampling the aquatic macroinvertebrate community in a stream or river reach and using the known sensitivities and tolerances of the taxa present to infer information about the water quality and health of the stream or river. The quality of the outcomes of a miniSASS survey is dependent on good sampling technique and accurate identification of aquatic macroinvertebrates by low-skilled citizen scientists. As such, there is potential for errors in sampling and identification which may impact the accuracy of results. In response, we aimed to 1) develop a smartphone application (miniSASS mobile app with built-in machine learning (ML) algorithm for the automatic, real-time identification of aquatic macroinvertebrates) to assist in miniSASS surveys, 2) modernise and upgrade the miniSASS website to handle new data submissions (including photographs) and improve the user interface (UI), and 3) develop an online miniSASS training course. This report presents the methodology and preliminary results pertaining to these objectives.
Introduction

The CGIAR Initiative on Digital Innovation and miniSASS

The Digital Innovation and Transformation project (DXI) seeks to harness digital technologies for timely decision making across food, land, and water systems. GroundTruth\(^1\), in conjunction with CGIAR and International Water Management Institute (IWMI) staff, have engaged in a project to, *inter alia*, develop and integrate digital innovations with the mini stream assessment scoring system (miniSASS). MiniSASS is a simple and accessible citizen science biomonitering tool for assessing the water quality and health of streams and rivers (Graham et al. 2004). The miniSASS concept was developed in South Africa, based specifically on the South African Scoring System (SASS) versions 4 and 5 (Dickens and Graham 2002; Graham et al. 2004). Like SASS5, a miniSASS stream or river health assessment relies on inferring ecological condition based on the established relationships aquatic macroinvertebrates share with the condition of their environment (e.g., Dickens and Graham 2002; Morse et al. 2007; Paisley et al. 2014; Odountan et al. 2019; Ndatimana et al. 2023). Essentially, different aquatic macroinvertebrates have different sensitivities to, or tolerance levels for, disturbance (e.g., via pollution or invasion by alien species) in their habitat. As a result, the macroinvertebrate community composition within a stream or river is an excellent indicator of the water quality and health of a stream or river (Alhejoj et al. 2014; Ndatimana et al. 2023). Healthy streams and rivers with good water quality will be typified by sensitive species which would be removed by disturbance, while poor quality,

\(^1\) [http://www.groundtruth.co.za/](http://www.groundtruth.co.za/)
unhealthy streams and rivers will be characterised by an absence of sensitive species and a dominance of species tolerant of disturbance (Dickens and Graham 2002; Palmer and Taylor 2004).

The need for digital innovation with miniSASS

MiniSASS samples the macroinvertebrate community (identified to Order level groupings allowing for easy identification by citizen scientists) in a river reach (Graham et al. 2004). The taxon-specific pollution and disturbance tolerances are then used to generate a stream or river health index (Graham et al. 2004). In a 2018 assessment of the suite of citizen science water resource monitoring tools used in South Africa, miniSASS was identified as the most promising for broader use in water quality monitoring (Graham and Taylor 2018). This recognition was based on it being a relatively easy technique to use, especially low-cost, and that there is no requirement for laboratory analyses – the results are developed in-field, real-time (Taylor et al. 2022). The potential of miniSASS was also recently recognised by the United Nations committee responsible for Sustainable Development Goal (SDG) 6 on Water, which is exploring the use of miniSASS for reporting on progress towards SDG 6.3.2 and SDG 6b. MiniSASS is featured in the current progress report for indicator 6.3.2 - Progress on Ambient Water Quality Global Indicator 6.3.2 Updates and Acceleration Needs - 2021. This recognition and endorsement by the UN highlights the synergy between the aims of the DXI and the SDGs.

However, despite its potential, miniSASS still has some drawbacks that limits its global utility and full integration into the range of tools available to gather data for SDG6 reporting. As miniSASS currently stands, the information from a miniSASS survey relies heavily on adequate sampling technique and the accurate identification of aquatic macroinvertebrates to Order (or Order-level groupings) level by low skilled (minimally trained) citizen scientists. This leaves potential for errors in both sampling and identification, which may impact the accuracy, validity, and reliability of the river health assessment. As with most citizen science, questions over data validity and reliability pose a huge challenge to having the data used for management or policy (Balázs et al. 2021). Citizen science is still broadly viewed with scepticism in terms of the utility and trustworthiness of the data it generates (Cohn 2008; Bonney et al. 2009; Kolok et al. 2011; Cook et al. 2021). The reality is that the data generated by citizen science must be considered high quality, trustworthy and legitimate if they are going to be used in natural resource management and policy (Buytaert et al. 2014; Hulbert et al. 2019; Arndt et al. 2022).

To attempt to address any reservations about miniSASS data validity, GroundTruth engaged with the CGIAR, IWMI, Amazon Web Services (AWS), the United Nations Children's Fund (UNICEF), and North-West University (NWU), in research and development of 1) a miniSASS smartphone application (app) with built in machine-learning (ML) for identification of macroinvertebrates, 2) an upgrade to the miniSASS website\(^3\) to streamline user interaction and enable capture of more complex and comprehensive data from

\(^3\) [https://minisass.org/en/](https://minisass.org/en/)
miniSASS assessments, and 3) an online, interactive course for miniSASS to educate and train miniSASS practitioners. Combined, these aims work towards the broad objective of digitally innovating and upgrading the entire miniSASS process, including training, surveying, identification, and data handling and visualization, so that verified miniSASS data can be collected and used with greater reliability. Ultimately, these developments aim to give miniSASS the credibility and reliability required to enable its use for water resource monitoring throughout Southern Africa, and even globally.

Methods

MiniSASS app creation

Macroinvertebrate photographic database creation
The process of app development required collection of images of aquatic macroinvertebrate specimens from all 13 miniSASS macroinvertebrate groups: 1) flat worms, 2) worms, 3) leeches, 4) crabs and shrimps, 5) stoneflies, 6) minnow mayflies, 7) other mayflies, 8) damselflies, 9) dragonflies, 10) bugs or beetles, 11) caddisflies (cased and uncased), 12) true flies, and 13) snails. Thirteen sites, 6 sites in the North-West (NW) and 7 sites in Kwa-Zulu Natal (KZN) Provinces, South Africa, were sampled exhaustively to obtain images for all 13 MiniSASS groups (Table 1). Sites were sampled using standard miniSASS techniques, modified by sampling for a greater period to thoroughly sample the study area (for details, see Graham et al. 2004 and Pattinson et al. 2022). The images were used to create a database that could train an artificial intelligence (AI) machine-learning (ML) identification algorithm.
Table 1. Table of the sites sampled for macroinvertebrates within the mini stream scoring assessment system (miniSASS) groupings. Site name, global positioning system (GPS) coordinates, a site description (including a subjective water quality measure), miniSASS groups sampled at the site, and the biotopes available for sampling (vegetation = VEG; gravel, sand, & mud = GSM; stone out of current = SOC; stones in current = SIC) are shown.

<table>
<thead>
<tr>
<th>Site name</th>
<th>Location</th>
<th>Site description</th>
<th>Macroinvertebrate groups sampled</th>
<th>Biotopes sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Mooi River</td>
<td>-26.68053, 27.0986</td>
<td>Medium depth, wide channel present with abundant riparian vegetation. Water quality moderate.</td>
<td>All groups - No stoneflies; No clams</td>
<td>VEG, SOC, GSM</td>
</tr>
<tr>
<td>S2 Mooi River</td>
<td>-26.68119, 27.09838</td>
<td>Deep, wide channel with soft sediment. Many reeds present. Water quality moderate.</td>
<td>All groups - No stoneflies; No clams</td>
<td>VEG, GSM</td>
</tr>
<tr>
<td>S3 Mooi River</td>
<td>-26.68431, 27.09954</td>
<td>Small, deep channel, slow flowing. Abundant riparian vegetation. Water quality moderate with some pollution evident.</td>
<td>All groups - Few dragonflies; No stoneflies</td>
<td>VEG, SOC, GSM</td>
</tr>
<tr>
<td>S4 Mooi River</td>
<td>-26.68558, 27.10148</td>
<td>Small, shallow stream with many boulders. High stream flow. Little to no riparian vegetation.</td>
<td>Mayflies; Bugs &amp; Beetles; Some Dragonflies</td>
<td>SIC</td>
</tr>
<tr>
<td>S5 Mooi River</td>
<td>-26.68676, 27.10341</td>
<td>Heavily shaded stream, small channel width and depth. Little riparian vegetation. Some pollution present.</td>
<td>Most Groups - No Stoneflies; Many clams</td>
<td>GSM</td>
</tr>
<tr>
<td>Location</td>
<td>Coordinates</td>
<td>Description</td>
<td>Groups</td>
<td>Vascular, Herbivorous, Carnivorous, Omnivorous</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
<td>--------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>S6 Mooi River</td>
<td>-26.6935, 27.10305</td>
<td>Site within NWU sport grounds. Many freshwater red algae. Strong current with many boulders. Some riparian vegetation.</td>
<td>All groups - No stoneflies; No clams</td>
<td>VEG, SIC, GSM</td>
</tr>
<tr>
<td>Karkloof Tributary</td>
<td>-29.30106, 30.22779</td>
<td>Pristine mountain stream, shading abundant. Shallow stream with scattered shallow pools. Some riparian vegetation.</td>
<td>All groups (mostly stoneflies)</td>
<td>VEG, SIC, GSM</td>
</tr>
<tr>
<td>Karkloof River at Spitskop</td>
<td>-29.3336, 30.2353</td>
<td>Slightly impacted site, located under bridge. Abundant riparian vegetation. Small stream with sloped channel.</td>
<td>All groups</td>
<td>VEG, SIC, GSM</td>
</tr>
<tr>
<td>uMgeni River downstream of Midmar</td>
<td>-29.49484, 30.22218</td>
<td>Large, wide channel. Mostly large boulders present. Little GSM. Some Riparian vegetation.</td>
<td>All groups - few stoneflies</td>
<td>VEG, SIC, SOC</td>
</tr>
<tr>
<td>Rietspruit</td>
<td>-29.50413, 30.26829</td>
<td>Small to medium stream, small waterfall present. High biotope diversity. Slightly impacted site. Rocky habitat.</td>
<td>All groups - no stoneflies</td>
<td>VEG, SIC, SOC, GSM</td>
</tr>
<tr>
<td>uMgeni River at uMgeni Valley Nature Reserve</td>
<td>-29.49844, 30.24635</td>
<td>Large wide channel, deep with strong flow. Many large boulders with abundant of algae. GSM abundant with many aquatic worms.</td>
<td>All groups - no stoneflies</td>
<td>VEG, SIC, SOC, GSM</td>
</tr>
<tr>
<td>Town Bush Stream</td>
<td>-29.5717, 30.35493</td>
<td>Many large boulders with abundant of algae. Little vegetation, abundant GSM.</td>
<td>All groups - Many crabs; No stoneflies</td>
<td>VEG, SIC, GSM</td>
</tr>
</tbody>
</table>
ML identification algorithm training and development

After pre-processing (i.e., cropping, sharpening, brightening, and increasing contrast; Figure 1), the database of aquatic macroinvertebrate images was refined to ~1000 images in each miniSASS group. Of these, 900 per group were used for training the ML identification algorithm over the course of 19 epochs or iterations. The ML identification algorithm uses neural networks to automatically identify and assign unique features of an image, and over repeated iterations learns the common unique traits typical of each group (Pattinson et al. 2022). After training, the model was tested on ~100 unseen images from each miniSASS group.
Figure 1 Examples of images of aquatic macroinvertebrates going through pre-processing before being used to train the machine-learning (ML) identification algorithm. Images of 1) a damselfly, 2) a minnow mayfly, and 3) a stonefly, prior to pre-processing (A, left column) and after pre-processing (B, right column).

App development

Defining app requirements:

App development began with defining the requirements of the app. The primary requirements of the app were defined as:

- Navigation to main screens correlating to primary functions of the app:
  - Map screen linked to Google Maps and miniSASS sites (the same as on the miniSASS website).
- Sites screen containing a list of the sites the user has created. This will be stored as part of the user profile, which will be accessible via the website as well.
- About screen including a short blurb on miniSASS, a link to the miniSASS website, and other relevant information (e.g., training videos, miniSASS how-to guides, the miniSASS dichotomous key, and scientific papers or online articles pertaining to miniSASS).
  - MiniSASS survey site creation:
    - Site creation includes options to input site user and site data, including the site name and location, the stream / river name, type, and description, the date, the collector's name, email address, and organization, and any other notes. Options to input anecdotal data into other fields, including pH, water temperature, water clarity (as measured by a clarity tube), dissolved oxygen.
    - GPS location service to capture site location.
  - MiniSASS survey:
    - Capture photographs of aquatic macroinvertebrates.
    - Provide access to interactive dichotomous key (with photo examples) for assisting the user with identification.
    - Allow the user to identify and label photographs.
    - In the background, use the ML identification algorithm to identify and label the photos.
    - Automatic calculation of the user miniSASS score and ML miniSASS score. The user score can be based on all the groups the user lists as present, even without photographs uploaded in support of an identification. The ML score will be based on ML identification of photographs uploaded.
Upload photos, site metadata, assessment data, and miniSASS scores from the user and ML identification model, along with user metadata (acquired based on the user profile). The data can be collected offline and submitted once a WIFI connection is established.

**User research and design – beta testers**

A beta version of software contains most of the major features of the software. However, the beta version of an app can potentially contain errors and bugs. Therefore, beta versions of software are often released only to a specific group of people to conduct testing and provide feedback. The app developers can then fix any issues raised by the beta-tester feedback. After all issues are identified and fixed, the final version of the mobile application can be released. The users selected as beta-testers were people experienced with conducting miniSASS surveys. Expert miniSASS practitioners were chosen given that:

1. A beta-tester has to be able to provide high-level feedback on specific errors that may arise, maximising the efficiency of discovering and dealing with bugs / errors.
2. Expert miniSASS identification and sampling by the user are essential; the data received during beta-testing need to be accurate and trusted since they will be used for further research and decision making. The data collected during beta testing are used to assess the feasibility of automatic data validation through the comparison of the accurate (i.e., expert) user calculated score and the ML algorithm score.
3. Expert miniSASS practitioners are likely to have the best insights regarding feedback on optimum app functionality for the end-users of the finalised app, which will initially be predominantly inexperienced, novice users. Final stage beta-testing will likely incorporate novice users, to test out functionality and ease-of-use for all users going forward.
Prototyping and wireframing

Prototyping and wireframing covers creating a visual representation of the mobile application's functionality and interface. The use-cases for the mobile application largely serve as the visual representation of the functionality of the application as for the intended user. The beta-version of the mobile app was developed for Android devices; iOS devices are not supported. This minimised development and support costs, while maximising the reach and usability of the app.

Development

Android Studio⁴ was used to develop the mobile app. Predetermined use cases (based on expert knowledge of miniSASS assessments, data collection and handling) were used to create the main activities, layouts, models, and functionality. All functionality was continuously tested using the Android Studio debugging tools as the development went through its iterative stages.

Data security and privacy

All data captured by the app are safely stored in a local database on the user's device. The final version of the app will push data to the miniSASS website. These data will be encrypted and sent to the miniSASS website Application Programming Interface (API) which will receive and handle the data.

Upgrade and modernisation of the miniSASS website

GroundTruth are working with Kartoza⁵, with support from the CGIAR-IMWI and UNICEF, to upgrade, modernise, and streamline the miniSASS website, which has become outdated and lost some functionality since its launch over a decade ago. The miniSASS

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⁴ [https://developer.android.com/](https://developer.android.com/)
⁵ [https://kartoza.com/](https://kartoza.com/)
Defining requirements for website upgrade and modernisation

Beginning the website upgrade began with defining the primary objectives:

- Modernisation and streamlining, given that the old site had become outdated and suffers from a multitude of logic redundancies.
- The landing page needed easy login and user profile settings which interface with the miniSASS app, with access to an editable user profile containing the user's name, organisation, and details on all miniSASS submission records.
- Redesign of an easy, accessible platform for data entry.
- Improved data visualisation, summarisation and reporting capacities.
- The new website needed to host all the new forms of data that will be submitted, including the site photographs, the images of aquatic macroinvertebrates, and the ML identification algorithm's predicted miniSASS score.
- The map visualisation needed to be improved by opening on the user's location when they navigate to the map and simplifying the map interface to be more globally applicable. This meant that some functionality of the map interface, such as the map layer containing South Africa's schools or rivers, needed to be removed.
- Media associated with miniSASS (i.e., publications, blogs, newsletters, photos, and training and education media) needed to be easy and intuitive to access.

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6 [https://www.saiab.ac.za/](https://www.saiab.ac.za/)
• Links to other relevant pages (e.g., Pluto Learning Management System [Pluto LMS]7, which currently hosts the miniSASS training course, the miniSASS Youtube page8, miniSASS Facebook page9, and the resource on SDGs and miniSASS10).

Beyond these primary goals, some stretch goals were also outlined:

• Development of a dashboard summary on miniSASS similar to that for the Freshwater Biodiversity Information System (FBIS)11, as well as links to the relevant SDGs. This could include having the landing page carrying improved summary data, covering, for example, the number of countries with assessments, the number of miniSASS assessments submitted, statistics on miniSASS scores, and number of records within each miniSASS group, all globally and per country.

• People in control of the website being able to add miniSASS-related photos, blogs, or any other related media, as needs be.

• The website will ideally have language translation capabilities.

• Data linkages to global databases (e.g., the Global Biodiversity Information Facility [GBIF]12 or FBIS) so that the miniSASS data are openly accessible across multiple global platforms for further use in research, policy, and management.

• Method detailing how to use the data for publication.

With the goals defined, the website upgrade and modernization could begin.

8 https://www.youtube.com/@groundtruthcitizenscience
9https://www.facebook.com/p/Minisass-Mini-Stream-Assessment-Scoring-System-100075822699486/?paippy=0&eav=AfahZg0A455nc4wr-bpKQVA0gz7sqfml42RWe2nFH-dy97elWbowf2zp-GMFWhF3rw&_rdr
11 https://freshwaterbiodiversity.org/
12 https://www.gbif.org/
Research and development of miniSASS course

In parallel with the development of the miniSASS app and upgrading the miniSASS website, new miniSASS education and training media could be created and integrated into a newly designed and developed online miniSASS course.

**Defining the media content required**

GroundTruth synthesised an outline of the miniSASS education and training media required by drawing on internal experience based on having developed and run miniSASS since 2004, as well as through coordinating several meetings and workshops with personnel from the Water Research Commission (WRC), UNICEF, Yoma\(^\text{13}\), and Duzi-uMngeni Conservation Trust (DUCT). These are all users of, and stakeholders in, miniSASS in South Africa. Therefore, they had valuable inputs towards the research and development of miniSASS media. The following content was identified as the best approach to splitting up the information and training needed:

- A short summary blurb in blog, digital pamphlet, and short video format, of what miniSASS is, what it achieves, and how and why to get involved in miniSASS and citizen science water resource monitoring.
- Short instructional ‘talking heads’ video explanations of:
  
  i. The important safety aspects of carrying out a miniSASS survey,
  
  ii. How to select a miniSASS survey site within a river or stream reach,
  
  iii. How to carry out miniSASS sampling within the different biotopes or micro-habitats within the stream, and

\(^{13}\) [https://www.yoma.africa/](https://www.yoma.africa/)
iv. How to identify the macroinvertebrates sampled using the dichotomous key and generate a miniSASS score from the sample.

- A video explaining the outcomes of a miniSASS assessment covering (updated once the website is upgraded and functional to align with the process of data submission and viewing):
  - What the miniSASS results mean in terms of the ecological health of the stream, and what to do with that information (i.e., reporting to a local water authority, or uploading the data to the website manually or via the app),
  - How the images captured can be used to create a global database for demographic research,
  - How the results can be used to identify and report local water quality issues, and
  - How the results contribute to a global database for SDG reporting and scientific publication.

- A training video on how to use the app (to be developed once the app is finalised).
- A video explaining how to use the basic functions of the website, including how to upload observations and view the map (to be developed once the upgraded website is launched).

These media are initially made available in English. A stretch goal is that they may become available in other languages.

**Content creation**

The miniSASS blog summary and information brochure were created using GroundTruth and open source imagery. Filming of original footage for the miniSASS education and training videos was primarily conducted by a local film duo, Luyanda Msane and Chikatizhyo Zulu from Chika Art, as well as GroundTruth. Open source imagery and audio
(under creative commons licenses CC 3.0 and CC0) from open source repositories Pixabay\textsuperscript{14}, Pexels\textsuperscript{15}, Coverr\textsuperscript{16}, MixKit\textsuperscript{17}, and Microsoft\textsuperscript{18} were also used in media creation. These sources allow for royalty-free use of imagery within video creation (though we are grateful to all contributors). Video editing and media creation were done primarily by GroundTruth.

**Beta testing the course**

The goal of the miniSASS training and education course is to develop proficiency conducting a miniSASS survey and understanding its outputs. This will be achieved in a adaptive-response manner via beta testing the media. Through the joint project efforts with UNICEF and Yoma, several hundred youth will undertake the miniSASS course online. They will be able to provide feedback on the course training and education media, highlighting any shortcomings or requirements for further media creation. A stretch goal is to incorporate training with the finalised app and website to ensure people undertaking the miniSASS course develop basic proficiency with use of the app and website. Ultimately, selected resources developed for education and training in miniSASS will be integrated with the miniSASS app and website for public access and use.

\textsuperscript{14} https://pixabay.com/
\textsuperscript{15} https://www.pexels.com/
\textsuperscript{16} https://coverr.co/
\textsuperscript{17} https://mixkit.co/
Results and Discussion

MiniSASS app

**Macroinvertebrate database**
Through extensive sampling at 13 sites, 20,711 raw images of specimens from all 13 miniSASS groups were collected for creation of the ML training database. After pre-processing, the database was refined to ~1000 good quality images in each miniSASS group (Pattinson et al. 2022).

**ML identification algorithm**
The model reached 78.31% identification accuracy to miniSASS group level, with 0.13% information loss, when identifying the unseen images. This was satisfactory performance to incorporate the model in the beta-version of the miniSASS app. Training of the ML algorithm will be ongoing as aquatic macroinvertebrate image submissions come in during the beta-testing phase, as well as over time after the app is launched. In this way, the identification continuously improves to ever-increase accuracy based on a global database of images.

**App development**
The following set of images (Figure 2) illustrate the current miniSASS mobile app screens as they appear in the preliminary beta-version of the app.
What is miniSASS?

miniSASS is a simple tool which can be used by anyone to monitor the health of a river. You collect a sample of macroinvertebrates (small animals) from the water and depending on which groups are found, you have an idea of the general river health and water quality in that river.
Figure 2 Screen shots showing the basic functions of the beta-version of the miniSASS mobile application (app), including a ‘Home’ login screen, ‘Map’ screen giving a view of the user location and miniSASS sites previously submitted, a ‘Sites’ screen showing the sites previously generated by the user along with the submissions at that site, an ‘About’ page showing pertinent information for miniSASS, a screen to capture information for creating a new site, with the associated information input features, the screens for capturing images of macroinvertebrates sampled during a survey, identifying them, and viewing the list of images captured, and finally the outcome of a survey, showing the user and machine learning (ML) generated scores. The ML score is generated based on
the ML identification algorithm running on the images submitted by the user as a background process. Note: All metadata, miniSASS scores, and photos in the images are only used for testing purposes and do not reflect real-world data.

MiniSASS website upgrade

As the miniSASS website upgrade stands:

- The primary aims and functions of the miniSASS website and app, as well as the requirements for them to interface once they are both functional, have been defined.
- The design of the app and website, with regards to appearance (e.g., colour scheme, fonts, screen resolution, photos and videos; Figure 3), functionality (i.e., core functions for information presentation, mapping, data upload and visualisation), and logic (e.g., page navigation, hyperlinks to other resources, how each button or link operates and how data should be entered) have all been discussed and finalised, subject to refinement during beta-testing.
- The Koen brothers have begun integrating feedback on the beta-version of the app, as well as incorporating the same appearance as the website.
- Kartoza have begun building the website, including prototyping the user interface integrating the modernised and streamlined look and operation.
- The role of AWS for aiding in funding and development in terms of developing and hosting the app and website has been defined, with their required contributions made clear.
- AWS has been solidified as the host of the app and website back-end and data going forward, as supported by the relationship between CGIAR and AWS non-profit. AWS and Kartoza have developed an ongoing hosting and maintenance cost for CGIAR to host the miniSASS app and website.
Figure 3  Prototype miniSASS website with upgraded appearance style. Content is based on the previous website and is subject to change with ongoing developments.

MiniSASS training and education course

**PlutoLMS**

All the training and education media for miniSASS are available on the PlutoLMS as part of the miniSASS training course developed and run by GroundTruth. The course covers background information on miniSASS, including short videos on a number of topics:
1. Getting to know the course co-ordinators.
2. “A quick introduction to miniSASS” broadly explaining the concept.
3. “Citizen science in Mpophomeni - a real life example”, a story of how the Enviro-Champs from Mpophomeni have been using miniSASS and other citizen science tools to monitor the quality of the water in their community.
4. “What is in a "miniSASS kit"?" covering the equipment needed.
5. “Safety concerns for miniSASS” and “Before you go into the water” covering the safety considerations while doing miniSASS sampling.
6. “How to choose a site” covering how to select a good site to conduct a miniSASS survey.
7. “How to take a miniSASS sample”, covering how to sample each of the main target habitats in a stream for a miniSASS survey.
8. “How to clean your miniSASS sample”, covering how to process the sample you have taken before proceeding to identification.
9. “How to use the key to identify what you have caught”, covering how to use the dichotomous key to identify the aquatic macroinvertebrates, generate the miniSASS score, and then get the ecological category.
10.“How to calculate the miniSASS score”, an explanation of how to calculate the miniSASS score based on your sample.
11.“Uploading your miniSASS score”, a tutorial on how to upload your miniSASS score to the miniSASS website.
12.“Using miniSASS for monitoring”, a brief explanation of setting up routine monitoring.
13.“miniSASS in summary”, a brief video summarising the entire miniSASS process.
The PlutoLMS miniSASS course also includes simple quizzes to unlock each step of the course. At the end of the course, a certificate is granted for proficiency in miniSASS theory for use on the Yoma platform.

Acknowledgements

The authors would like to express their sincere appreciation to CGIAR, the International Water Management Institute (IWMI), International Food Policy Research Institute (IFPRI), United Nations Children’s Fund (UNICEF), the Water Research Commission (WRC) and Amazon Web Services (AWS) for their unwavering support in the research and development of the miniSASS materials. Special thanks are extended to Kartoza, Luyanda Msane and Chikatizhyo Zulu from Chika Art, Rhodes University, and Yoma. Gratitude is also extended to Jawoo Koo from IFPRI for translating the support from AWS into a reality and all his support throughout this project. The authors are particularly thankful for the collaboration with the Duzi-uMngeni Conservation Trust (DUCT) and acknowledge their pivotal role in forming meaningful partnerships for the successful execution of this work.

References


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