WWQA
World Water Quality Alliance

Guidebook for training Local Water Forums

MODULE 3: Monitoring and Data Collection Expertise

Citizen Science water quality data collection techniques

Developed for World Water Quality Alliance (WWQA)

by Human Right 2 Water and Women for Water Partnership

Human Right 2 water

WOMEN FOR WATER PARTNERSHIP

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Author: Amanda Loeffen

Peer reviewers: Noemie Plumier, Mariet Verhoef-Cohen

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Introduction

The aim of the workshop is to train Local Water Forums (LWF's), either through leaders of the LWF, or through regional and national institutions, on how to set themselves up to be supported as an entity that can monitor water quality through citizen science.

The workshop follows a four-module outline, that supports LWFs to develop an engagement strategy; explains how to conduct stakeholder mapping to consider the sources of support from different potential sources; runs through the technical options for data collection; and uses all these tools to develop a funding strategy that is local, sustainable, and supported by the local community.

Figure 1: Outline of the Modules

	MODULE	CONTENT COVERED	OUTPUT
	Welcome	Introduction and icebreaker	
1.	**Engagement**	Develop an Engagement Plan	A Vision for the LWP, preliminary assessment
	BREAK		
2.	**Stakeholder Mapping**	Identify and involve the optimal partner stakeholders.	A structured approach for mapping
	LUNCH		
3.	**Monitoring and Data Collection Expertise**	Water quality data collection techniques and the people required to make this work.	Technical options and who to ask for help
	BREAK		
4.	**Funding Strategy**	Design a local funding strategy.	An outline template for the funding strategy

The workshop was initially designed as a one-day workshop, but based on the feedback received by the participants, it would have benefitted from more time for the breakout groups. Given the modular design, the training could be given as four modules over a two-day period, or each module could stand alone, and be presented once a week.

This guideline accompanies updated slides and templates provided for the first WWQA train-the-trainers workshop help in Nairobi on 19th October 2023, following the WWQA Nairobi Conference. They can be used as an aid for trainers working with LWFs, giving guidance on how to present the slides, with additional templates and materials for developing ideas during the breakout groups, and after the workshop.

Module 3 Overview

Each of the modules are designed to walk the participants through the methodologies and processes need to form a sustainable LWF that will be capable of attracting funding and support through local contacts and institutions.

Module 3 deals with an overview of some of the main techniques for water monitoring together with some suggestions for how to attract support. It provides a brief introduction into the meaning of citizen science, a review of the most accessible technologies for collecting water quality data, and the sources of support for each one with case studies.

In this module, it is most likely that you will be able to attract technical support from local universities and development agencies rather than financial support, although that is not out of the question. Many of the methodologies are freely available through apps online, but the more complex testing systems for establishing the source of contamination will require scientific testing and the support of specialists.

Don't underestimate the power of starting the monitoring using free-to-use applications that collect data based on smart phones, simple visual techniques and require no special equipment. This data is extremely important to help raise awareness and education in the community, and it is accessible to everyone that wishes to contribute, creating a much larger database.

Once you have the support of a community, it is much easier to then justify technical support that requires external support and resources, and also to attract it.

Module 3: Monitoring and Data Collection Expertise (1-hour)

Slide 1 _____

Outline

1. What is Citizen Science?
2. Water Quality monitoring tools & Case Studies
3. Breakout Session to test one of the Apps

Module 3 covers the technical options for water quality monitoring, determining which are suitable for your own LWF, and suggesting ideas for how to set up and source support for the different options available. The presentation will take around 45-60 minutes depending on the number of questions and interactions. This guide will walk you through the slides and provide any background that might be helpful to them.

3.1 What is Citizen Science?

Slide 2 _____

- The collection and analysis of data relating to the natural world by members of the general public
- Inclusion of non-professional scientists in scientific work
- Community based
- A mechanism to support SDGs primarily related to biodiversity
- Education and awareness about water issues

Citizen science can be described through any of the bullets on this slide. The Oxford dictionary defines citizen science as scientific work conducted by citizens, often in collaboration with or under the direction of professional researchers and scientific institutions.

Citizen scientists not only collect valuable data, but can also raise society's awareness of environmental issues, in this case water.

Slide 3

Advantages

- Scientific knowledge
- Advocacy & awareness
- Education
- Data for national statistics
  - SDG6 data
- Local engagement for WRM decision-making
- From knowledge to action (RBO)

Who can be a Citizen Scientist?

- Individuals
- Volunteers
- Students and school children
- Professors
- Groups of Neighbours
- Friends
- Local NGOs
- Activists

The advantages of citizen science are very broad. Regarding water quality data specifically, it is not possible to collect data in all the rivers and streams without citizen support – the task is too large and too expensive in the short term. The importance of gathering the data should not be under-estimated, and by using regular people to help gather and monitor data, we not only help to spread awareness and education about the link between our actions and water quality and the environment, but we can also really help to make a difference.

Local engagement is critical to encourage change in cultural habits, and getting youngsters involved in testing water quality can educate them about cleaning up the rivers, as well as taking the messages home to their families.

The list of people that can get involved is not limited to experts in this area, and all sorts of individuals, organisations and movements are encouraged to get their feet wet!

Slide 4

The 10 principles of Citizen Science

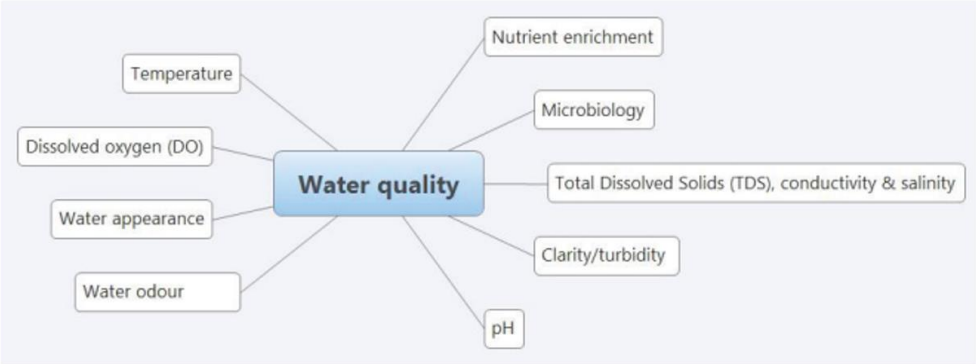
1. Actively involves citizens
2. Genuine science outcome
3. Benefits for scientists and citizens
4. CS can be involved in all stages
5. CS receive feedback
6. Research with greater public involvement
7. Data/metadata made publicly available
8. CS acknowledged in results/publications
9. Programmes bring scientific output and wider societal/policy impact
10. Leaders consider legal and ethical issues

Citizen science is a flexible concept which can be adapted and applied within diverse situations and disciplines. The statements in this slide were developed by the 'Sharing best practice and building capacity' working group of the European Citizen Science Association, led by the

Natural History Museum London with input from many members of the Association, to set out some of the key principles which as a community we believe underlie good practice in citizen science.

Slide 5 _____

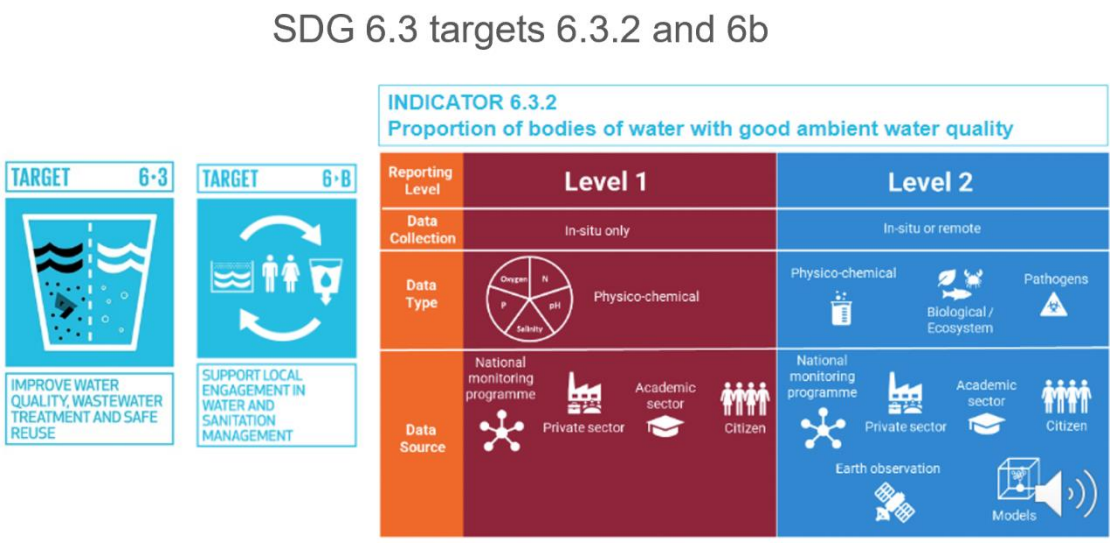
Water Quality



> Water quality refers to the chemical, biological and physical characteristics of water. These typically relate to the suitability of water for supporting life and whether the system as a whole is healthy or not (Diersing, 2009).

Water quality can be assessed by measuring any of the characteristics that are displayed in this slide. Some are very visible and easy to monitor by ordinary citizens, for example the more physical aspects of smell, appearance, clarity, and temperature. Others require specially adapted equipment to measure chemical content, but these do not need to be difficult to use. The important aspect is to make sure that the testing is done in a systematic and replicable manner such that trends can be monitored over time, with results gathered by different people.

Slide 6



SDG Target 6.3 sets out to **improve ambient water quality**, which is essential to protecting both ecosystem and human health, by eliminating, minimizing and significantly reducing different streams of pollution into water bodies.

Numerous physical, chemical, and biological factors affect the quality of water in the ponds, the lakes, the streams, the rivers, the oceans, and the groundwater, all of which can be detected by citizens if given the proper support.

Level 1 reporting, as described in indicator 6.3.2 considers in-situ data collection, is provided by national monitoring programs involving the private sector, academics, and citizens. Level 2 reporting also includes remote sensing through earth observations and foundation models, which can provide another level of accuracy and analysis that enables greater interpretation of the data. Both include citizen science as a key source of basic data.

Huge gaps in data for this target are seen because high income countries are scaling back monitoring efforts and low income countries have little monitoring infrastructure.

3.2 Water Quality Monitoring Tools for Citizen Science

Slide 7

This first set of tools are already available through the WWQA system, with support systems for LWFs that are interested in using them. They are very different tools, and provide different data sets. However, all are suitable for measuring SDG 6.3.2 and contributing to the larger national and global monitoring program.

The first two are free-to-use applications that can load the data through smart phones.

a. **MiniSASS** uses google maps to upload the exact location of the test, and tracks changes over time using ecological information. It requires some simple equipment, and the desire to get wet.
b. **CrowdWater** is completely smart phone connected, and uses a series of questions and photographic evidence to track physical characteristics of your river.
c. **FreshWater Watch** is a scientific organisation that supports LWFs to collect samples and analyse them in a laboratory. This enables the collection of simple chemical data, but also has a cost attached to it.
d. **Gems of Water** is a European Commission program that is setting up chemical testing pilots in various countries to monitor a wide range of contaminants using a clever collection vial, but it is still at the development stage.

3.2.a MiniSASS, for ecological monitoring

Slide 8

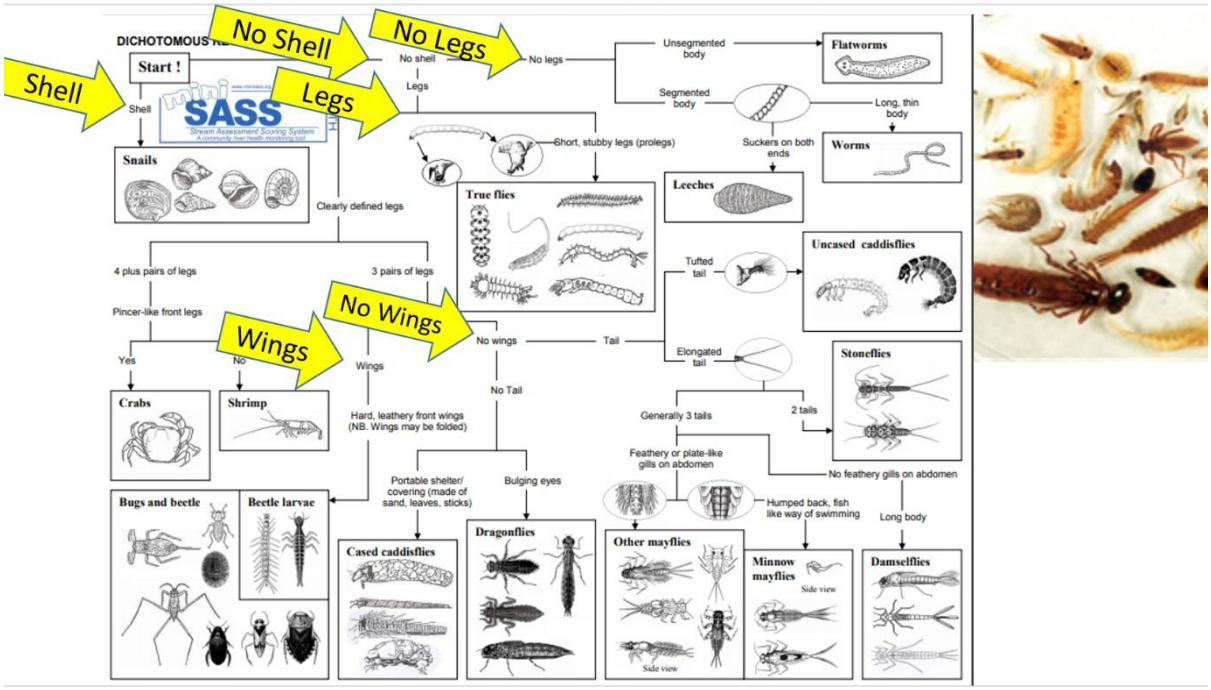
a. MiniSASS: A Global Stream Assessment Scoring System

- Simple kit : boots, net, gloves, a bucket or a cup, mobile phone.
- Collect a sample of macro-invertebrates from your local stream
- Follow the chart classification : the dichotomous key -> "**Yes**" or "**No**"
- Calculate the River Health Index via a ranking of 5 colours (blue to purple)

MiniSASS is a South African initiative that has been tested thoroughly nationally, and now globally. It is accepted as a partner with WWQA. It is easy to use and no cost involved.

Slide 9

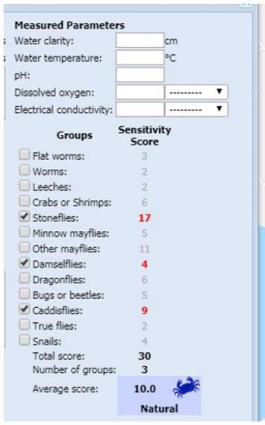
Simple identification key



A simple dichotomous key is used to identify macro invertebrates that live in the river. It is pictorial, and suitable for school children to use. Basically, you spend five minutes catching whatever bugs that you can find at the edge of the river, and look at them in a white plastic container. You then identify them by following the key: Does it have a shell? Does it have legs? What kind of legs? Does it have wings?

Slide 10

Calculate the river health index

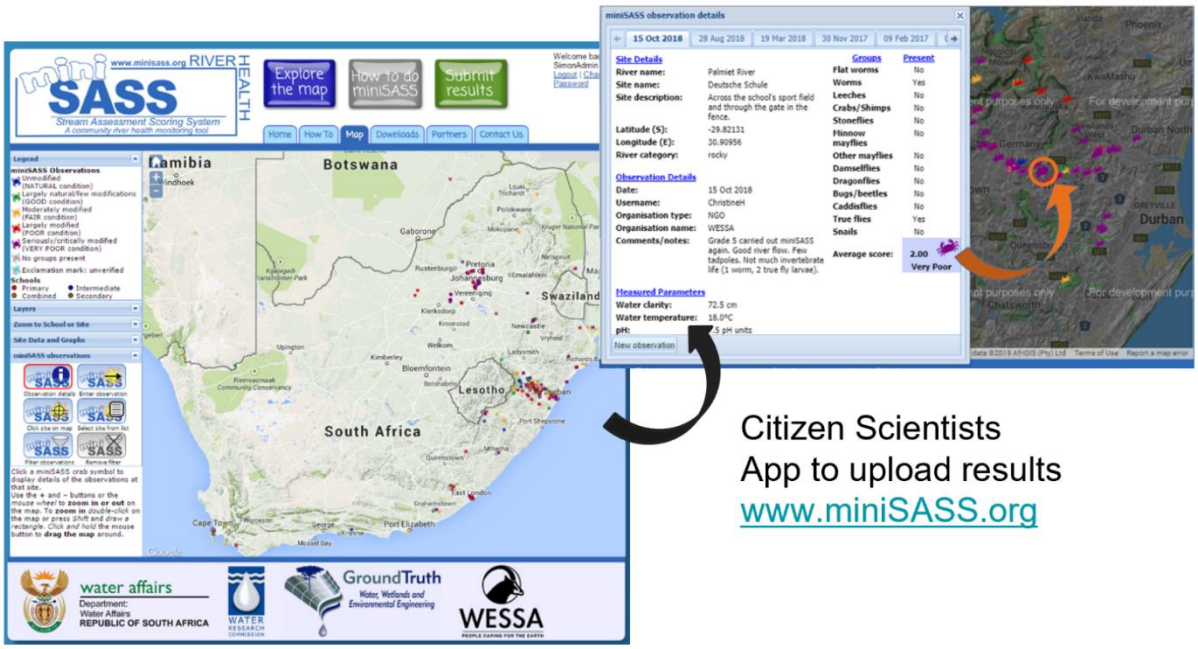


	Condition of River	River Type	
		Sandy	Rocky
	NATURAL	> 6.9	>7.9
	GOOD	5.8 to 6.9	6.8 to 7.9
	FAIR	4.9 to 5.8	6.1 to 6.8
	POOR	4.3 to 4.9	5.1 to 6.1
	VERY POOR	< 4.3	< 5.1

The river health index is then calculated by the miniSASS app based on the number of each kind of invertebrate that you have identified. The condition of the river is then classified as natural, good, fair, poor or very poor, with a crab colour to match. A 'natural' river with evidence of the most sensitive groups of organisms will demonstrate that the river is not polluted. On the other hand, a purple crab describes a river system that is highly polluted, so not very many organisms are able to survive in these conditions. Damselflies, caddisflies and stoneflies, for example, are only found in the cleanest waters, while you can find some of the aquatic worms and leeches in even the most polluted conditions.

Slide 11

Upload to Google Maps



The results of your miniSASS tests can be uploaded through the app to google maps, and your spot on the river is given a coloured crab based on your test. It provides a useful comparison of the health of that spot on the river versus other lengths of the same river, and other parts of the country.

Here you see the results in South Africa, with the focus on the Palmiet River near Durban, showing many of the tests with very poor water quality and a purple crab.

Slide 12

Satellite view Google Earth

Youth - Children – Community - Engagement

Contact: Dr Jim Taylor jimtaylor835@gmail.com https://minisass.org/en/

The purple crab just downstream of the red crab on the Umgeni River, South Africa, suggested a point source pollution in Shiyabazali that must be spilling into the river, and led to investigations by the local municipality. Without the tests, this problem would not have been detected and cleaned up.

If you would like to know more about miniSASS please refer to their website, and reach out to Dr Jim Taylor, one of the developers of this application.

3.2.b CrowdWater, for physical and visual monitoring

Slide 13

b. CrowdWater App

- Started in 2016 at the University of Zurich as a citizen science project specialised in hydrology
- A non-sensor based mobile app for data collection and communication
- Gather 6 types of hydrological data : virtual staff gauge, soil moisture, temporary stream, physical staff gauge, plastic pollution, and stream type.
- Increase public interest in water topics including teaching materials

crowd water

Sara Blanco Ramirez
info@crowdwater.ch
https://crowdwater.ch

The CrowdWater application can be found as a free app through their website. It gathers six types of physical data that contribute to water quality, using your smart phone.

Slide 14

CrowdWater Dashboard App contributions by Sept.'23

The map shows places where people have used the app to successfully monitor water-course data through the CrowdWater app. There were already 44,413 contributions at that time.

Slide 15

A visual approach for water quality observations

- Visual and qualitative in scientific literature
  - e.g., Indigenous peoples
- Local people notice changes first
- Track changes over time
- Broader understanding

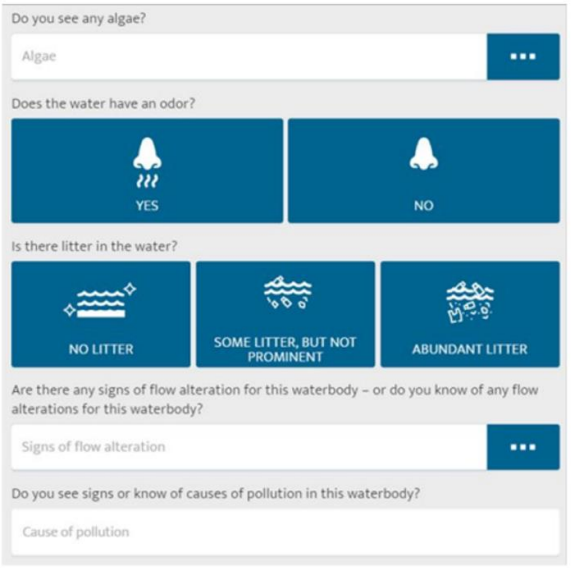
The approach for water quality observations is well documented in the literature, and indigenous peoples have used visual markers for water management for centuries. It is well known that local people notice changes first, so they are the best placed to track them. The process itself provides an opportunity for education and awareness of the issues.

The dashboard demonstrates the amount of data for each water characteristic, shown here in 7,522 spots, and with over 46,000 readings. The colours represent virtual staff gauges (aqua), soil moisture (pink), temporary streams (green), physical staff gauges (yellow), plastic pollution (purple), stream type (orange), and number of stations and users with more than 10 contributions (blue/green).

Slide 16

How to use CrowdWater App

- Simple visual questions
- Yes/No or multiple choice
- A few qualitative questions
- Can use for everyday decisions e.g., swimming, fishing, boating



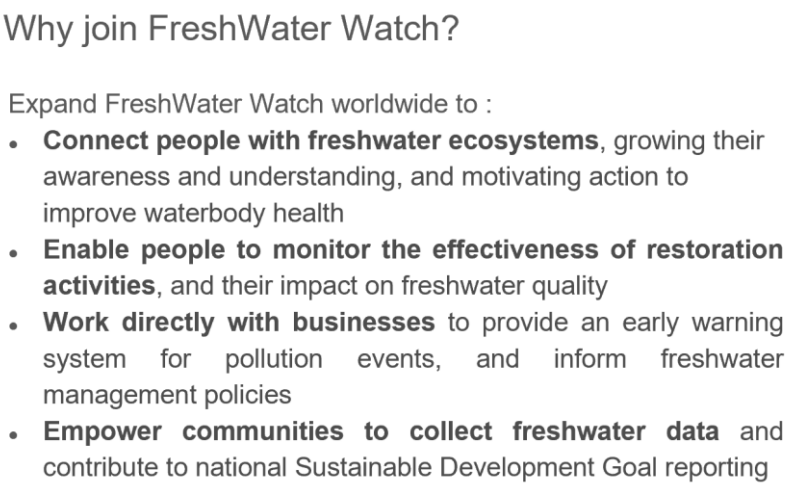
The information can be used for everyday decision, such as whether the water condition is suitable for recreational activities. The app uses very simple questions to gather the data, for instance this page asks if the water has an odour, and how much litter is in the water. There are additional qualitative questions around changes in flow, and signs for the causes of pollution in the waterbody.

3.2.c FreshWater Watch, for ecological, hydrological, chemical and optical testing

Slide 17

FreshWater Watch uses ecological, hydrological, chemical and optical observations to monitor water quality.

Slide 18



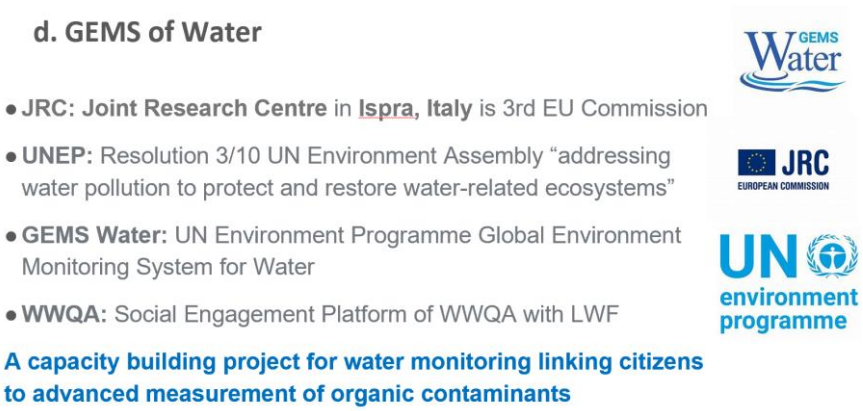
This slide summarises the benefits of water quality monitoring with the technical assistance of FreshWater Watch.

Slide 19

As a guide, there is a basic cost of joining starting at £440 for the first year, but it is worthwhile discussing with Steven directly to find out if there are sponsorships, and how you could get started.

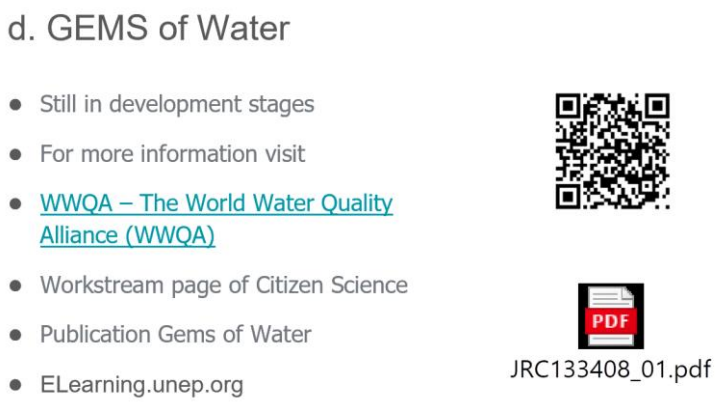
3.2.d GEMS of Water, for advanced measurement of organic contaminants

Slide 20



GEMS of Water is a partnership between JRC, UNEP and WWQA, designed to set up advanced measurement of organic contaminants in water to support the monitoring of target SDG 6.3.2. It is still at the pilot stages, and requires specific sampling equipment that is used to send samples back to a central laboratory. It can test from a wide range of contaminants.

Slide 21



While GEMS of Water is not yet widely available, it promises to develop a highly sensitive testing kit for a full range of chemicals that can be found in water. You can find more information on the WWQA website under the workstream page for Citizen Science, and the attached publication on the European Commission website entitled 'How to become a GEM of Water.'

3.2.e Other 'free' monitoring options, for monitoring algae and turbidity

Slide 22

e. Other 'free' monitoring options - Algae

- Pictorial reporting of algal blooms using smart phone
- An indicator or quality related to Nitrate and Phosphate contamination
- Used for rivers and lakes

Bloomwatch https://cyanos.org/bloomwatch

Bloomin' Algae www.ceh.ac.uk/our-science/projects/bloomin-algae

There are a number of other free monitoring options using smart phones and photographic recording of visual data. The first is designed to track algae, using the phone camera to detect coverage and colour. This is useful in rural areas where periphyton can be a problem if farmers are over-using fertilisers on their crops, effectively washing nitrates and phosphates into the aquifers and river systems.

Slide 23

e. Other 'free' monitoring options - Turbidity

Hydrocolor https://hydrocolor.en.aptoide.com/app

- Simple pictorial method to determine turbidity (0-80ntu), suspended particulate matter (SPM, g/m^3), back scattering coefficient in the red (1/m)
- Reflectance directly relation to amount/type of suspended particles
- Turbidity (suspended sediments) ->light scatter and reflectance
- Pigmented particles, e.g. algae, absorb light in visible spectrum
- -> detect pigmented particles in RGB reflectance

Turbidity can also be measured using colour, and even the amount and type of suspended particles in the water. It works by detecting pigmented particles such as algae, and testing reflectance.

Slide 24

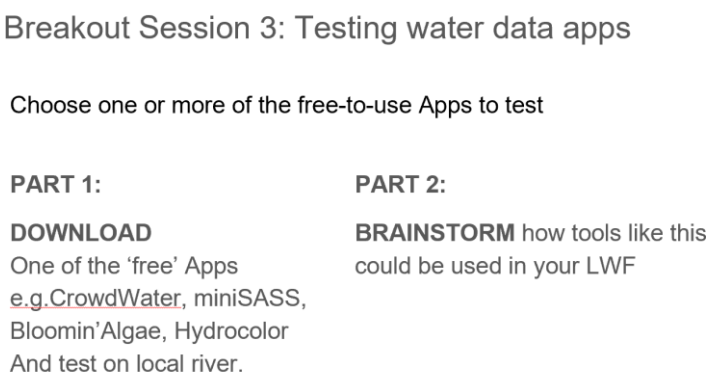
1. Citizen Science can increase:
    1. environmental democracy
    2. scientific literacy
    3. social capital
    4. citizen inclusion in local issues, and
    5. benefits to government
2. Choose the most suitable tool for your LWF
3. Reach out to experts from the WWQA for support

In summary, citizen science is a useful way to invite more people into the discussion on environmental issues, by helping them to understand the link between human action and environmental degradation. There are benefits to education, inclusion and knowledge for local government.

Each LWF will have different reasons for starting their forum, driven by differing causes for water quality problems and varying levels of contamination. The first step is to start measuring whatever physical or ecological parameters that you can afford to do, and share the data. Please reach out to WWQA experts if you need advice.

3.3 Breakout Session (1-2 hours in total)

Slide 25



It is suggested that for this breakout session that you conduct the activity at your local river or water body. Decide on which App you would like to test out, and make sure that you have the basic equipment needed, including at least one smart phone. Divide into manageable groups of 5 to 6 people.

At least one person in each group should download the Water Quality testing App and use it to work through a simulation case. Ideally, it should be carried out by the riverside to carry out a real time exercise setting up the App and recording visual details of the state of the water body.

The teams should then reconvene afterwards as a plenary group to share the main learnings from each team and to discuss how this tool could be useful in your LWF.

One person should be nominated as rapporteur for each team for this breakout group.

OUTPUT: An understanding of how a water quality testing app could be useful in your LWF, and even a first reading of water quality parameters for your LWF.