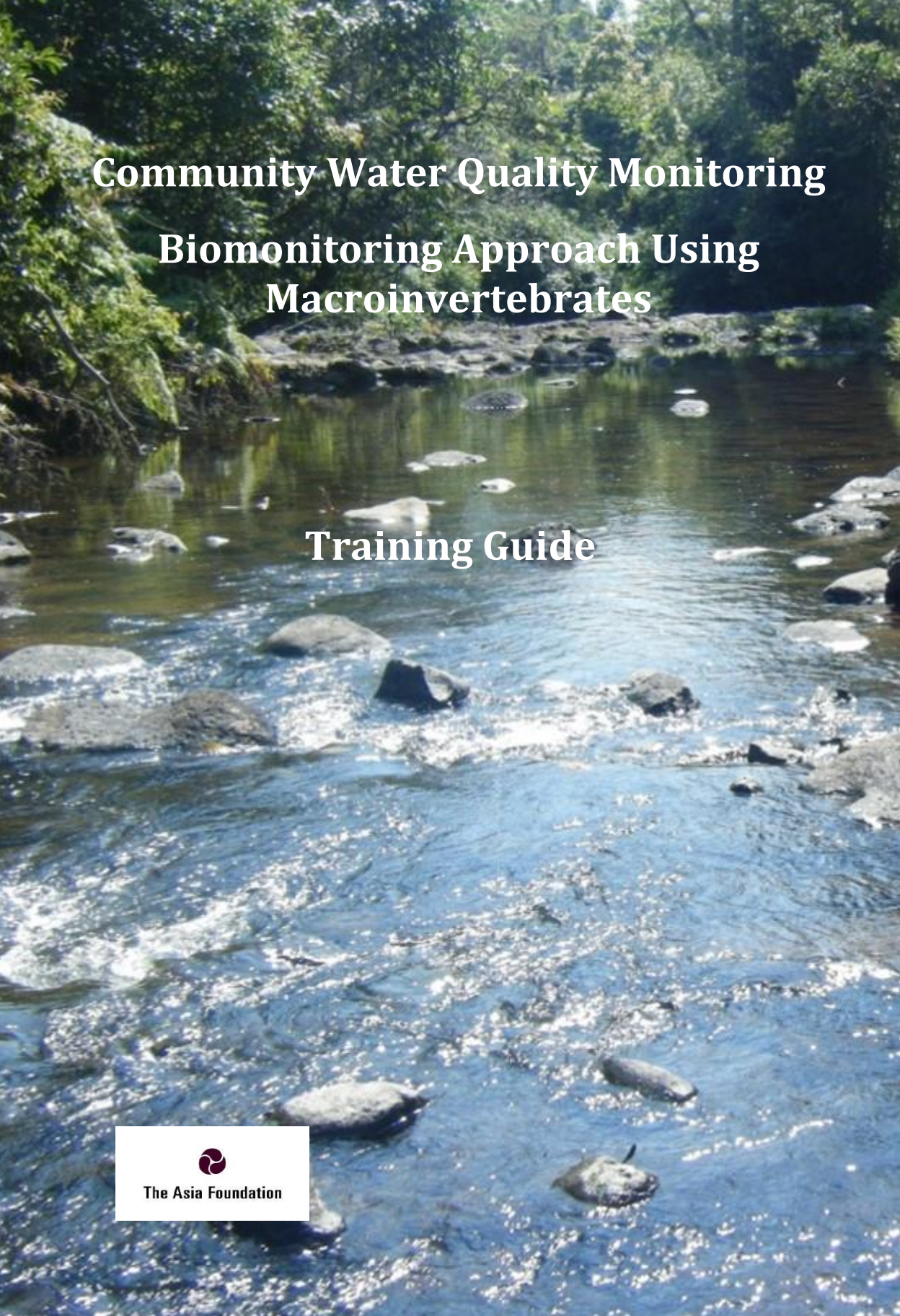

Community Water Quality Monitoring

Biomonitoring Approach Using Macroinvertebrates

Training Guide

The Asia Foundation

Please see The Asia Foundation's website (https://asiafoundation.org/where-we-work/laos/) for copies of this Training Guide, the Macroinvertebrate Identification key, the Macroinvertebrate Assessment Guide, and the Site Disturbance Record. Please contact The Asia Foundation's office in Laos for more detailed guidance and discussion.

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Introduction

This introductory Training Guide is based on a more in-depth, peer-reviewed Manual for Water Quality Monitoring in Rivers, produced by The Asia Foundation – first for Mongolia and then for Lao PDR.

The Asia Foundation is a non-profit international development organization committed to improving lives across a dynamic and developing Asia. Informed by six decades of experience and deep local expertise, our programs address critical issues affecting Asia in the 21st century—governance and law, economic development, women's empowerment, environment, and regional cooperation. Established in 1954 and headquartered in San Francisco, the Foundation has country offices in 18 Asian countries.

In Lao PDR, The Asia Foundation fosters effective and responsive governance; citizen participation in decision-making, including natural resource management; increased access to information; and empowerment of women and vulnerable groups.

In 2012, in partnership with the Ministry of Natural Resources and Environment and National University of Laos, The Asia Foundation-Laos launched a Community Water Quality Monitoring (WQM) initiative in Bolikhamxay and Vientiane provinces. Communities were trained on a low-cost biomonitoring approach using macroinvertebrates. As different macroinvertebrates have various degrees of sensitivity to pollution in the water, their presence or lack thereof can function as an indicator to help determine the quality of the water and river health. In 2015, The Asia Foundation refined the approach and began applying it more strategically to an integrated watershed area (Xe Bang Fai River Basin).

Ultimately, The Asia Foundation aims to empower communities to understand and take ownership over the management of community water resources and ecosystem health. Macroinvertebrate monitoring can also play an important role as part of local government authorities' watershed monitoring program since it is a low-cost technique that can be completed in the field and does not require lab analysis.

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Instructor Information

This booklet provides step-by-step instructions for trainers to teach students, teachers, and communities about water quality in Lao PDR and how to monitor water quality by using macroinvertebrates.

All sections are to be read aloud by the trainer except the sections in italics. These sections in italics provide additional instruction to the trainer, or expected answers from the participants that are NOT to be read aloud.

Make sure you read through the whole book first before instructing a class so you have an understanding of the content. Before you begin, make sure you have all your materials:

- Identification Key to Macroinvertebrates in Lao PDR
- Aquatic Macroinvertebrate Record Sheet
- Macroinvertebrate Sampling Kit with Net, and
- Site Disturbance Record Sheet

Natural Resources in Lao PDR

Good morning everybody. How are you? *[Introduce yourself if people do not know you.]*

Today I am here to tell you about protecting our environment.

[Write the following on flip chart paper or on the blackboard: "Water Quality Monitoring by Macroinvertebrate Assessment."]

Can you read what this says? ***[****Have everyone read together. Read with them, and make sure you read it loud and clear so everyone can hear.]* "Water Quality Monitoring by Macroinvertebrate Assessment". ***[****Encourage participants to read louder by saying:]* "It's too quiet, louder and everyone together please!!! Water Quality Monitoring by Macroinvertebrate Assessment."

Very good, Water Quality monitoring by Macro-invertebrate assessment.

First, I will tell you some information about natural resources in Lao PDR, then we will talk about macroinvertebrates, what they are, why they are important and how to monitor them.

Do you know how much land area there is in Lao PDR?

[Point to the text that says "236,800 km2", encourage participants to read out loud, then say:] 236 800 km2 - that is the land area of Lao PDR, our village makes up a part of that land area.

And the total percentage of forest cover is? [*Point to the 40% figure on the next page and encourage participants to read out loud, then say:]* Yes, we have approximately 40% forest cover. Forest cover is important, especially on the slopes and tops of mountains. Trees stop soil from eroding and washing into waterways, and they help clean water from rainfall before it enters waterways.

The Mekong is the main river in Lao PDR. It has many tributaries in Lao PDR that flow into it. Can you tell me the name of some of these tributaries? [*If they are shy to answer tell them one of the rivers names e.g. Nam Theun, Nam Hinboun, Nam Xong. Try to get trainees to name at least 5 tributaries.]*

Lao PDR has a small population with less industrial activity than its neighboring countries, resulting in less impacts on its forests and waterways. But, 60% of the forest has already been lost to human activity. We can work together to protect and manage our natural resources for a sustainable future. Otherwise, we could lose it all.

Natural Resources in Lao PDR

- Lao PDR is a small, landlocked country with an area of 236,800 sq. km.
- Natural forest cover is about 40% (World Bank Report 2012)
- There are 14 major tributaries that flow into the Mekong River
- Lao PDR has a small population with less industrial activity than its neighboring countries, resulting in less impacts on its forests and waterways
- However, rapid economic growth and natural resource extraction has put increasing pressure on the environment, especially water

The Asia Foundation

Did you know that 80% of Lao PDR is mountainous?

When it rains, most of the rain falls on the mountains and runs down the mountain into small streams, and then they all run into bigger streams or rivers.

Most people in Lao PDR live along rivers or streams. Why do you think we live near rivers or streams? **[***The answer should be "WATER". Go to the next page to talk about CLEAN water.]*

Geography of Lao PDR

About 80% of the country is mountainous

The majority of villages in Lao PDR are located along rivers or streams

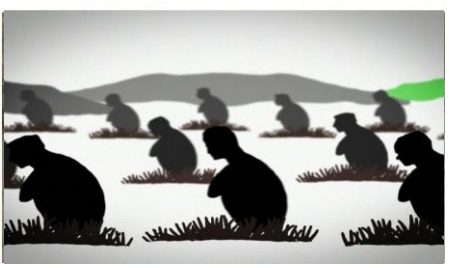
So, most people in Lao PDR live along rivers so they can be close to water. We need water for many things like drinking, bathing, and growing rice.

But we also need CLEAN water.

Water can be polluted by a number of things, most of these are human activities such as:

- Land clearing which causes erosion of soil into waterways
- Agriculture that can also cause erosion, and runoff of pesticides or other chemicals into waterways
- Harmful chemicals, heavy metals and sediment from mining activities
- Open defaecation which leads to contamination of waterways with human faeces

All of these activities can pollute waterways making water unsafe for humans and animals. Poor water quality can have many impacts.



Impacts of poor water quality can include:

- Fertilisers and pesticides - damage brain development, particularly in children, as well as respiratory problems, cancer, and reproduction issues including damage to unborn babies.
- Heavy metals from mining - can cause respiratory and eye irritations, stomach and skin irritations, and damage brain function. Heavy metals can also cause fish kills or contaminate fish and other aquatic species which are then eaten by people - making them sick.
- Detergents (phosphates) from soap and washing clothes or cars can cause skin irritations in humans, and also damage the gills and skin of
- Fish - killing them or making them unsuitable to eat
- Faeces from open defaecation of adults or children, or from sewage can cause severe illness in humans including parasites and worms
- In Lao PDR, around 3 million people are treated for diseases related to poor water quality - that's almost half of the entire population!




We depend on water for many things.

Do you use water for drinking?
[Wait for an answer: "Yes."]

Does the water need to be clean to drink it? Or do you like drinking dirty water that is polluted?
[Wait for an answer: "clean water".]
That's right! We want clean water.

Do you like to swim in the water and have a bath in the water?
[Wait for an answer: "Yes."]

Does the water need to be clean to swim in it and bathe in it? Or do you like playing and bathing in dirty water that is polluted?
[Wait for an answer: "We want clean water."]
That's right! We want clean water.

What do you need to wash your dishes and clothes? *[Wait for an answer: WATER].* Do you want clean or dirty water to do this?
[Wait for an answer: "clean water."]

So, is water important in your livelihood or not?
[Wait for answer: "Yes."]
That's right! We want clean water.

So, now we can see that people have a strong relationship with water. We cannot live without it.





We also need water to grow food to eat and sell, in fact, 75% of the Lao PDR population depends on agricultural farming for their livelihood.

And in Lao PDR, most people (75%) depend on aquatic species like fish for our protein which is very important to good health.

Who here depends on agriculture for your food or for income? *[Wait for their answers.]* What sort of crops do you plant? And what animals do you raise? *[Wait for their answers.]*

And do you need water for this? *[The answer should be "yes".]*

Who collects and eats or sells aquatic animals? *[Wait for their answers.]*

What sort of aquatic animals do you eat or sell? ***[****Wait for their answers,]*

Relationship between Humans and Rivers

- Lao PDR has many rivers and waterways and abundant water from North to South
- About 75% of people in the county depend on aquatic species like fish for their protein
- Over 50% of people's protein comes from freshwater rivers, streams and lakes

Here you see many things that we eat, can you name them for me? [*Wait for answers, such as: "small fish and big fish, snails, crabs, frogs, river weed, etc.]*

What do they all need to live? *[The answer should be "WATER".]*

What would happen if the water they lived in was polluted? *[Wait for their answers.]*

If you at fish or snails or crabs that were living in polluted water, what would happen? *[Wait for their answers.]*

And if you use polluted water on you rice or vegetable crops, what could happen to people if they eat the rice or vegetables? *[Wait for their answers.]*

Could you get sick? *[Wait for their answers.]*

When someone is sick you can't go to school so you don't get a good education. You cannot work, so you cannot earn money. You have to spend money to buy medicine.

What about animals like cows and chickens that drink bad water? *[Wait for their answers.]*

When your animals are sick, you cannot get a good price for them, or they might die!

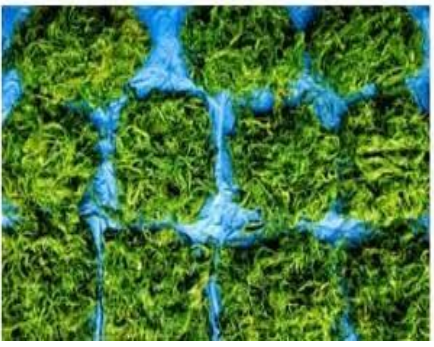
So, is water quality important? Do you think water quality impacts humans? *[Wait for their answers.]*

Macroinvertebrates (Water Bugs) in Rivers

Relationship between Humans and Rivers

- Over 50% of people's protein comes from freshwater rivers, streams and lakes



[Divide students into groups of 3-6 depending on the size of your class. Provide groups with paper and pencils so they can write down their answers.]

- Do you know what is in these photos? [*The answer should be "insects."]*
- Write down the names of all the insects you can think of. *[Allow 2 minutes to write down.]*
- Now talk together and write down the sort of foods you can cook using insects. *[Allow 2 minutes to write down.]*
- Where do you find these insects? *[Ask groups to discuss and write down their responses. 2 minutes to write down.]*
- What tools do you use to catch them? *[Ask groups to discuss and write down their responses. Allow 2 minutes to write down.]*

[Ask one person from each group to stand up with their lists. You can compare lists of names and see who has the most insect names. Go through each question and ask the person to read out what their group wrote.]

Insects are delicious to eat!

Did you know that many insects live in water? Any many insects start their life in water!

Let's look at the insects that live in water. We call these, "macroinvertebrates" or "water bugs."

Do you know the names of the aquatic animals in this picture? ***[****Point to each of the images of insect in the picture and then ask the participants for the name.]*

[Many places may have different local names. You can tell them the common names if the local name is different.]

Prawn

Mussels

Mayfly

Snail

Dragonfly larvae

Leech

Macroinvertebrates in Our Rivers

Here are some more water bugs, or macro-invertebrates. Can you tell me the names of any of these? *[Wait for answers.]* Can you see any here that you can eat? *[Wait for answers.]* If there were no water bugs, some people might not have enough to eat! If there were no water bugs, what will other aquatic animals eat?

[You can ask other questions such as:

Do they find different ones at different times of the year?

Which ones do they find in the wet season?

Which ones in the dry season?]

Do you find many of these aquatic insects in polluted water? *[Wait for answers.]*

Using Macroinvertebrates to Monitor Water Quality

Do you know what is meant by the term “water quality”? ***[****Wait for answer.]*

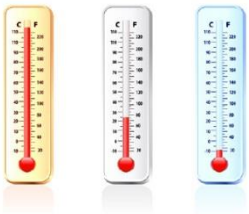
Water quality refers to the physical, chemical and biological characteristics of water.

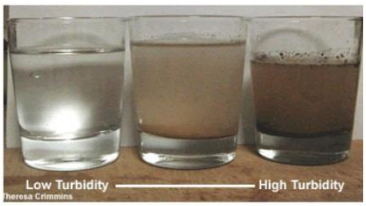
What do We Mean by Water Quality?

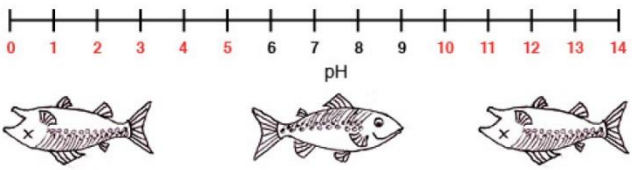
- Water quality refers to the chemical, physical and biological characteristics of water

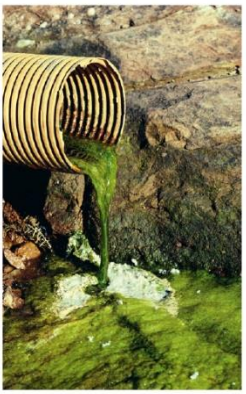
Physical characteristics of water quality include:

- Water temperature,
- Turbidity - how clear the water is, so how much soil, sand, algae or other things are in the water,
- As well as colour, odor, and taste.
- Chemical characteristics of water quality include pH, which is a way to measure how acidic or alkaline the water is. For example, lemon juice has a pH of 2 [point to the pH scale at 2]
- If water had a pH of 2, fish would die and it would corrode pipes and your teeth! Soapy water has a pH of 12 [point to the pH scale at 12]
- If water had a pH of 12, fish would die!
- Good quality water should have a pH of 6-9 so animals can live!
- Dissolved oxygen - all aquatic animals need dissolved oxygen to breath
- Heavy metals, nitrates and pesticides - these are all chemicals that can cause human and environmental health issues as we mentioned.




Low Turbidity
High Turbidity
Theresa Crimmins


0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
pH



Biological characteristics of water quality include: “water bugs”

Mayflies, Stoneflies, Molluscs, Caddisflies, and bacteria such as E. coli that can come from animal and human faeces

Whether or not different types of macroinvertebrates are found in the river tells us something about the quality of the water in the river.

Now you know the basic theory on water quality.

Mayflies

Stoneflies

Molluscs

Caddisflies

Let's look at some human activities that can cause negative impacts to the water quality in our waterways.

What human impacts can you see in the photos? *[Wait for answers: "Dams, pesticides, land clearing, livestock."]*

What other human impacts can you think of that can pollute water? *[Wait for answers: "Open defaecation, washing cars/motorbikes in waterways, mines."]*

Why do you think it's important to monitor the quality of water in our waterways? *[Wait for answers: "Because we drink water, bathe in water, put water on crops."]*

If we don't monitor water quality, how will we know if the water is safe to drink, or swim in, or to put on our crops? *[Wait for answers: "We won't!"]*

Monitoring water quality can help us understand what is polluting our waterways, where is it coming from, and how we can stop it.

So, you see, water quality monitoring is very important.

Why Should We Monitor Water Quality?

One way that we can all monitor water quality is to look at what macroinvertebrates (“water bugs”) are living in the water.

Macroinvertebrates are a “biological indicator” of water quality.

Different macroinvertebrates have different tolerance to water pollution.

And some macroinvertebrates can live in different quality of water at different stages of their life - so when they’re young they may be able to only live in good quality water, but as adults they may be able to live in poorer quality water. This is the same with humans - adults can often tolerate things that will make babies and children very sick.

So, you can determine if your waterway is in GOOD, OKAY, or BAD condition by looking for macro-invertebrates.
Let’s learn how!

How to Monitor Water Quality by Using Macroinvertebrates

Using biological indicators such as macroinvertebrates is a low-cost and effective way for communities to monitor the health of a river

Data Collection

Step 1: Site Selection

First of all, we need to know where to find macroinvertebrates in the water.

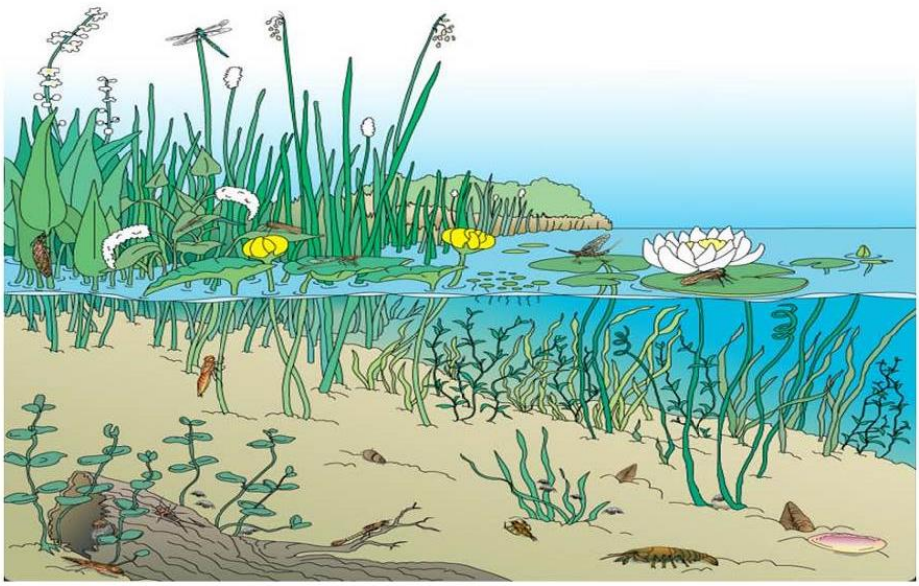
Macroinvertebrates like places where:

- It is not too deep - they like shallow water.
- There is vegetation cover (so the water doesn't get too hot).
- There are aquatic plants in the water (to eat and hide in).
- Slow flowing water e.g. riffles and pools - so they don't wash away
- Places to hide from predators such as under rocks and logs, and
- Sandy or rocky substrate (river bed).

Step 1

Can you find the macroinvertebrates in this picture?

Get students to point out where the water bugs are hiding.



Step 2: Collecting the Macroinvertebrates

One way of collecting macroinvertebrates is called the KICK SAMPLE.

[As you go through each of the steps, have a student act out each one to demonstrate to the rest of the class.]

This technique collects water bugs that are bottom dwellers, found in the sediment and mud. It is best used in running water.

Select an area in the waterway that is shallow enough to stand in (ideally knee deep), and that has an area of at least 5 metres that you can walk, upstream, in a straight line.

To begin, face down stream and submerge your sampling net so that it is positioned directly in front of your feet, on the floor of the river bed, with the mouth of the net facing upstream.

Shuffle and kick the ground as you WALK BACKWARDS upstream for 5m. As you kick the ground, sediment, mud, and rocks will be disturbed; the flow of the water will wash dislodged invertebrates into the net. Try not to collect too much mud, silt or organic matter.

Collecting the Macroinvertebrates

Collecting a sample

Step 3: Sorting the macroinvertebrates

Before you can identify the water bugs you have collected, you will need to sort them first.

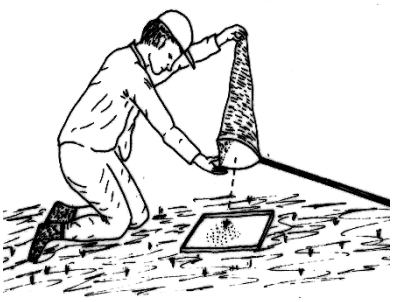
Follow these steps: As you go through each of the steps, have a student act out each one to demonstrate to the rest of the class.

i. Half fill your white sorting tray with water.

ii. Turn your net inside out and empty your sample into your sorting tray. Wash down the sides of your net with some water to make sure you get your entire sample into the tray.

iii. Be careful not to overfill your sorting trays with sediment and leaves, as you won't be able to see the macroinvertebrates. If necessary, spread your sample over a number of trays.

iv. Place your sorting trays in the shade, as macroinvertebrates do not like to be exposed to strong light.



Empty contents into the tray

Remove macroinvertebrates from the tray to small dishes

v. If there is a lot of mud in your sample, let it settle for about 10 minutes, this will make it easier for you to find the water bugs.

vi. Pick and sort through the collected material. Look very hard, some water bugs are great at camouflage and it may take time to find them.

vii. When you spot an animal, use tweezers, a tea strainer, spoon or pipette to fish it out and place it into the petri dish with clear water from your site.

Now that we've sorted them, it's time to identify them!






Step 4: Identify the Macroinvertebrates

First, let's look at the different parts of macro-invertebrate bodies that help us identify them. Some macroinvertebrates are so small we need a magnifying glass to see them! For the others, here are some simple things to tell them apart.

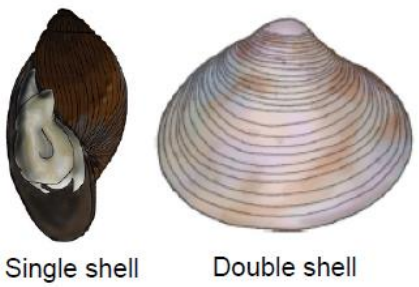
Different species can have:

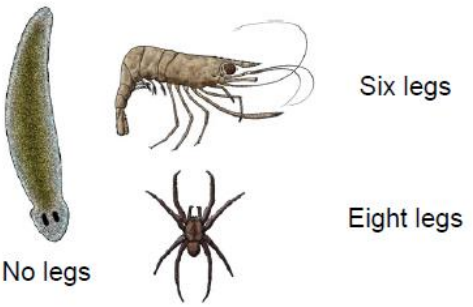
Shells or no shells. A single shell or double.

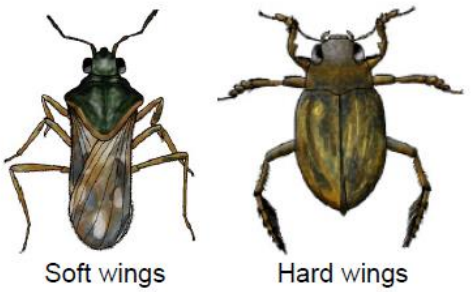
Legs or no legs. Six legs or eight.

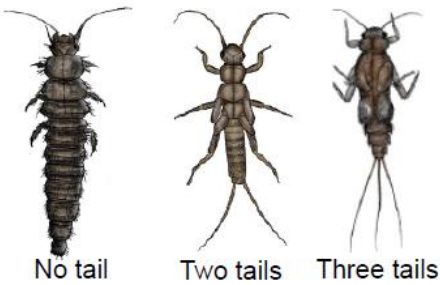
Wings or no wings. Soft wings or hard wings.

A tail or no tail. Two tails or three.





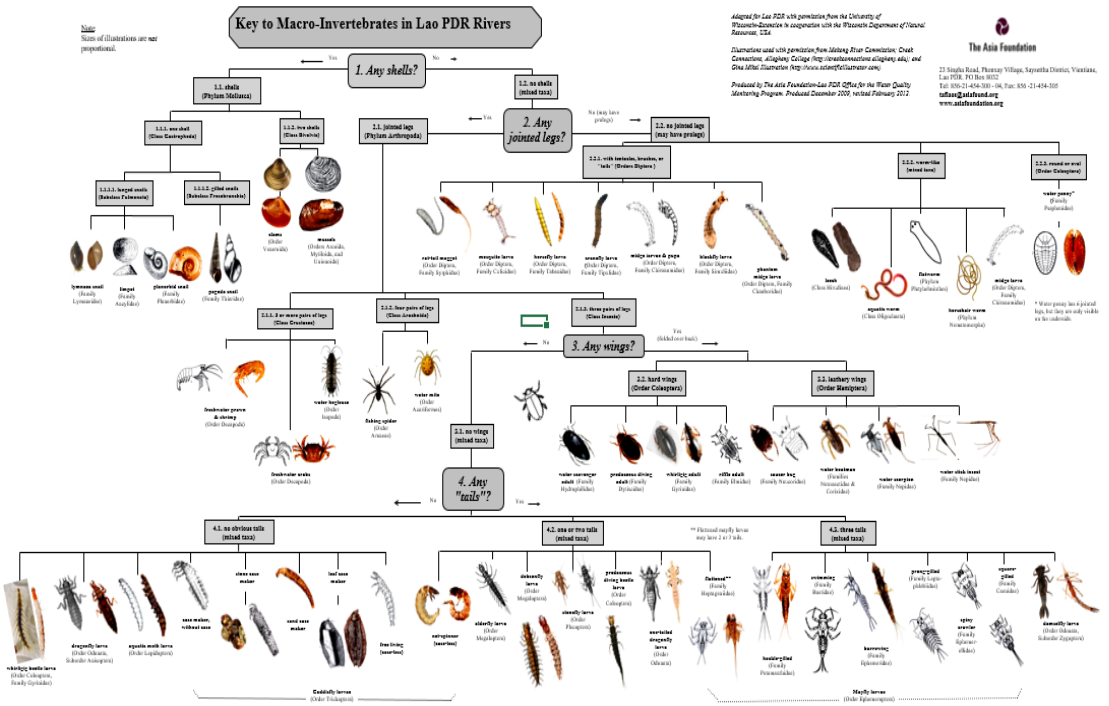




Now we know the different body parts that macroinvertebrates can have, we can use the Identification Key to Macroinvertebrates of Lao PDR

Identification Key: We start at the top and work our way down until we have identified each individual bug collected. Let's go through it together once and then you can practice by yourself.

Identification Key to Macroinvertebrates in Rivers in Lao PDR



Use the picture of the macroinvertebrates on this page to demonstrate to students how to use the identification key to identify macroinvertebrates.

Let's try to identify this water bug! Are there any legs? *[Answer is YES]*

Does it have 3 or 4 PAIRS of legs? *[Answer is THREE (3)]*

Are there any wings? *[Answer is NO]*

Does it have a tail? *[Answer is YES]*

Does it have two (2) or three (3) tails? *[Answer is TWO (2)]*

So, do you know what it is called?

It is a Stonefly nymph. They like fast water and stream edges. And they like good quality water.

[Now have students work through examples by themselves, either in groups, or in front of the class using photos of water bugs or preserved samples.]

Different water bugs can tolerate different levels of pollution in water.

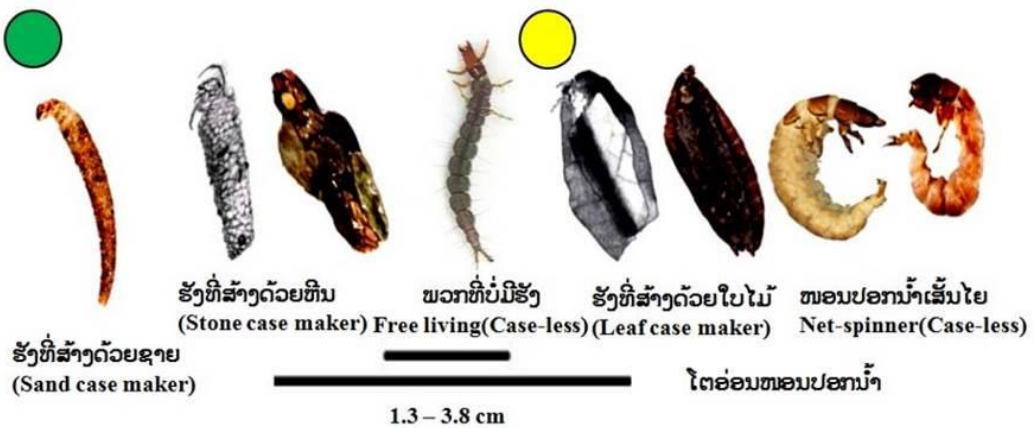
They are divided into three sensitivity groups that are colour coded as green, yellow, and red.

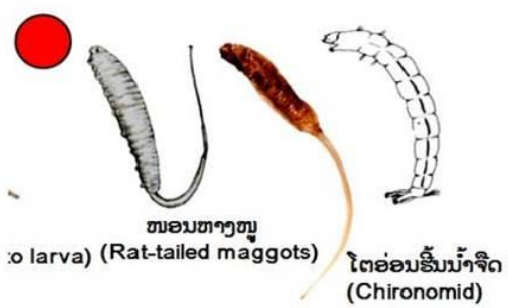
This is what helps us to know if water is good, ok or bad.

Insects with a low tolerance to polluted water are in the GREEN group

Insects with a moderate level of tolerance to polluted water are in the YELLOW group, and

Insects with a high level of tolerance to polluted water are in the RED group.





Each species has a sensitivity score from 1 to 10.

8 - 10 means it is very sensitive to pollution and you will ONLY find it in good quality water.

4 - 7 means it is moderately sensitive to pollution and you can find it in moderate to good quality water.

1 - 3 means it is not very sensitive to pollution and you can find it in poor to good quality water.

Megaloptera (Dobsonflies & Alderflies) (ແມງກ້າບເຕ່ີ)	*ໂຕອ່ອນແມງກ້າບເຕ່ີໃຫຍ່ (Dobsonfly larvae)*		8
	ໂຕອ່ອນແມງກ້າບເຕ່ີນ້ອຍ (Alderfly larvae)		6
Diptera (ແມງສອງປີກ, ຍຸງ, ແມງວັ້ນ)	*ໜອນຫາງໜູ Rat-tailed maggots*		*3*

Step 5: Record your Findings, and Calculate the Sensitivity Score

Now that we have identified each of the macroinvertebrates, we need to find out what their sensitivity score is to pollution in the water.

On the Macroinvertebrate Assessment Data Sheet, place a tick next to all the macroinvertebrate types you identified AND write the number of how many you found.

Only place one tick for each type (taxa) found (e.g. if you have more than one Stonefly you still only put one tick).

We also need to write in the sensitivity number for each macroinvertebrate present.

Remember, this is the sensitivity number between 1 and 10 that lets us know the water quality.

At the bottom of the record sheet, add up the total number of ticks. This gives you the Taxa Richness. *Remember, there should only be one tick for each type collected.*

Then add up the total sensitivity score. This gives you the Pollution Index.

Please remember to use one record sheet per site.

After you have identified all the macroinvertebrates in your sample and have completed the record sheet, return the macroinvertebrates back to the waterway.

Macroinvertebrate Assessment — Data Sheet

(Page 1 of 8) *(To be completed before and during assessment)*

Can live in **good** water quality conditions	Color	Can live in **good or fair** water quality conditions.	Color	Can live in **good, fair, or poor** water quality conditions.	Color
10 to 8 points	**Green**	**7 to 4 points**	**Yellow**	**3 to 1 points**	**Red**

Megaloptera (Dobsonflies & Alderflies)	Dobsonfly larvae		✓ 3	8	8
	Alderfly larvae		✓ 6	6	6

Water Quality Score Formula

1. Add up all of the ***Sensitivity Points*** that you assigned during collection.	**Sum of Points** =	120
2. Add up all of the ***Types of Macro-invertebrates*** you found during collection.	**Number of Types** =	16

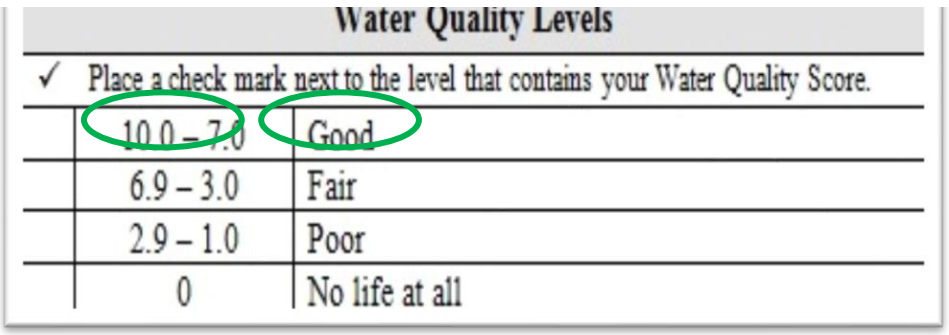
Step 6: Calculate the Water Quality Score

Now it's time to work out how healthy the waterway is using the Water Quality Score formula.

Divide the POLLUTION INDEX by the TAXA RICHNESS to get your WATER QUALITY SCORE.

[Follow the formula shown in the slide.]

3 Divide Sum of Points by Number of Types. $\text{Water Quality Score} = \frac{\text{Sum of Points}}{\text{Number of Types}} =$	(120 / 16) 7.5



Water Quality Levels		
✓	Place a check mark next to the level that contains your Water Quality Score.	
	10.0 – 7.0	Good
	6.9 – 3.0	Fair
	2.9 – 1.0	Poor
	0	No life at all

Step 7: Site Disturbance Record

What types of disturbances near a waterway can you think of? Participants may need prompting, below is a list of common disturbances for you to suggest if they need help.

- Extracting sand and gravel, or dredging the channel for river boats.
- Mining near your river site or upstream of it
- Building a dam, bridge or road
- Building houses, schools, markets, factories or hospitals
- Agriculture near the riverbank, such as gardening and grazing on the riverbank
- Human sewage and solid waste
- Forestry such as slash and burn, or logging activities near river bank
- In-stream aquaculture
- Fishing intensity
- Boat traffic
- Bathing and washing of clothes in the river
- Unnatural fluctuations in water level

Step 7: Site Disturbance Record (continued)

Recording a description of the site where we collect macroinvertebrates, helps us to identify what may be causing poor water quality.

When we understand what activities are causing poor water quality, we can take action to stop it, or reduce the impact and therefore help to improve water quality.

The Site Disturbance Record form helps us to identify activities that may change over time and assess how this might be affecting water quality based on the macro-invertebrate sampling. For example - if we test for macroinvertebrates and find that the water quality is good and there are no human activities in the area; and then 6 months later, we look for macroinvertebrates again and see that water quality is only “OKAY” we can look around and see what human activities have changed.

It is good to record water quality at least every 6 months – at least once during the wet season and once during the dry season – so we can look at changes over the year.

Site Disturbance Record (Page 1 of 4)	**Protocol & Data Sheet** *(To be completed during the field visit)*

Date:	**Time:**	☐ **Control site**	☐ **Compared site**
Name of reporter:	**, Title:**	**River name:**	
Site GPS- N:……..; E:……; Elevation:……			

Site Disturbances

Please answer the following questions on what is an existing human activities along your rivers.

Extracting sand and gravel * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name: ……** **GPS point: N:……..E: ……**
For examples: • People and machinery entering the river can destroy riverbank vegetation (see *General Information* above). • These activities deepen the channel, reducing the amount of sunlight that reaches aquatic plants on the river bottom.	
• Please describe, what is happening? _____ _____ _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located: …….. - Distance from water quality monitoring site: …….. - Area: …….. - Date(s) of site disturbance(s):…… **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**

Gold/mineral mining near your river site or upstream of it * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name:……** **GPS point: N:……..E: ……**

Now we're ready to practice in the field!!

While we prepare, think of the Lao proverb

"We will enjoy a better life if we care about the environment and protect our water resources"

Thank You

Thank you for learning

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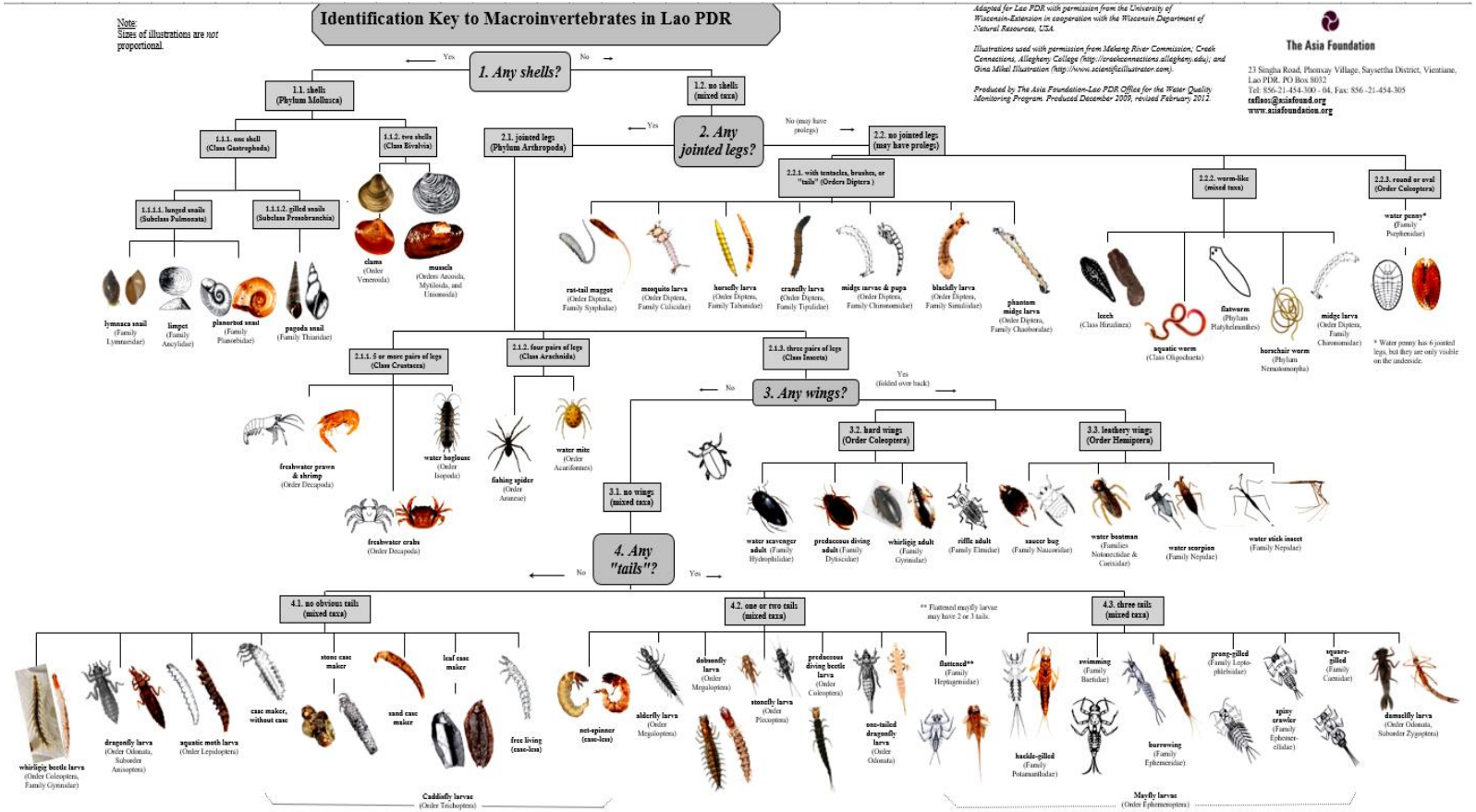
Annexes

Annex 1 – Identification Key to Macroinvertebrates in Lao PDR

Annex 2 – Macroinvertebrate Assessment Data Sheet

Annex 3 – Site Disturbance Record

Annex 1 – Identification Key to Macroinvertebrates in Lao PDR



Annex 2 - Macroinvertebrate Assessment Data Sheet

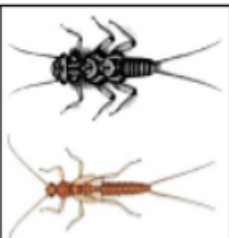
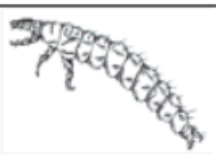
The Asia Foundation

Macroinvertebrate Assessment — Data Sheet

(To be completed before and during assessment)

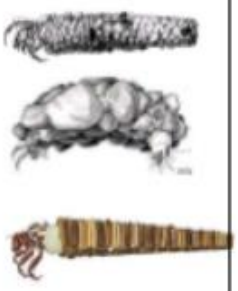
Part I: Color Dots (Before assessment)	Part II: Water Quality Score (During assessment)
1. Read ***Color Code & Sensitivity Points*** below to understand the water quality conditions represented by the colors green, yellow, and red. Place the correct color in the ***Color*** box beside the points. 2. For each ***Type of Macroinvertebrate*** listed below, look at its ***Sensitivity Points*** and place the correct color (green, yellow, or red) in the ***Color*** column. 3. Look at each picture in the ***Picture*** column and review the ***Color*** and ***Sensitivity Points*** assigned to it.	1. Collect macro-invertebrates at your river site. For each ***Type*** in your collection, write its sensitivity points in the blank box in the ***Sensitivity Points*** column. 2. Use the ***Water Quality Score Formula*** provided below to compute a ***Water Quality Score***. 3. Compare your ***Water Quality Score*** to the ***Water Quality Levels*** **table** to understand the conditions at your site.

Color Code & Sensitivity Points					
Can live in **good** water quality conditions	Color	Can live in **good or fair** water quality conditions.	Color	Can live in **good, fair, or poor** water quality conditions.	Color
10 to 8 points	Green	**7 to 4 points**	Yellow	**3 to 1 points**	Red

Scientific Name of Group	Type of Macroinvertebrate (Common Name)	Picture	Color	Sensitivity Points
Plecoptera (Stoneflies)	Stonefly larvae			10
Trichoptera (Caddisflies)	Caddisfly larvae without cases (except net-spinner caddisfly larvae)			9

Macroinvertebrate Assessment **Data Sheet**

(Page 2 of 8) *(To be completed before and during assessment)*

Trichoptera (Caddisflies)	Caddisfly larvae with sand/gravel cases			10	
	Caddisfly larvae with leaf, stick, debris cases			7	
	Net-spinner caddisfly larvae			5	
Ephemeroptera (Mayflies)	Flattened mayfly larvae			9	

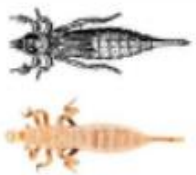
Macroinvertebrate Assessment **Data Sheet**

(Page 3 of 8) *(To be completed before and during assessment)*

Ephemeroptera (Mayflies)	Prong-gilled mayfly larvae	 		8	
	Spiny crawling mayfly larvae	 		10	
	Burrowing mayfly larvae	 		5	
	Hackle-gilled mayfly larvae	 		5	
	Swimming mayfly larvae	 		5	

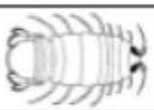
Macroinvertebrate Assessment **Data Sheet**
(Page 4 of 8) *(To be completed before and during assessment)*

Ephemeroptera (Mayflies)	Square-gilled mayfly larvae	 		4	
Hemiptera (True Bugs)	Long-mouthed saucer bugs			9	
	All other water bugs			5	

Megaloptera (Dobsonflies & Alderflies)	Dobsonfly larvae			8	
	Alderfly larvae			6	
Odonata (Dragonflies & Damselflies)	One-tailed dragonfly larvae			8	
	All other dragonfly larvae			5	
	Damselfly larvae			5	
Coleoptera (Beetles)	Whirligig beetle adults and larvae (Gyrinidae)			6	
	Water penny larvae (Psephenidae)			7	

	All other water beetles and larvae			5	
Lepidoptera (Moths and Butterflies)	Moth larvae			5	
Diptera (True flies)	Black fly larvae			6	
	Mosquito larvae			3	
	Crane fly larvae			5	
	Phantom midge			3	
	Rat-tailed maggots			2	
	Non-biting midge larvae			2	

Macroinvertebrate Assessment **Data Sheet**
(Page 7 of 8) *(To be completed before and during assessment)*

Decapoda (Prawns, Shrimp, & Crabs)	River prawns			8	
	Freshwater shrimps			4	
	River crabs			3	
Isopoda (Isopods)	Water hoglouse			3	
Pelecypoda (Mussels & Clams)	Swan mussels (Pseudodontinae)			6	
	Pea cockles			3	
Gastropoda (Snails & Limpets)	Freshwater limpets			5	
	Pagoda snails			6	
	All other snails			3	
Turbellaria	Flatworms			3	

Macroinvertebrate Assessment (Page 8 of 8)				**Data Sheet** *(To be completed before and during assessment)*	
Hirudinea	Leeches			3	
Oligochaeta	Segmented worms			1	

Water Quality Score Formula			
1. Add up all of the *Sensitivity Points* that you assigned during collection.	**Sum of Points**	=	
2. Add up all of the *Types of Macro-invertebrates* you found during collection.	**Number of Types**	=	
3. Divide Sum of Points by Number of Types.	*Water Quality Score* = $\frac{\text{Sum of Points}}{\text{Number of Types}}$	=	

Water Quality Levels		
✓	Place a check mark next to the level that contains your Water Quality Score.	
	10.0 – 7.0	Good
	6.9 – 3.0	Fair
	2.9 – 1.0	Poor
	0	No life at all

Annex 3 - Site Disturbance Record

The Asia Foundation

Site Disturbance Record — **Protocol & Data Sheet**
(Page 1 of 4) — *(To be completed during the field visit)*

Date:	Time:	☐ Control site	☐ Compared site
Name of reporter:	, Title:	River name:	
Site GPS- N:.....; E:.....; Elevation:.....			

Site Disturbances

Please answer the following questions on some existing human activities along your rivers.

Extracting sand and gravel

* If more than one site disturbance of this type, please make another entry at the end of this form.

Site name: .....
GPS point: N:.....**E:** .....

For examples:

- People and machinery entering the river can destroy riverbank vegetation (see *General Information* above).
- These activities deepen the channel, reducing the amount of sunlight that reaches aquatic plants on the river bottom.

- Please describe, what is happening?

_____
_____
_____
_____
_____
_____

- In your opinion, how is this affecting your water resources (now or potentially in the future?)

_____
_____
_____
_____

- Where located:.....
- Distance from water quality monitoring site:.....
- Area:.....
- Date(s) of site disturbance(s):.....

How serious is the disturbance? Please tick one box.

- ☐ **Little Overall Distribution**
- ☐ **Moderate Overall Distribution**
- ☐ **Substantial Overall Distribution**

Gold/mineral mining near your river site or upstream of it

* If more than one site disturbance of this type, please make another entry at the end of this form.

Site name:.....
GPS point: N:.....**E:** .....

For examples: • People and machinery on the riverbanks can destroy riverbank vegetation. • Any poisonous substances used in mining operations can flow into the river and harm or kill aquatic organisms. • Humans who eat poisoned aquatic organisms can become ill. • Mining activities sometimes draw water from the river, which lowers its level and can harm aquatic organisms and their habitats.	
• Please describe, what is happening? _____ _____ _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:..... - Distance from water quality monitoring site:..... - Area:..... - Date(s) of site disturbance(s):..... **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
Development of residential/communities, schools, markets, hospitals, restaurants, road building, bridges near the riverbank * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :..... **GPS point: N:**.....**E:** .....
For examples: • These activities can destroy riverbank vegetation and create the problem to living aquatic life. • The main sites of public communities, hospitals, markets that people can release the bad pollutions in the river as well as bank erosion. • Road surfaces do not allow water to sink into the soil, causing water to run off the road surface and erode soil beyond the road. Runoff often carries pollutants from vehicles, such as gasoline and oil, as well as sediments.	
• Please describe, what is happening? _____ _____ _____ _____ _____	- Where located:..... - Distance from water quality monitoring site:..... - Area:..... - Date(s) of site disturbance(s):..... **How serious is the disturbance? Please tick one box.**

• In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
Factories, power plants, /communities, schools, markets, hospitals, restaurants near the riverbank * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :..... **GPS point: N:**.....**E:** .....
For examples: • These activities can destroy riverbank vegetation and aquatic life. • The main sites of public communities, hospitals, markets that people can release the bad pollutions in the river as well as bank erosion. • If there is discharge, spills	
• Please describe, what is happening? _____ _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:..... - Distance from water quality monitoring site:..... - Area:..... - Date(s) of site disturbance(s):..... **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**

Agriculture near river bank such as: garden/crop farming, livestock grazing, swidden agriculture. * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :..... **GPS point: N:**.....**E:** .....
For examples: • These activities can destroy riverbank vegetation. • Fertilizers and pesticides used on crops can become chemical pollution in the river. • Humans who eat aquatic organisms poisoned by pesticides can become ill. • Livestock wastes can cause organic pollution in the river.	
• Please describe, what is happening?	- Where located:..... - Distance from water quality monitoring

_____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	site:…….. - Area:…… - Date(s) of site disturbance(s):…… **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
Forestry: slash and burn, logging activities near river bank * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :…… **GPS point: N:**……..**E:** ……
For examples: • These activities can cause bank erosion and make water turbidity • Logging activities (selective or intensive logging) can cause flood and drought phenomena and affect to hydrological system. • Shade from trees can be reduced, which allows the sun to warm the water. This reduces dissolved oxygen levels in the river	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:…….. - Distance from water quality monitoring site:…….. - Area:…… - Date(s) of site disturbance(s):…… **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
In-stream aquaculture * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :…… **GPS point: N:**……..**E:** ……
For examples: • Large populations of aquatic organisms produce large volumes of waste, which can cause organic pollution in the river. • When many aquatic organisms are confined to a small area in the river, diseases can multiply rapidly and can be spread to wild	

populations of aquatic organisms.	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:…….. - Distance from water quality monitoring site:…….. - Area:…… - Date(s) of site disturbance(s):…… **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**

Fishing intensity * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :…… **GPS point: N:**……..**E:** ……
For examples: • Overfishing can deplete populations of fish, which can cause other organisms to decrease or disappear. *Please note: Lao rivers can accommodate a lot of fishing pressure as long as the aquatic habitats that support them are healthy.*	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:…….. - Distance from water quality monitoring site:…….. - Area:…… - Date(s) of site disturbance(s):…… **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**

Human sewage and solid waste * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :…… **GPS point: N:**……..**E:** ……

For examples:

- Human sewage can cause organic pollution in the river.
- Solid waste (trash, car washing and other discarded items) can get into the river and harm aquatic organisms.
- Some trash may contain toxic substances that can harm or kill aquatic organisms.
- Trash from human activities often gets into rivers. Trash can include plastic bags and other items that do not break down. If aquatic organisms swallow plastic items, they can die. Plastic items that become stuck on the riverbed can smother aquatic organisms and their habitats.

- Please describe, what is happening?

_____
_____
_____
_____

- In your opinion, how is this affecting your water resources (now or potentially in the future?)

_____
_____
_____
_____

- Where located:.....
- Distance from water quality monitoring site:.....
- Area:.....
- Date(s) of site disturbance(s):.....

How serious is the disturbance? Please tick one box.

- ☐ **Little Overall Distribution**
- ☐ **Moderate Overall Distribution**
- ☐ **Substantial Overall Distribution**

Boat traffic

Site name :.....

GPS point: N:.....**E:** .....

For examples:

- People walking into and out of the river can destroy riverbank vegetation.
- Boats can stir up sediments on the riverbed, which can clog the gills of aquatic organisms.
- Motor boats can leak gasoline and oil into the river, causing chemical pollution.

- Please describe, what is happening?

_____
_____
_____
_____
_____
_____

- In your opinion, how is this affecting your water resources (now or potentially in the future?)

- Where located:.....
- Distance from water quality monitoring site:.....
- Area:.....
- Date(s) of site disturbance(s):.....

How serious is the disturbance? Please tick one box.

- ☐ **Little Overall Distribution**
- ☐ **Moderate Overall Distribution**
- ☐ **Substantial Overall Distribution**

_____ _____ _____ _____	

Bathing and washing of clothes in the river * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name :**..... **GPS point: N:**.....**E:** .....
For examples: • These activities introduce soap and/or detergent into the river, causing chemical pollution. • People walking down to the river can destroy riverbank vegetation.	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:..... - Distance from water quality monitoring site:..... - Area:..... - Date(s) of site disturbance(s):..... **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
Unusual animal conditions in/near River * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name :**..... **GPS point: N:**.....**E:** .....
For examples: • Fish died or using explosives to catch fish • Animals, waterfowl died	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now	- Where located:..... - Distance from WQM site:..... - Area:..... - Date of site establishment:.....

or potentially in the future?) _____ _____ _____ _____ **Please tick one in the box** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**	
Unnatural fluctuations in water level * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :…… **GPS point: N**:……**E**: ……
For examples: • This could be due to a dam, water diversions, water withdrawals, or other human activities. • Low water levels can cause aquatic organisms to become stranded above the water level, where they suffocate without the dissolved oxygen contained in water. Stranded organisms are also more exposed to predators. • Low water slows down and warms up. • Low, slow water does not effectively flush out pollutants. This can degrade drinking water supplies and allow disease organisms to multiply, impacting human health. • High water levels can cause riverbank erosion and sedimentation downstream. • High water moves fast and can dislodge aquatic organisms from the river bottom. • Flooded rivers can pick up pollutants and trash from riverbanks.	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:…… - Distance from water quality monitoring site:…….. - Area:…… - Date(s) of site disturbance(s):…… **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
Unusual physical characteristics of water resources * If more than one site disturbance of this type, please make another entry at the end of this form.	**Site name** :…… **GPS point: N**:……**E**: ……

For examples: • River : taste, smell, color • The well: taste, smell, color	
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____	- Where located:..... - Distance from water quality monitoring site:..... - Area:..... - Date(s) of site disturbance(s):..... **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**
Other (please specify and insert a new entry for each different site disturbance)	**Site name :**..... **GPS point: N:**.....**E:** .....
• Please describe, what is happening? _____ _____ _____ _____ • In your opinion, how is this affecting your water resources (now or potentially in the future?) _____ _____ _____ _____	- Where located:..... - Distance from water quality monitoring site:..... - Area:..... - Date(s) of site disturbance(s):..... **How serious is the disturbance? Please tick one box.** ☐ **Little Overall Distribution** ☐ **Moderate Overall Distribution** ☐ **Substantial Overall Distribution**

Sum of Points = ☐

Observer Score = $\frac{\text{Sum of Points}}{\text{10 Disturbances}}$ = ☐

Site Disturbance Score Range		
Little overall disturbance	Moderate overall disturbance	Substantial overall disturbance
3.0 – 2.6	2.5 – 1.7	1.6 – 1.0