



Cumulative Environmental Impact of Humans' (Agro-Business) Activities

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Abstract

This study analyzed the wastewater discharge of a four-region area comprised of agro-businesses (i.e. vegetable as well as commercial animal farms) and an adjacent urban area. Each region is respectively using a five-kilometer-long human-made irrigation system that collectively concludes at (and is injecting wastewater into) a major river leading to the Pacific Ocean. Using research methodology involving scientific measurements taken at strategic points located throughout this irrigation system, we deductively isolated which region in this overall area is the most significant respective contributor to the amassed wastewater. We hypothesized that the agro-business area involving commercial animal farming would be the most significant contributor. While we discovered that this is partly correct, the urban area is discharging the most concentrated levels of waste, including raw sewage. We do suspect that Taiwan's environmental pollution regulations are being violated. However, further analysis involving wastewater volume, soil analysis, agro-business, and urban social construction identification, as well as the identifying of relevant environmental protection laws is still needed. This would best capacitate activism efforts toward lobbying government or non-government organizations for potential environmental violations related to the intervention.

1. Introduction

Global environmental pollution issues are surely becoming ever-more prominent. Humans, perhaps after over one century (or more) of functioning in a stage of industrial and materially driven comfort-slumber are arguably becoming more aware (or reminded) of our intimate and vital connection with Planet Earth's holistic ecosystems [1], [2]. However, capitalist global market-driven business initiatives continue with our planet's finite natural resources as a commodity. A socio-ecological business model designed with capitalism's purpose of perpetual profits 'growth' is indeed unsustainable [3].

Generally speaking, while the scientific observation of environmental issues has traditionally in many ways been understood largely from a bird's-eye macro-scale view, this observatory reality is increasingly transforming to that of a more dynamic micro-details scale [4]. Observations that have been typically that of science-based protocols are now becoming ever-more coupled with social-based observations and related multi-level governance initiatives. People are realizing evermore that we need each other, and everything is connected[5]–[7]. Hopefully, it is not too late.

Water is vital for all life. In terms of human activities, particularly land commodification for the purposes of food (and business) production water is also a required single resource that is often used by multiple stakeholders [1], [2]. Water management is essential; mitigating resource conflicts is also crucial. Poor water resources management flows downstream, philosophically and literally impacting everyone and everything. This is particularly true when the actions of one party impact the environments of others [6]–[8].

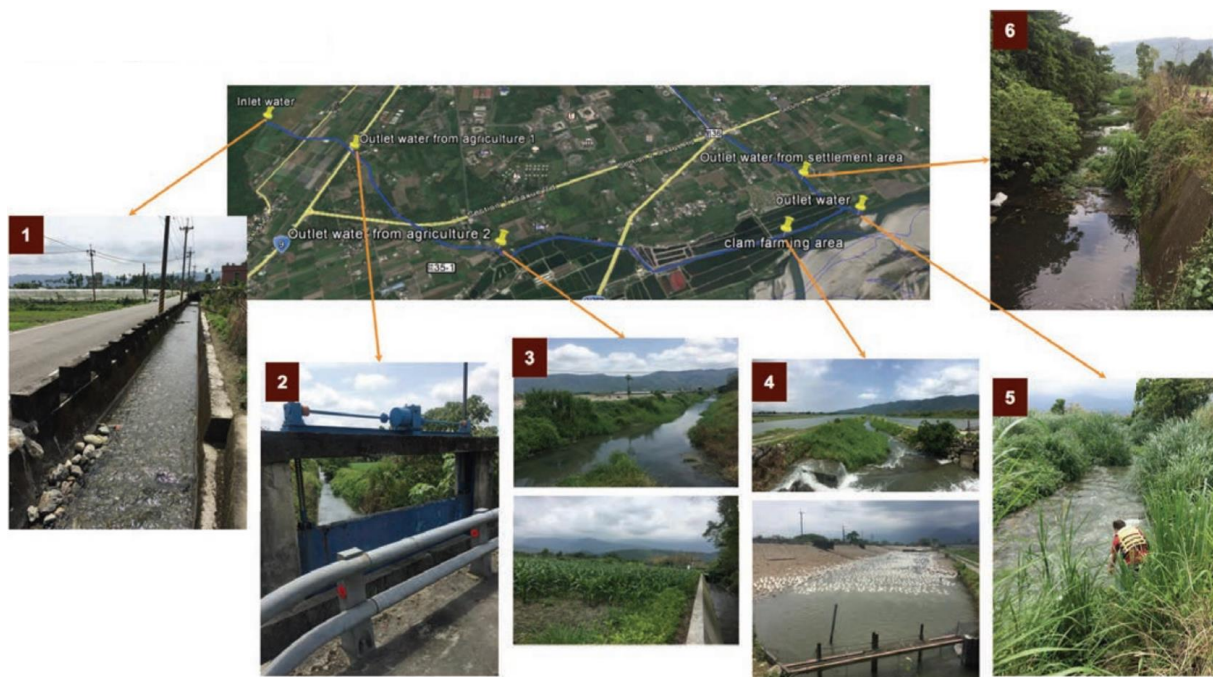


Figure 1. The sampling location with its field conditions, 1) the upstream water, 2) the outlet water from agriculture 1, 3) the outlet water from agriculture 2, 4) the outlet water from livestock farming area, 5) the outlet water from all water systems, and 6) the outlet water from settlement area.

2. Environmental condition of the study area

Used primarily for agro-business purposes, this two-part irrigation system has a length of 5.11 km (used for agriculture and livestock, see figure 1), the second irrigation system has a length of 1.8 km which is used for urban wastewater discharge. In addition to farming activities, this water flow is exploited by local urban communities for daily needs. The water is supplied via ditches that direct the water southward of the Zhixue area. This water-flow system ends at the Hualien longitudinal river that flows directly into the Pacific ocean (figure 2).

The study area is comprised of marble (rich CaCO_3) and a metamorphic rock belt (rich metal elements, and Potash) [9]. The groundwater and surface water are reacting with the surrounding rocks until there is an equilibrium condition. it is estimated that the water type is bicarbonate water (based on pH neutral, basic, and alkaline).

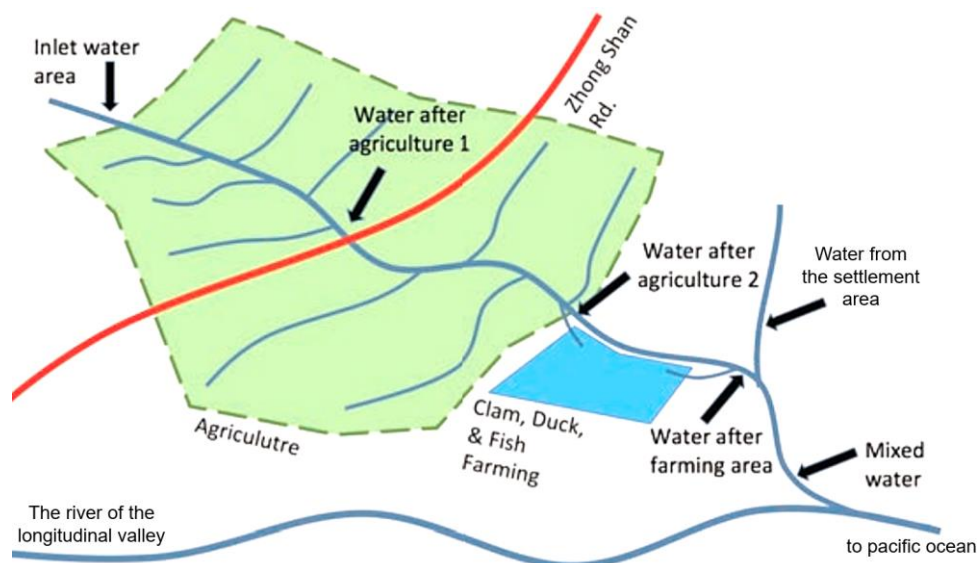


Figure 2. The conceptual model of water utilization around the study area

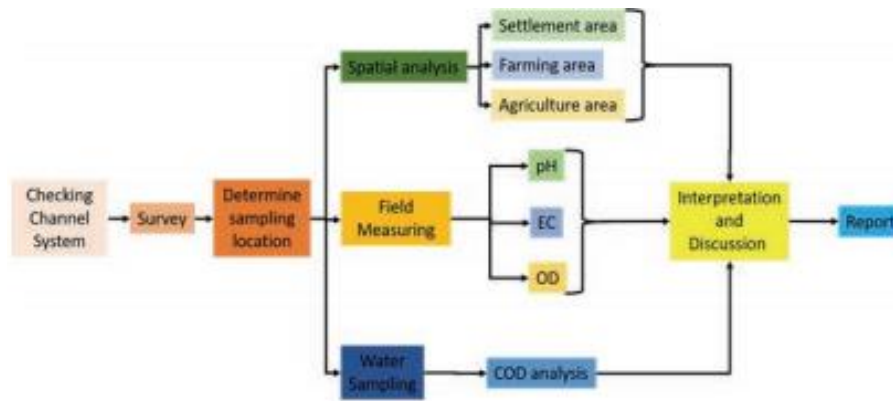


Figure 3. The flowchart and stages of the study

3. Methodology

This research project was accomplished in three stages (Figure 3): survey, implementation, and reporting. The survey stage involved identifying and analyzing our study area's four regions and their respective land water utilization. We mapped this, our planned water measuring points, and discussed our methodology [10], [11]. The water sampling was executed into two stages, which help each time to arrive at some new and important hypothetical conclusions. The first measurement was taken on a dry day. The second measurement was on a rainy day. The trial was mostly conducted on location during a day that best replicated the severe pollution taking place (i.e. potential illegal dumping) during our preliminary survey that is not able to accomplish this [3], [8], [12]–[14].

Taiwan government irrigation water quality standards for our study was pH range six to nine, the electroconductivity cannot be more than 750, dissolved oxygen must be more than 3, while the COD value has not regulated. These regulations would become the basic water quality standard of each sample. The study has divided the study area into four parts based on activities taking place (see figure 4). This includes the inlet water area (region 1), rice and tarot field (region 2), banana plantations and another gardening area (region 3), animal farms including ducks, clams, and pigs (region 4), the mixing water utilization (region 5), and the urban (region 6) [15], [16].

4. Results

The observed environment of the study area varied greatly depending on the sampling days. In addition to scientific measurements, we performed weekly observations while taking photographs and on fixed water samples. We place the date of full-day sunny (April 27th, 2018) and the date of full-day rainy (June 1st, 2018). We measured pH, electroconductivity (EC), and dissolved oxygen (DO) directly on the field. The chemical oxygen demand (COD) analysis was conducted in the water quality lab. The analysis result has shown the water quality changing through each water utilization (see figure 4).

Apparently, the agency of water purification plant distributes water into this stream and regular measure the water quality, while this may be their water being distributed into the stream by the water treatment plant, our individual results reveal a much different picture of this stream, including raw sewage being injected into this tributary. We provided preliminary results that compared with the water quality station belonging to the local agency (table 1). The water quality station is located nearly outlet water flow to the pacific ocean.

Table 1. The preliminary result of water quality measurement. The marked * belongs to the local water quality agency

Date of sampling	time	PH	EC μmho/cm 25 °C	DO mg/L	COD mg/L
2018/05/10*	11.25	8.44	240	9.7	6.9
2018/05/10 sunny	-	8.1	400	5.43	-
2018/05/17 rainy	-	7.7	315	4.45	-

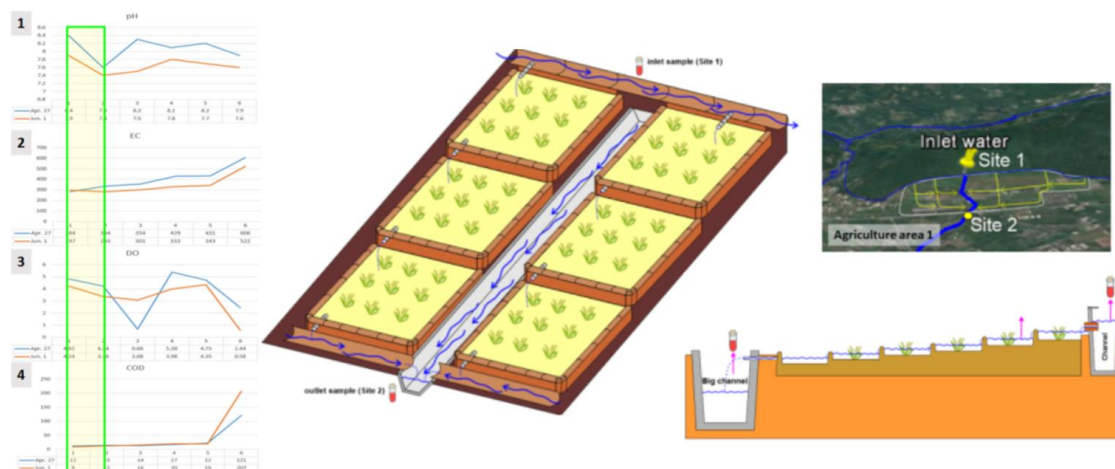


Figure 4. The result of water quality analysis through various land utilization. The number location is referring to figure 1.

5. Discussion

5.1. water condition of agriculture area 1

The first (organic) farming area is quite normal. The pH becomes acidic because of fertilizer usage. The EC increase also indicates reactions to the fertilizer, increasing iron content. DO levels are normal for this type of agricultural area. The oxygen levels will decrease during the day. A lot of algae exists in this area, creating photosynthesis. Water condition when clear day and rainy day, April 27 was a clear day and June 1 was a rainy day. Basically, rainwater is neutral and acid (if environmental conditions are bad). When rainwater is mixed with the surface water, it will change the surface water condition. Purely source water is basic water (bicarbonate water), the pure water changed due to each land utilization, so water got acid from rainwater. EC represents the ion content of surface water, so when mixed with rainwater, the EC is reduced. Similar to DO. Especially on site 3, there was dry agriculture, so the DO process was very low when clear day, but when the rainy day the water surge some from site 2 then recorded on site 3 (see figure 5).



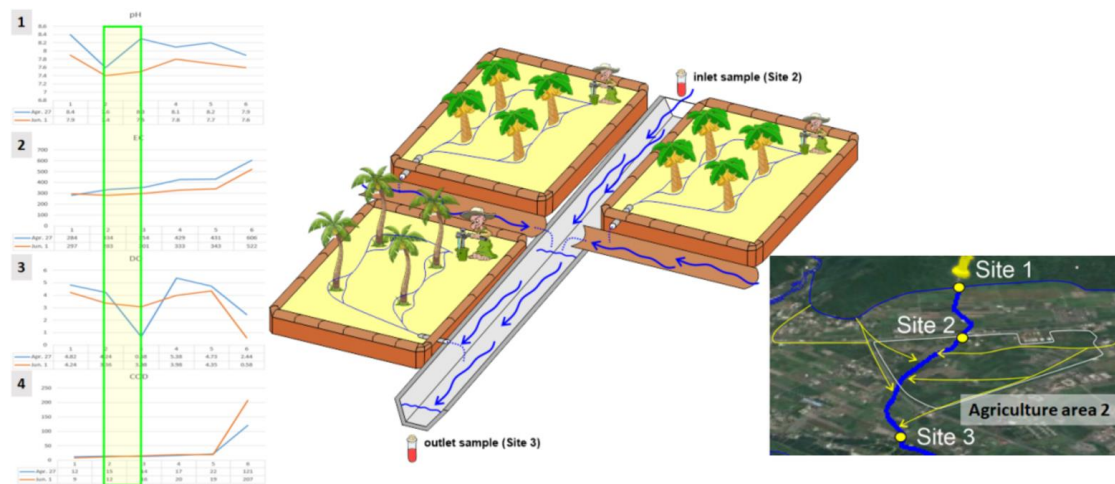


Figure 6. The conceptual model of water utilization system in the agriculture area 2

5.2. Water condition of agriculture area 2

This is the commercial banana farming and gardening area. The pH became basic, and the EC increased slightly. Maybe the farmers weren't using fertilizer during this time, or there was less water application. The fertilizer from the first area may get absorbed into the soil within area two. The DO increases significantly in this area. water condition of agriculture 2, Site 3 represents water accumulation from agriculture 1 and agriculture 2. Agriculture 2 is dryland agriculture, the farmer when use water just only when dewatering time. pH becomes basic the water flow through the water channel made by cement infrastructure. Cement contains rich bicarbonate. This phenomenon proved when had rain the water become acid. The water dilutes some materials from agriculture 2 which is using fertilizer, that's why the EC number was increasing. The DO process was very low when clear day, but when the rainy day the water surge come from site 2 was dominated when recorded on site 3. COD represents organic material in the water, it shows that organic material in the area is still in normal condition (see figure 6).

5.3. water condition of the aquafarm area

This area represents water accumulation from areas one and two (see figure 7). Area two is dryland agriculture; the farmer uses water only when needed. The pH became basic because the water only flows through the water channel that is made of cement. Cement contains rich bicarbonate. This phenomenon explained why when their rain the water became acidic. The rainwater dilutes some pollution (e.g fertilizer) from agriculture two; this is why the EC increased. Not much for DO processes happened during a clear day. However, a rainy day caused the water to surge from area two into area three, which was recorded in area three. COD represents organic material in the water. Our measurements reveal that organic in the area is still in normal condition.



Figure 7. The conceptual model of water utilization system in the aquafarm area



Figure 8. The conceptual model of the water utilization system in the mixed area

Water condition freshwater farming area, the site represents water accumulation from agriculture 1, agriculture 2, and freshwater farming. The pH becomes acid because the water gets with the feces of ducks, pigs, fishes, and waste food animal feed. The EC increases because of the reaction of water with feces and waste food that may contain high ions. The DO dramatically increased, because of the demand for the high amount of animal water. To increase the DO number they used an aerator. The COD represents organic material in the water, it shows that organic material in the area is still in normal condition.

5.4. water condition of the mixed water

Water accumulation from agriculture areas one, two, and freshwater farming. The pH became acid because of the water mixing with feces from ducks, pigs, and fish, as well as animal feed; all of this material may have high iron content. The DO dramatically increased, because of so much feces-polluted water. Still, COD represents organic material, and the area still is relatively in the normal condition. Mixing of wastewater from agricultural and urban areas. Mixed with the sewage water from the urban area. The water is acidic. Water condition of mixed water, site 5 represents accumulation condition water from all sampling sites. The pH becomes basic because of the water reaction with cement infrastructure that contains high bicarbonate. The EC, DO. And COD decreased because the water was not underutilization again. Physically the water condition still showing not feasible for consumption purposes (see figure 8).

5.5. water condition of the settlement area

The most significant influence on our study area is from the urban area. The pH is highly acidic. The EC is very high, representing high chemical content (potentially DDT) that is related to iron concentration; this is an indication of domestic activities, such as laundry detergents and other household products. It is concentrated. Water condition from the settlement area, water condition from settlement area physically has yellow smell bad and has many bubbles. pH acid represents the house chemistry utilization (soap, detergent, DDT). The high EC number represents the high reaction chemistry from houses. Also, the urine and salt made the EC number dramatically increase. The DO number is low because the water condition is saturated and trapped in the small basins of the channel. The high COD number represents the high organic content that came from human feces (see figure 9).

The water from the settlement area physically has yellow and black colors, smells bad, and has many bubbles which indicate chemical reactions. The high EC number represents further the high reaction chemistry from urban activities. Also, urine and salt can make the EC levels dramatically increase. The DO levels are very low because the water condition is saturated and trapped in the small basins of the channel. The high COD number represents from high organic content that came from human feces. On our final day of measuring, a covey of ducks was in this sewage water.



Figure 9. The water quality produced from the settlement area and the distribution of the settlement area (right)

6. Conclusion

Additional notable phenomena we observed — via field measurements, as well as multiple random weekly (photographic) visits to our study site — is that during our preliminary study area survey, significant pollution was being discharged at the final point of our study area (i.e. at the Hualien River). This was on a rainy day. This discharge water was of high volume, of brown color, and noticeably reeked of sewage. We (during this survey stage, prior to having done any scientific analysis) ignorantly hypothesized that the entire agricultural area was consistently discharging such poor quality wastewater. We later discovered that pollution discharge was (and is) transpiring within the agricultural area does increase in a cline pattern — from measuring point one (water source) and point six (the Hualien River) — but at far lesser (visible and smell) levels than on our preliminary survey day. The determining factor was a dry versus rainy day. We then suspected that the heavy pollution we observed during our preliminary survey was an episode of illegal dumping. However, upon further analysis (including field observations scientific data) we now hypothesize that, while an episode of illegal dumping is surely possible, our preliminary observation of extreme water pollution discharge may actually have been off (and caused by) rainwater purging amassed feces within the canal coming from the urban area and also animal feces from the commercial animal farming area.

As hypothesized, each region within our case study is respectively creating the amassed wastewater being discharged into the Hualien River and therefore the Pacific Ocean. It is undoubtedly that the agrobusinesses and urban areas are contributing most significantly. Rainwater (and potential episodes of illegal purge-dumping) is a primary variable in this phenomenon. As per our objective for this environmental measuring project, we hope that from an environmental activism standpoint our study could be used to perhaps further concretely identify and address potential environmental regulation violations taking place in this area, linked with these human activities. This would capacitate activism efforts toward lobbying government or non-government organizations for environmental violations related to intervention.

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