

HOW INVESTIGATION OF CATCHMENT WATER QUALITY AND ITS ENVIRONMENT CAN BE POSSIBLE FOR HIGH SCHOOL STUDENTS

— — A Case Study of Huanglongxian
Eco Village and Its Implications
on Environmental Education

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1 Abstract

With the aim of investigating the relationship between human activity, water quality and natural ecosystem, we tested selected water bodies following the water cycle—from rainwater to tea plantation irrigation and finally to a reservoir. Using simple equipment, we found that domestic waste and pesticide deteriorates water quality in the short run while wetlands and buffers like reservoirs act as cleansing agents. Advocation of water purifying systems will be quite effective, especially in spots like domestic sewage. For high school students, the experience facilitates understanding of society’s influence on the environment and urge positive action to restore wetlands, reduce the use of pesticides and further the exploration of the environment.

2 Background

40 kilometers away from Nanjing, one of the major cities in China, lies a hilly and mountainous region where villagers have been growing tea for decades. Tea plantations and production are the local people’s main way of making a living, sometimes accompanied by paddy fields. As the ecosystems in this region is directly connected with that of the Yangtze River, whose main stream passes through this region in merely under 20 kilometers away, the ecological health and water quality of this region is receiving an increasing amount of attention from scholars, environmentalists and experts on catchment management. One of the villages named “Huangongxian” has become a tourist attraction site with a growing number of guesthouses and restaurants, making it more vulnerable to degrading water quality. There are currently 52 registered households and approximately 1.5 square kilometer of tea plantation in this village.

Founded with the prospect of promoting environmental education, QBY is now becoming a multifunctional complex that does environmental evaluation for various projects, holds event to invite urban children into the villages to learn about the environment hands-on, and most prominently, utilizes the natural resources in the area to conduct experimental farming in order to reduce the use of pesticides and restore the ecosystem of the Yangtze River basin. In addition, QBY monitors the water quality in the area regularly to study the ef-

fects of tea plantation and other farmlands on it and the implications on management of catchment water in this area.

As the conflict between the incessantly expanding population and the want of better quality of life on our planet worsens, the environment is facing ever intensifying problems. One of the most pressing need at the moment is to let the inhabitants of our planet, among whom students being the most efficient, to realize the problem and start paying attention. The whys and hows regarding this are still being debated. Coming from UWC¹ and the IB system, we believe that environmental education for high school students is necessary and should become an indispensable part in secondary education and that the best way to learn is through experience and preferably, tangible results. With all these in mind, we started this project as an experiment of using simple and accessible equipments and resources to do environmental investigation, in the hope of deriving certain results and prove this mode of education plausible for the future.

3 Resources and Equipments

All resources and equipment we use are easily operable and accessible for high school students.

3.1 Portable pH Monitor

In this project, we used the pH probe from Mettler Toledo company, a quite expensive and accurate machine, from a yogurt company partnering with AWS, as in Figure 1 Another cheaper and more accessible alternative is the simple pH indicator paper that changes color according to the pH of the liquid it's soaked in, and the pH value can be read by comparing the color with the standards.

¹The United World Colleges are a global education movement that makes education a force to unite people, nations and cultures for peace and a sustainable future by bringing diverse (in terms of nationality) groups of students together deliberately. The International Baccalaureate (IB)—a diploma program aiming to prepare students for college and beyond—is taught in the UWCs and it emphasizes experiential learning and encourages its students to explore the world. Combining UWC's core values of respect for environment and a sense of idealism with IB's "learn from experience", we take the initiative of learning about the environment and trying to identify the potential problems along with their solutions through field trips and investigation.



Fig. 1. pH probe from Mettler Toledo



Fig. 2. The water quality testing kit

3.2 Simple Surface Water Testing Kit

Testing kits are a simple method of measuring water quality indicators like phosphate, nitrate or metals. As in Figure 2, the plastic tubes each contain a specific kind of powder that reacts with the water quality indicator in question, appearing in different colors according to its concentration. The kits are highly operable. We simply pull out the yellow string(which would open a small hole at the top of the tube), squeeze half of the air out of the tube and put it under the sample's surface. Atmospheric pressure pushes the water inside the tube and there they meet the powder. After the water stops coming into the tube, we take the tube out, shake the tube and wait for a certain period of time according to the type of water indicator tested. Then comparison has to be made between the color shown and the standards. A packet of testing kit which contains four of the testing tubes are affordable at the price around \$20 and can serve the purpose of testing the concentration of some of the water quality indicators.

3.3 Google Earth, The Internet and Camera

Google Earth, a new generation of map, contains 3D representation of our planet earth based on satellite image. For the project, this software provides a relatively high resolution image of the landscape and water bodies in both 2D and 3D forms. It also provides data of the altitude of every point on the map, which can be very helpful for us to determine the direction of water flow— a key aspect when analyzing water quality. We can find other scholar's research papers, relevant data, developments made in the village in past years and all kinds of things that are enormously helpful from the internet. Taking

photos is a easy way to instantly record our discoveries for future use and reference.

4 Understanding Water Flows and Choosing the Sampling Sites

As for the investigation, we began with understanding the water cycle in order to choose sampling sites. To study the quality of water in a catchment, it's necessary to analyze the cause of the changes in water quality presented by the data with relation to the environment, namely, how the component of the water is influenced by the lands that the water pass through. By walking around the area, we determined that the water bodies can be classified into the following categories: natural lakes, artificial landscape lakes for tourism purposes, fishing ponds, small seasonal ponds, paddy fields, reservoir and small connective waterways, as you can find them in the annotated map in Figure 9.



Fig. 3. Natural Lake



Fig. 4. Reservoir



Fig. 5. Waterway



Fig. 6. Fishing Pond



Fig. 7. Artificial Lake



Fig. 8. Domestic Sewage



Fig. 9. Overall anotated map of investigated area

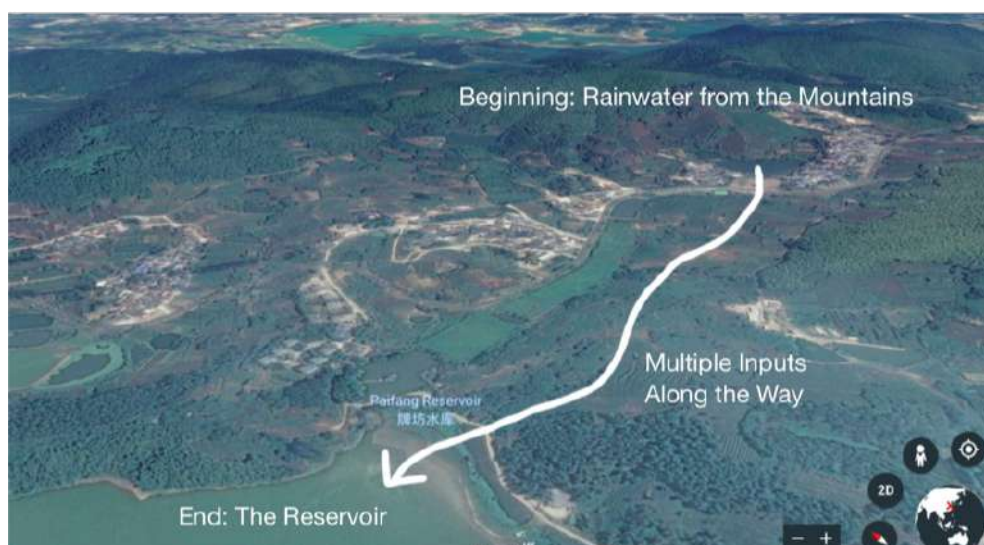


Fig. 10. 3D map of investigated area from Google Earth

Using the altitudes recorded on Google Earth in Figure 10, we then try to find out the direction of water flow. The natural lake is the highest part and the altitude of the waterway gradually decreases as it moves through the tea plantations and paddy fields towards the reservoir. So it can be concluded that generally, water in the streams and runoffs in this area flows from mountain top into the reservoir.

With a closer look at the tea plantations themselves, water flows are highly regulated by constructed channels and how the water gathers becomes clearer.

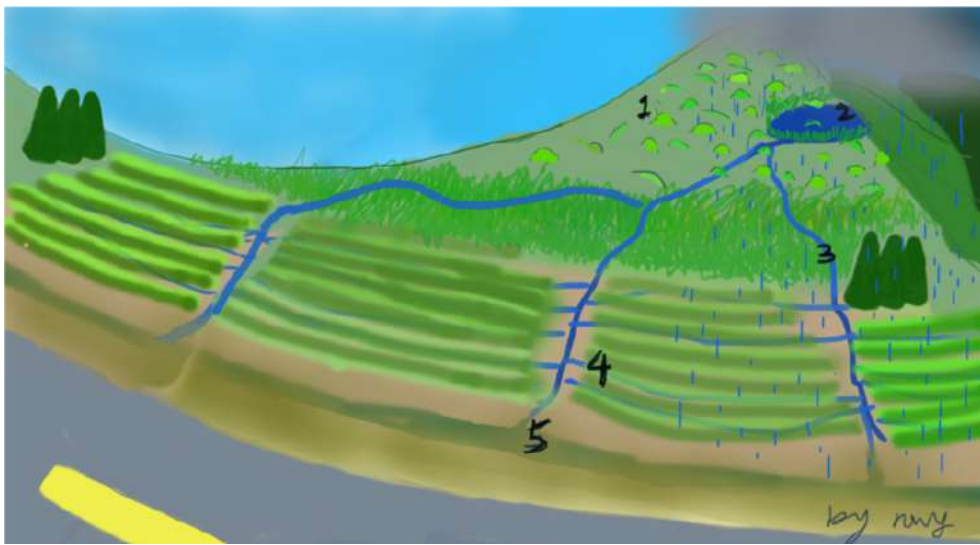


Fig. 11. Illustration of the water flowing in a typical tea plantation in the area

In the illustration in Figure 11, the number (1) represents the top region of mountains that are often covered by naturally occurring coniferous and/or bamboo forests. (2) is a natural pond collecting rain water that can be found in most of the mountains in the region. And as it rains, these ponds or lakes overflow and the water then flows down the mountains through natural or artificial streams (3) towards the tea plantations. And then manipulated by farmers, the streams divide into smaller streams that irrigate the tea plantations (4) before gathering into the waterways (5) directed towards the reservoir.

Table 1. Chosen Sites

Mountaintop Lake	#1
Artificial Lake	#2
Natural Lake	#3
Paddy Field	#4
Reservoir	#5
Small Pond	#6
Domestic Sewage	#7

In order to investigate the effect of tea plantations, paddy fields and domestic water usage on the surface water quality of the region, we decided to take samples before and after water flowing into particular places shown in Table 1.

5 Testing Results and Analysis

With the tools introduced above, we measured the pH, phosphate, heavy metal, ammonia-nitrogen, COD and iron of each sample.

The results are shown in the table below:

Table 2. Collected data for water quality

	Number	Phosphate (ppm)	Heavy Metal(ppm)	pH	Ammonia- Nitrogen(ppm)	COD	Iron(ppm)	Evaluation
Mountaintop Lake	#1	0.02	0	8.50	0.2	8	0	moderate
Artificial Lake	#2	0.03	0.1	9.20	0.2	8	0	slight
Natural Lake	#3	0.02	0	8.84	0.2	8	-	slight
Paddy Field	#4	0.1	-	7.30	0.2	8	-	moderate
Reservoir	#5	0.02	0	8.75	0.2	7	0.1	slight
Small Pond	#6	0.02	0.1	8.50	0.2	8	0.05	clear
Domestic Sewage	#7	0.2	0.4	7.84	0.2	7	-	severe

The overall water quality is quite satisfying. The pollution of the water spots are increasing with the amount of human activities, so certain actions taken at some spots is quite essential in order to maintain the health of the water body. Visualized information of pollution can be found in the map at the end of this session.

We can see that the data of the Mountain top Lake is quite normal. However, since the water stinks while it bears a high turbidity value and shines a dirty greenish color under the sunlight, we consider it moderately polluted. Through the interview afterwards, we find out that all kinds of organic waste, including the kitchen waste, are gathered near the tea plantation and fermented into nature fertilizer. Knowing that the Mountaintop Lake are near the fermentation area, it's likely that there are a lot of nutrients like nitrate or phosphate in it.

The water of the Artificial lake looks beautiful and only the pH value of the data is abnormal. However, there are some algae floating on the water, so we marked it slightly polluted. The pH of the the Natural Lake is slightly abnormal. However, the lake is mostly isolated and its water are mostly rain water apart from the water flows down from higher altitude. We mark this Natural Lake slightly polluted.

Now we arrive at the Paddy Field. In the photo in Figure 6, we can see the waterway that water flows down through. The phosphate are rather high while the pH value of it is below normal range. We mark this spot as moderately polluted but we believe there will be a change.

This piece of land is now owned by QBY Environment Centre and they are carrying out a program to use no fertilizers and pesticides raising the paddy. Research has shown that the increase of the use of fertilizers have lead to the increase of the use of pesticides. Before the invention of fertilizer and pesticide, people use natural fertilizer at most and there were no phenomenon of artificial-eutrophication or frequent plague of insects. When we use fertilizers today, the young seedlings are growing up too quickly and they become so delicious that enough insects arrive and eat them up before they become ripe. In this case, the seedlings need extra help and the help is the pesticide. However, agriculture today needs to pursue efficiency and productivity, so the project QBY Environment Centre is doing today can only count as an experiment while the possibility of keeping both zero-fertilizer and productivity still requires exploration.

Finally, we reach the reservoir. The pH is a bit high, but since it's the spot with the largest water capacity and any pollution can be

diluted in this case, we mark it as slightly polluted. The temperature was high when we collected the water and you can see the channel use for flooding is completely dry. However what remains unknown to us is where the water flows after it exit the reservoir.

There are some spots that are not on the main flow from the mountaintop to the reservoir:

The first one is #6, the Small Pond. We find this small pond on the way between the Paddy Field and the Reservoir. The water quality is quite nice so we suspect that its majority is accumulation of rain water. When there is a lot of precipitation and water level of this pond rises, it can leak through the channel at the bottom of the photo, joining water in waterway and head towards the reservoir.

Spot #7 is a Domestic Sewage gathering point. Indubitably, this spot the the most severely polluted one. We mark this spot as severely polluted. From the table, we can see the data of phosphate and heavy metals are far exceeding normal level.

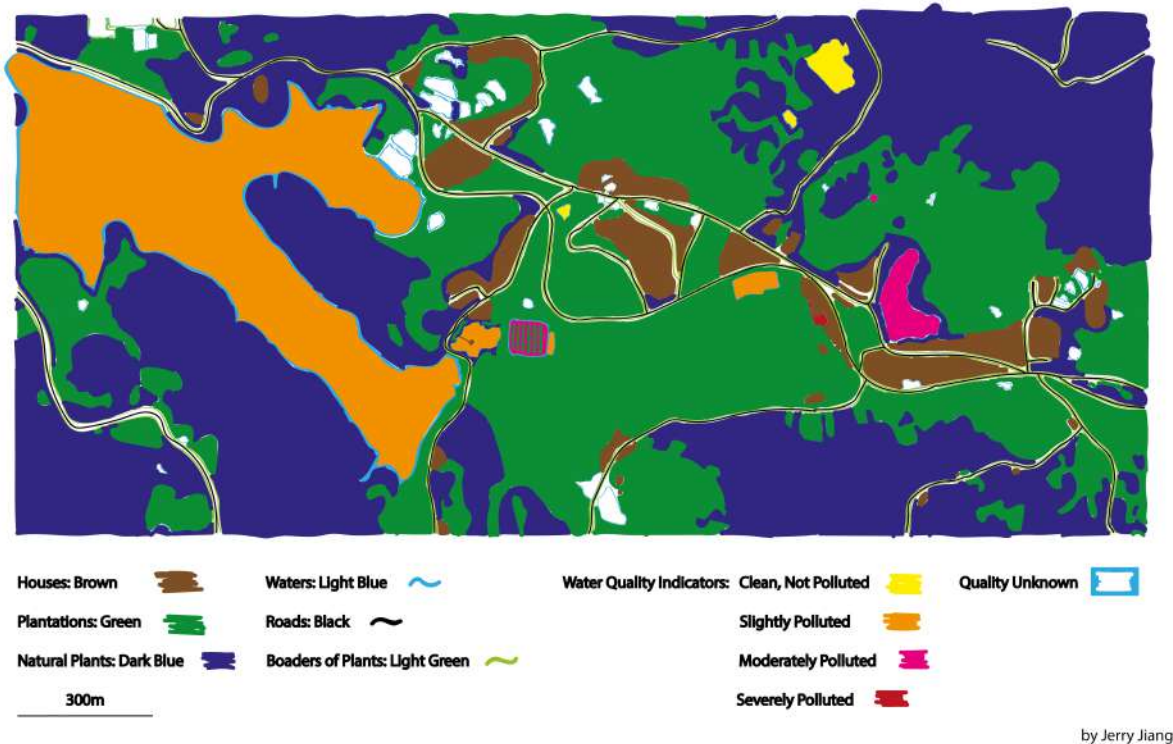


Fig. 12. Hydrographic Map

Gathering all the data and referring to the digital map, we create this hydrographic map, as in Figure 12. The black lines are roads, green blocks are plantations while dark green blocks are forest. Yellow, Orange, Dark Orange and Red blocks are used to illustrate the water quality of the spots. Unpredictable water spots are not colored.

5.1 Other Observations

Human Activities

Another water spot I want to mention is the lake locating on the mountain. Actually, we didn't bring back any water sample from that lake and we have only been there once when we went into the mountain to watch the fireflies at night. But you can find the photo of the fireflies in Figure 13 However, since that lake is deep inside the forest and bushes, and no artificially contacted water reach there, we decide to mark it as clean and unpolluted in the hydrographic Map. A side proof is that fireflies are seen to drink the water from the lake and footprints of wild pigs are found near the lake. Fireflies are known to be highly selective in their habitants, so it's quite reasonable to say that the fireflies are act as the indicator species to show the good water quality of the water.



Fig. 13. Photo of fireflies in the mountain

6 Discussion

Major threat to the local water bodies and people's awareness

People are not fully aware of the water quality condition there. Although the overall quality is not bad yet, it's very important to establish the awareness. Educational speeches and lecture can be made by Qianbaiyuan Centre to the local inhabitants, systems with purifying functions like the one in the Qianbaiyuan Centre is worth of advocating to the community.

Personal learnings from this activity

Through this project, we met some environmental science experts and went through the brilliant design of the Qianbaiyuan Centre. We had the opportunity to have a taste of how going into the fields, collecting samples and analyzing them is like. A lot of information and knowledge of environmental science, especially about water systems is gained in the project and the establishment of the importance of water health is made. It's a pity not to have the amazing ideas inside the center spread out.

Suggestions to environmental education of High-school Students

The awareness of the importance of environment health is not clear yet to high-school students. More projects and experiments should be encouraged in the science education system. Meanwhile, projects outside classroom in to the water bodies is quite meaningful and informative. School should start to pay attention to the topic and pass down this idea to the student. As the society develops, deterioration of the environment is gradually becoming obvious. It's not to late now for student to start paying attention on this subject and they will make a difference when they become an adult.