Environmental Investigation Mission on the Impact of Bioethanol Co-generation Plant to San Mariano, Isabela

TECHNICAL REPORT

AGHAM – Advocates of Science and Technology for the People

in cooperation with

Kilusang Magbubukid ng Pilipinas (KMP), Danggayan Dagiti Mannalon ti Isabela, and SENTRA – Cagayan Valley,

with the support of the Social Action Center of the Diocese of Ilagan

TABLE OF CONTENTS

EXECUTIVE SUMMARY

An Environmental Investigation Mission (EIM) was conducted on April 2014 in the two mining-affected communities in Nueva Vizcaya to evaluate the impacts of the mining operations to their immediate environment. Two mining companies operate in the province: Oceana Gold Philippines, Inc. and FCF Minerals. Oceana Gold – Didipio Gold Copper project has been operating in the Municipality of Kasibu, Barangay Didipio since April 2013. The FCF Minerals Corporation-Runruno Gold-Molybdenum Project is currently at the construction phase and targets to start its commercial operation before the end of 2014.

Three sampling sites each were selected in Brgys. Didipio and Kasibu through consultations with key community figures. At each sampling site, biological characteristics of the site were determined. Physico-chemical parameters such as temperature, pH, turbidity, stream velocity and water conductivity were also identified. Sediment and water samples were also collected at each sampling site and were sent to laboratories to determine the concentration of heavy metals (mercury, lead, copper, arsenic and cadmium) in it. Community interviews and focus group discussions were initiated in order to identify the socio-economic impacts of the mine projects to the livelihood and welfare of the residents dwelling in these communities hosting large-scale mining activities.

The results gathered in the EIM provide a concrete picture how the activities these two large-scale mining companies affect the environment and the lives of the people in the community. The following are some of the most noticeable effect of mining activities in the area:

1. Turbid waters
   In both Brgy. Didipio and Runruno, water from the impact area and the confluence were significantly more turbid compared with the non-impact site. Turbid waters may reduce the productivity of streams and rivers as this can block the passage of sunlight to deeper parts of the water body, thereby preventing aquatic plants and/or algae from producing food and oxygen.

2. Heavy metal contamination
   In Brgy. Didiopio, increased copper concentration in both water and sediment samples in the impact area and the confluence were observed as compared to that of the non-impact area. The amount of copper in sediment samples at each of the three sampling sites exceeded the Severe-Effect Level, indicating that the sediments are heavily polluted, which could negatively affect the health of benthic or sediment-dwelling organisms. The level of copper contamination in water samples from Didipio River exceeded the maximum level both for irrigation use and the survival of aquatic organisms, which are 200 $\mu g\ L^{-1}$ and 50 $\mu g\ L^{-1}$, respectively.

   Similarly, in Brgy. Runruno, copper and other heavy metal concentration in the impact site were greater than that of the impact site. This denotes increased input from other sources aside from natural weathering transpires in Sulong River, probably from the construction of FCF Minerals, which includes soil excavation, which exposes copper-rich ores.

3. Human rights violations

According to residents interviewed in Brgy. Didipio, OceanaGold employs many private securities who watch the area. Aside from this, a military detachment is located near Barangay Dinaoyan. In an interview with one of the residents, he said that his father was forced to sell their land at a low price because of the intimidation that the mining companies employed.

In Brgy. Runruno, residents reported forced demolitions without prior notice and with the presence of uniformed and armed men. A resident was even arrested under a trumped-up charge of illegal possession of explosives. The people who guard the barricade usually feel fear due to the presence of uniformed men with firearms.

4. Lack of compensation

   One resident in Brgy. Didipio claimed that until the time of the EIM, his family was not paid for the land that the company bought. They were given a document stating that they would be paid, but the signatory wasn't OceanaGold but its predecessor, ARIMCO

Based on these findings, immediate suspension of the mining operations should be imposed until needed rehabilitative and investigative measures are implemented. Furthermore, comprehensive assessment of the impacts of all mining activities within the vicinity of each site must be conducted. This includes, but not limited to, biological diversity assessment, long term monitoring of heavy metal concentration (for sediments and water) and other chemical characteristics for all impacted water bodies.

ACKNOWLDGEMENT

The authors extend their deep appreciation for all the people who aided in the Environmental Investigation Mission (EIM) from its conception to the production of this report. Several organizations were involved in the EIM, namely Alyansa ng Nagkakaisang Novo Vizcayano para sa Kalikasan (ANNVIK), Kalikasan People's Network for the Environment, AGHAM Youth, Taripnong Cagayan Valley, University of the Philippines Minggan, College Editors Guild of the Philippines-Cagayan Valley, Kabataan Patylist, National Union of Students of the Philippines, and delegates from Solano High School and Nueva Vizcaya State University.

The success of the Mission would have been impossible without the support of the communities in sitios Compound, Malilibeg and Tayab in Brgy. Runruno, Quezon as well as the citizens of Brgy. Didipio, Kasibu. We hope our efforts could help the people of these communities protect their lives and the environment.

INTRODUCTION

San Mariano is a remote agricultural town in east Isabela, about 400 km north of Metro Manila. It boasts of having the biggest municipal land area in the country. It is endowed with rich natural resources covering prime agricultural lands, forests and mineral resources that are located at the vicinity of the Northern Sierra Madre Natural Park. As an agricultural area, farmlands in San Mariano are devoted to staple crops such as corn, rice and banana.

The Isabela Bioethanol and Cogeneration Plant (IBCP) located in Barangays Mallabo and Santa Filomena, San Mariano is currently the biggest renewable energy project in the country, worth about PHP 6 billion. It is also the first integrated biofuel plant that covers production to processing operation. San Mariano is declared as an Ecofuel Agro-Industrial Ecozone, with an area of 31 hectares (ha), beside the Pinacanauan River and the town center of San Mariano ("Green Future Innovations," n.d.).

The bioethanol plant is a joint venture of Green Future Innovations Inc. (GFII) - Ecofuel Land Development Inc. and Itochu, JGC Corp., the Philippine Bioethanol and Energy Investments Corp., and GCO, a Taiwanese holding firm. The Plant has started its operation in May 2012.

It utilizes sugarcane for the production of 200,000 liters per day or 54 million liters of anhydrous alcohol per year. The cogeneration plant, after converting excess bagasse to energy, generates approximately 19 megawatts of renewable power, 13 megawatts of which will be exported to the Luzon power grid. To be able to meet this level of production, GFII needs a supply of 700,000 tons of sugarcane per year derived from 11,000 hectares of sugarcane farmland. Currently, it is maintaining sugarcane growership contracts with 4,000 farmer families in Isabela Province ("Green Future Innovations," n.d).

In 2011, an International Fact Finding Mission (IFFM) was launched to investigate the potential environmental and social impacts of the 11,000 ha of sugarcane monocrop plantation. The plantation project covers forest regeneration areas under the Socialized Industrial Forestry Management Agreement (SIFMA) scheme of the DENR which aims to restore the country's forest cover. The findings of the IFFM include the higher risk of erosion, landslides and flooding incidents in downstream areas of the plantation and ecological imbalance as a result of the encroachment of the forest land area affecting the watershed ecosystem. Other potential threats of the biofuel plantation were also identified, such as the increase in the toxicity of water resources and farm areas, soil quality deterioration attributed to intensive usage of fertilizers and pesticides and also threats on land tenurial rights and food security. Given that sugarcane is an industrial crop that utilizes massive use of soil and water resources, it contradicts the purpose of forest conservation.

Currently, the communities residing within the biofuel plant have been experiencing health and environmental problems. Processing of biofuel plant has affected air, water and soil resources. To assess the impact of the IBCP, an Environmental Investigation Mission (EIM) was conducted on November 22-23, 2014 by AGHAM-Advocates of Science and Technology for the People, Kilusang Magbubukid ng Pilipinas (KMP), Danggayan Dagiti Mannalon ti Isabela, and SENTRA – Cagayan Valley, with the support of the Social Action Center of the Diocese of Ilagan to determine the environmental and socio-economic impacts of the biofuel plant operation. The results of this investigation will be used in education and advocacy work for the assertion of the rights of rural communities and vulnerable sectors affected by the biofuel plant operation.

Objectives

1. To assess the biological and the physico-chemical impact of the deposition of vinasse produced from the biofuel plant operation on the surface water and the farming areas;

2. To investigate the impacts of the use of vinasse declared as liquid fertilizer in farming areas to soil quality and the environment as a whole; and

3. To determine the immediate impacts and long-term implications of the biofuel plant operation on the health and livelihood of the communities living near the plant.

Profile of the Companies

The IBCP is owned and operated by Green Future Innovations, Inc. (GII) and Ecofuel Land Development, Inc. a consortium of Filipino, Japanese and Taiwanese companies. The Japan Bioenergy Corporation (JBC) which is composed of two Japanese companies, the Itochu Corporation, involved in general trading and JGC, an engineering company that has the biggest corporate share with 69.5%. The Philippine Bioethanol and Energy Investments Corp. and GCO Investment Corp, a Taiwanese holding firm has corporate shares of 25.5% and 5%, respectively (Green Future Innovations, Inc., 2012). The plant started its operation in May of 2012.

According to the website of the Bureau of Agricultural Research, the GII has availed tax holidays and other incentives stated in the Biofuels Act of 2006 or Republic Act 9367 which mandates the local production and processing of biodiesel and bioethanol crops for local use. As a pioneering biofuel producer from the Philippine Economic Zone Authority (PEZA), the IBCP ensures steady feedstock supply by encouraging private investment in biofuel industry. The IBCP aims to produce 54 million liters of bioethanol that is worth about $27.5 million in profit.

The operation of IBCP covers the sugarcane production aspect which includes cultural farm management, ecological requirements, land preparation, crop establishment, water management, fertilization, pest and disease management, weed management and the harvest management. The sugarcane processing aspect involves milling, mechanical extraction, fermentation and distillation.

METHODOLOGY

Physico-Chemical and Biological Analysis

Water Quality Impact Analysis

Sampling Sites

Community mapping was carried out to identify the impact areas affected by the biofuel plant operation.. Key informants such as Barangay officials were consulted in the identification of the sampling sites. As a result, five (5) sampling sites for water quality and six (6) for soil quality were identified as shown in Tables 1 and 2 respectively and illustrated in Figure 1.

a. Pinacanuan de Ilagan River (W1, W4 and W5)

Pinacanuan de Ilagan River is one of the major tributaries of Cagayan River and is classified by the Environmental Management Bureau as a Class C principal river (EMB, 2013). It drains the eastern central portion of the Cagayan River basin with an annual discharge of 9,455 million cubic meters ("The Cagayan," 2009). Water from Ilagan River flows westward and joins the Cagayan River at Ilagan, Isabela.

The Isabela Bioethanol and Co-generation Plant (IBCP) is located near the bank of this river. It flows through three sampling points which were established along the river: one site is situated immediately adjacent to the power plant (W4), one was a few meters upstream of site W4 (W5), one was downstream from W4 at the point of confluence with the creek draining from the Small Water Impounding Project in Sta. Filomena (W1).

b. Sta. Filomena Small Water Impounding Project (SWIP, W2)

The SWIP is an artificial structure used to store water for irrigation and aquaculture purposes. It is about 400 meters at its longest axis and about 120 meters wide. According to the residents, water from within the IBCP drain to a creek which empties to the SWIP. Sampling point W2 was established here.

c. Natural Lagoon (W3)

This is a small natural depression on the ground about 5 meters in diameter. According to the residents, GFII use this area as dumping ground of some of its wastes. It is only a few meters away from the creek that drains to the Sta. Filomena SWIP. Sampling point W3 was established here.

Table 1. Location and description of the sampling sites for water quality assessment.

Sampling Site	Time of Sampling	Description	Category
W1	9:20 AM	Confluence of creek from the SWIP and Pinacanauan River	(impact area)
W2	10:35 AM	Sta. Filomena SWIP	(impact area)
W3	3:07 PM	Natural Lagoon	(impact area)
W4	2:19 PM	Pinacanauan River	(impact area)
W5	4:05 PM	Upstream of Pinacanauan River	(control)

Table 2. Location and description of the sampling sites for soil quality assessment.

Sampling Site	Location	Crop	Area	Most Recent Vinasse application
So1	Brgy. Mallabo, San Mariano	Corn	1.0 ha	None
So2	Brgy. Mallabo, San Mariano	Corn	1.0 ha	November 15, 2014.
So3	Brgy. Lukban, Benito Soliven	Rice	7.000 sqm	September 29, 2014.
So4	Brgy. Lukban, Benito Soliven	Rice	3,000 sqm	None
So5	Brgy. Santa Felomena, San Mariano	Corn	1.0 ha	None
So6	Brgy. Santa Felomena, San Mariano	Corn	1.0 ha	around May 2014.

Figure 1. Mapped sampling points for water quality and soil quality assessment, respectively.

Water Quality Assessment

The methodology for water physico-chemical assessment was based on the Water Quality Monitoring Manual of EMB-DENR (2008). In-situ determination of pH, temperature, dissolved oxygen (DO), turbidity, and electrical conductivity (EC) and stream velocity were conducted. Water samples were also collected for the laboratory analysis of biological oxygen demand (BOD).

Biological Characterization

A rapid biodiversity survey was conducted to assess the integrity of the ecosystem at each sampling site. Spot identification of trees, undergrowth and visible fauna was carried out. Samples were identified to the lowest taxa possible. Due to time and logistical constraints, a more rigorous sampling and species identification was not possible.

Soil Quality Impact Analysis

Sampling Sites

A total of six (6) sampling points were identified in Barangays Mallabo (site of the bioethanol plant), Lucban and Sta. Filomena. These were composed of three (3) sampling sites applied with vinasse and three (3) sampling sites without vinasse. Vinasse or vinasse is a waste material for distillery industry. The selection of the sampling sites was based on the key informant interview with the communities who allowed the application of the vinasse in their respective farm. Soil samples were gathered based on the protocol of the Bureau of Soils and Water Management, brochure on How to Collect Soil Sample for Analysis,from the farm areas applied with vinasse coming from the biofuel plant operation.

Soil Quality Assessment

The parameters measured were pH, organic matter (Colorimetric Method), Phosphorous (P, Olsen's Method) and Potassium (K, cold sulfuric acid method) analyzed by the Department of Agriculture (DA) Regional Soils Laboratory in Isabela.

Data Gathering and Field Documentation

Field observations covered documentation of the following observation points: the location of the identified sampling sites using the GPS, the type of flora and fauna present in both terrestrial and riverine ecosystems and river water quality (color, odor and clarity of water). The time of the observation and the weather condition were also recorded during field assessment. Data sheets for field assessment were indicated in Appendix A.

Socio-Economic Impact Analysis

The health and socio-economic impacts of the biofuel plant's operation were evaluated through Focus Group Discussion (FGD) and Key Informant Interview (KII) for the communities of Brgys. Mallabo, Lucban, Sta. Filomena, and Zamora. The health and socio-economic guide questions used in this mission were shown in Appendix E.

RESULTS AND DISCUSSION

Physico-Chemical and Biological Analysis

Water Quality Impact

The values of the physico-chemical parameters measured in each of the sampling site for the water quality assessment are presented in Table 3.

Dissolved oxygen (DO) concentration is an important feature of water body since it signifies the ability of that body to sustain aquatic life. Dissolved oxygen may come from the atmosphere through diffusion which may be enhanced through re-aeration, i.e., the agitation of water. Dissolved oxygen may also come from the photosynthetic action of aquatic plants and/or algae.

Values of dissolves oxygen concentration across all sites ranged from 0.3 to 15.4 mg/L, with the highest concentration recorded from Site W2 (Sta. Filomena SWIP) while the lowest measure was from Site W3 (Natural Lagoon). According to DENR, the DO in a class C water body should not be less than 5 mg/L. At 2-3mg/L DO level, it will cause stress to some fish species. Below 2 mg/L, some fish species will die.[1] The natural lagoon registered a very low DO at 0.27 mg/L.

The high level of dissolved oxygen in site W2 may be due to the abundance of phytoplankton in its waters, as characterized by its greenish tint. High levels of DO are appropriate for the cultivation and/or natural growth of commercial fish for the livelihood of the people.

On the other hand, the near absence of DO in Site W3 can be attributed to the direct discharge of vinasse by the biofuel plant that was reported by the community. Vinasse contains organic and inorganic compounds that undergo decomposition process that consumes dissolved oxygen leading to its depletion in the water column. It it is highly probable that vinasse has contributed to the deteriorating quality the natural pond.

Pond scum growing on the surface of the natural lagoon also contributes to the further depletion of DO in the water. It is a mass of algae forming a green film on the surface of stagnant water. Algal death produces organic matter which uses a large amount of dissolved oxygen. The condition of a natural lagoon is ideal for the development of pond scum because of high nutrient values that can be be attributed to the reported vinasse disposition to the natural lagoon.

While the natural lagoon has no direct usage for the community, it is linked to the Sta. Filomena SWIP that endangers the resources and affects velihood of the fisherfolks in the area. During extreme circumstances (like heavy rains), water rich with organic matter and nutrients from the waste pond could spill into the streams that lead to the SWIP. At sufficient amount, this could cause the depletion of oxygen in the SWIP and leads to fish kills.

Biological oxygen demand (BOD) is the amount of oxygen needed by microorganisms to decompose organic matter in a given water sample. As shown in Table 3, BOD for each sampling site was within the reference limit except for Site W3 (natural lagoon). As earlier mentioned, high organic matter could endanger the quality of nearby water bodies which are economically significant to the community.

Table 3. Average values of physico-chemical parameters of water samples from different sampling points.

Sampling Site	Temp (°C)	DO (mg/L)	BOD (mg/L)	EC (µS/cm)	pH	Turbidity (NTU)	Stream velocity (m/s)	Color	Odor
W1	25.10	7.83	1.5	96.57	8.13	23	0.64	Clear	None
W2	28.03	15.43	7.5	225.50	9.10	28.16	NA	Greenish	None
W3	28.93	0.27	36	257.30	8.47	221.33	NA	Dark brown	Similar to decomposed leaves
W4	26.10	8.40	<2	95.8	8.13	19.77	0.18	Clear	None
W5	26.70	8.43	<1	94.17	8.33	17.93	0.13	Clear	None
Reference values	-	5*	7 – 10*	2-100***	6.5 – 8.5*	50-100**	-	-	

* DENR Administrative Order No. 34 Series of 1990
** Oregon Department of Environmental Quality, 2010
*** Sanders, 1998

As shown in Table 3, the natural lagoon (impact area) exceeded the standard at 36 mg/L. The impact areas such as the SWIP and the Pinacanauan River were below the standards ranging from 1.5-2 mg/L while the upstream of the Pinacanauan River (control) is less than 1 mg/L BOD. Only the BOD of the SWIP is within the standard.

Electrical Conductivity is the ability of water to conduct electricity. This is affected by the concentration of metal ions in the water column. The higher the conductivity, the more metal ions dissolved in the water. Metal ions may be in the form of nitrates, sodium, potassium, magnesium, heavy metals, and others. According to Sanders (1998), surface waters usually have conductivity levels between 2-100 µS cm-1. Sampling sites W2 and W3 exceeded the said standards indicating the presence pollutants.

The pH values of all sampling sites are within the allowable limit except for W2 which is higher than the pH range (6.5-9.0) suitable for the survival of aquatic organisms based on the fundamentals of environmental measurement.

Turbidity is the measure of water clarity. Turbid waters may be caused by solids such as decomposing organic matter, sediments and plankters suspended in the water column. While all the other sites were relatively clear (17-28 NTU), W3 registered a drastically high turbidity. In relation to its BOD and DO values, the turbidity may have been caused by organic matter loading on the natural lagoon.

As it has been pointed out in detail in the previous discussions, it is important to stress in this report the risks associated with the poor management of biofuel effluents from the bioethanol plant. The waste produced in the production of bioethanol from sugarcane is primarily composed of vinasse, a black liquid formed during the distillation process. The IBCP utilizes three artificial lagoons within its compound as impoundments of its wastewater. To compensate for lack of storage space, the company also offers its waste vinasse to farmers for ferti-irrigation use, calling it "liquid fertilizer," the impacts of which will be discussed in Soil Quality Impacts below.

Biological Characterization

A rapid survey of the flora and fauna was conducted on the identified sampling sites and yielded the results shown in Table 4.

The confluence, SWIP and Pinacanauan impact areas are still in good water quality condition based on the surveyed macroinvertebrates while the natural lagoon can be classified as having poor water quality condition due to the presence of larvae and flies which are pollution tolerant macroinvertebrates. The survival of these bioindicators is not dependent on dissolved oxygen, temperature, pH levels thus enabling them to flourish even in polluted habitats (Chadde, n.d.). Macroinvertebrates were not observed in the sampling site of the upstream of Pinacanauan River. This can be attributed to strong water current and sandy sediments of the river that has unstable surface for the macroinvertebrates to thrive in.

Apart from the macroinvertebrates, other aquatic organisms such as fishes were also observed and recorded on SWIP and Pinacanauan River. This indicates a healthy aquatic ecosystem that provides a sustainable condition and allows higher trophic level of organisms to survive and reproduce.

In the floral survey, grasses surrounding the sampling sites are commonly observed in the confluence, SWIP, and natural lagoon. In the natural lagoon, water surface was fully covered with aquatic macrophytes that already affected its natural ecosystem. Bamboo was also observed in the confluence while ferns were dominant in the Pinacanauan River..

Table 4. Biological survey of flora and fauna on identified sampling sites.

Sampling Site	Description	Flora	Fauna
1	Confluence of creek from the SWIP and Pinacanauan River (impact area)	Bamboo, Grasses	Water strider, snail, worms
2	Sta. Filomena SWIP (impact area)	Water lily, Grasses, trees	Fish, snails
3	Natural Lagoon (impact area)	Water lily, Grasses	Flies, larvae

4	Pinacanauan River (impact area)	Ferns	Snail, water strider
5	Upstream of Pinacanauan River (control)	Grasses	Tadpoles, small fishes, shrimps

Soil Quality Impacts

The values of physico-chemical parameters used to determine the soil quality are presented in Table 5.

Soil pH
The soil samples gathered from two farm areas applied with vinasse exhibited low pH at 4.3 (planted with corn) which is extremely acidic and 4.7 (planted with rice) as very strongly acidic, respectively. A low pH reading of 5.3 was also noted on soil samples from the farm area not applied with vinasse. Soil acidification can be due to various reasons such as the constant utilization of soil for farming and the inappropriate application of nitrogen fertilizer. Further verification is needed to determine if the farm area not applied with vinasse is using nitrogen fertilizer for sampling site So4 classified as strongly acid. Both farm areas So3 and So4 are planted with rice crop. Other sampling sites (So1, So2, and So5) were within the normal range of pH level.

Soil pH pertains to the degree of acidity and alkalinity. Soil pH influences its physical, chemical and biological properties and processes. It affects the solubility of minerals and nutrients, hence the growth and yield of crops and also the decomposition of organic matter. At low pH, beneficial microorganisms that decompose organic matter are absent resulting to the organic matter accumulation that becomes bound with nutrients. A pH range of 5.5 to 7.0 is the optimum condition for the normal metabolic activities of plants. The availability of nutrients occurs at a pH range of 6 to 7. In acidic condition, minerals and nutrients become more soluble compared to a neutral and slightly alkaline soil pH.[i]

With a pH below 5.5., some micronutrients, like aluminum, manganese and iron, become toxic to crops. There are also some ions that become unavailable such as phosphate due to fixation with iron and aluminum.

Soil Organic Matter
Organic matter pertains to the organic fraction of the soil with plant and animal residues at various stages of decomposition, some cells and tissues of soil organisms and substances found in the soil. The presence of organic matter is crucial for better soil aeration, texture and granulation and storage areas for nutrients that are released in the process of mineralization. At least 1% organic matter should be present in the soil to allow the existence of nitrogen and also for microbiological activity. However, for upland crops the required amount of organic matter must be at least 3%.[ii]

Vinasse contains high organic matter and potassium content. The organic matter content of all soil samples gathered are above 1% with sampling site So6 (applied with vinasse) having the lowest organic matter at 1.2% while sampling site So2 (applied with vinasse) has the highest organic matter at 3.4%. Both sampling sites are planted with corn crops.

Available Phosphorous (P)
Phosphorous (P) is a crucial element that makes up the plant structure and is important in a variety of biochemical processes. The pH level of soil affects the availability of

Table 5. Average values of physico-chemical parameters of soil samples from different sampling points.

Site	pH	OM (%)	P (ppm)	K (ppm)
So1	6.6	1.7	20.13	356
So2	5.7	3.4	14.52	500+
So3	4.7	1.18	36.69	267
So4	5.3	1.19	7.39	278
So5	5.9	1.9	10.19	445
So6	4.3	1.2	9.43	237

phosphorous. A pH value of less than 5.5 will allow aluminum phosphorous and iron phosphorous over calcium phosphates. A reading of >10 ppm for agricultural soils is considered sufficient for crop growth (Marx et al., 1999).

All soil samples analyzed for phosphorous content exceeded 10 ppm except for sampling site 4, planted with rice (not applied with vinasse) and sampling site 6 planted with corn (applied with vinasse) at 7.39 ppm and 9.43 ppm, respectively.

Potassium
Soil samples derived from So2 (corn farm) that was applied with vinasse in Brgy. Mallabo exhibited the highest level of potassium with more than 500 ppm of K while Site So6 exhibited the lowest K content. All soil samples had medium (So6) to high levels of extractable K (Marx et al., 2015)

The disposed vinasse is very rich in organic matter and potassium and is also associated with the presence of calcium, magnesium, sulfur and other minerals in small quantities with impact on surface water, ground water and soil (Coraza and Salles-Filho, 2014). The impact of vinasse infiltration of soil on ground water resources would lead to salinization and the potential accumulation of nitrate, nitrite, ammonia, magnesium, phosphate, aluminum, iron, manganese, chloride and organic carbon. The mobility of metals such as iron, copper, cadmium, chromium, cobalt, nickel, lead, and zinc would be triggered. Ground water and soil acidity will also be changed.

While the use of vinasse may have contribution to soil fertility (Silva et al., 2007), reports of dried-up trees and crops in receiving farm areas should be further investigated. Unforeseen impacts such as seepage of associated pollutants (including toxic heavy metals) to groundwater reservoir pose long-term concerns for the community (Silva et al., 2007). Users should consider the natural characteristics of the receiving soil such as ion retention capacity to avoid ion leaching into groundwater reserves (Silva et al., 2007). But in the case of IBCP, residents never mentioned any testing done to their farmlands.

Furthermore, other studies point to the negative effect of vinasse to soil invertebrates such as earthworms and mites (Alves et al., 2015). Reduction of invertebrate populations in the soil could lead to decreased organic matter breakdown and decreased soil aggregation.

Socio-economic Impacts

A total of one hundred twenty-three (123) individuals from fourteen (14) puroks from four (4) different barangays namely Mallabo, Lucban, Brgy. Sta. Filomena and Zamora surrounding the biofuel plant were interviewed.

Farming is the major source of livelihood of the communities but due to lack of government support to agricultural production, their farming practices remain backward. Most of the landholdings of a poor farmer ranged from 0.5 to 3 hectares (ha). There are only a few farmers who own around 5 ha. Rice and corn are the major agricultural commodities produced in the area but due to lack of government support, the farmers always deals with exorbitant costs of seeds, fertilizers and pesticides and agricultural services such as fees for irrigation. Their farming is also tied-up with high loan interest that led to their continuous indebtedness.

As added burden, public services such as electricity rates and irrigation fees remained expensive for the farmers to avail. Social services that include community health care were not fulfilled specifically in Brgy. Mallabo that hosts the biofuel plant.

When the biofuel plant started its operation, residents of Brgy. Mallabo experienced noxious smell when sugarcane is processed into bioethanol. The distinct smell emanating from the biofuel plant occurred when there is strong wind and after a heavy rain. They also observed that the plant is also emitting fly ash resulting to respiratory illnesses. Residents also complained of heavy dusts accumulating inside their houses.

The clarity and color of water from deep wells significantly changed when the artificial lagoon constructed by the biofuel plant overflows affecting the ground water. There were several cases of children ages seven years old and below were afflicted with diarrhea. There were also incidents of farm animals such as pigs, chickens and ducks killed when they drank water from the overflowed artificial lagoon. Fisher folks also complained of the series of fish kills and reduced fish catch from Pinacanauan River when the biofuel plant started its regular operation.

All the respondents believed that the biofuel plant did not improve the well-being of their families. They remained poor and impoverished. Those who landed a permanent work earned less because of salary deductions for limited benefits given to them. The company has deceived the community when they were told that the plant to be built is meant for production of paper, carton and sack.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the results from the gathered data, it is therefore concluded that the continued operation of the Isabela Bioethanol and Cogeneration Plant poses a significant risk to the ecological integrity of the environment surrounding it, particularly the quality of soil and water bodies. It also significantly endangers the health and livelihood of the communities surrounding it.

Recommendations

1. The impacts of the plant's operations warrant its immediate suspension until appropriate mitigation and protection measures are put up in place to ensure the safety of the people and the environment.

2. Just compensation should be given to the residents whose health and livelihood had been affected by the plant's operation.

3. A comprehensive independent investigation on the impacts of IBCP's operations should be carried out. This is should encompass studies on air emissions from the plant and soil and water quality assessment, including drinking water quality.

4. An independent monitoring team composed of multi-sectoral representatives should also be established to monitor the environmental and socio-economic situation in the area in relation to the operation of the plant.

5. The affected residents should be engaged and mobilized in activities that promote environmental sustainability and the genuine development for the community.v

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APPENDIX A:

Data Sheets for Biological, Physical and Chemicals and Chemical Indicators for the River System and Farmland Areas

I. For River Ecosystem

Field Survey Data Sheet 1 - Description of the Surveyed Sites

General Data ______________________

Date: ______________________

Surveyors' Name(s): ______________________

Name of Province/Municipality/ Barangay: ______________________

Name of Surveyed Water: ______________________

Type of Water surveyed:
(brook, stream, river, lake, pond, reservoir, estuary, other) ______________________

Types of land-use present: ______________________

Field Survey Data Sheet 2

a. Quality of the Riverine Ecosystem

	OP*	OP	OP
Clarity of the water			
Color of bottom			
Other remarks			

OP – Observation points*

b. Biological Indicators

Description of biological survey point ______________________

Location:
(name, number, reference to maps(s), reference to field survey, short description) ______________________

Description of bottom materials:
(Dead leaves, silt, sand, mud, rock, boulders, etc.) ______________________

Color of water bottom: ______________________

c. Physical and chemical parameters

Temperature ______________________

Electrical Conductivity (EC) ______________________

Total Suspended Solid (TSS) ______________________

Turbidity ______________________

Acidity (pH) ______________________

Biological Oxygen Demand (BOD) ______________________

Dissolved Oxygen (DO) ______________________

d. Description Sampling Location

Method of sampling:
(from the shore, from a bridge, by boat, other) ______________________

Water plants and animals present: ______________________

Possible non-point source(s) present): ______________________

(types of land-use, other) ______________________

Type of sample water:
(reference water, concentrated discharge water, polluted water, other) ______________________

II. Farmland Ecosystem

Field Survey Data Sheet 1 - Description of the Surveyed Sites

General Data ______________________

Date: ______________________

Surveyors; Name (s): ______________________

Name of Province/Municipality/Barangay: ______________________

Types of land-use/Existing Vegetation Cover ______________________

Area covered ______________________

APPENDIX B
Determination of biological indicators

Biodiversity is measured using Sequential Comparison Index (SCI). The CSI can be computed using the following formula:

$$SCI = \frac{\text{number of runs}}{\text{total number of organisms picked}}$$

Run is unbroken sequence of similar events

Quality ratings: 0-0.3 poor water quality
0.3-0.6 fair water quality
0.6-1 good water quality

Benthic macroinvertebrates live closely to the water bottom. In flowing water, they exist in riffle/rapid in flowing water as the constant flow of water provides constant supply of food and oxygen. The deepest part of a large river supports few macroinvertebrates because the silty bottom is unstable and lacks O2 since silt has high organic content.

Macroinvertebrates such as tube-building worms, burrowing mayflies, blood worm midges, mussels and clams thrive well in streams with silt or mud bottoms. Sandy bottoms provide few macroinvertebrates because of unstable surfaces.

For the identification of the community of macroinvertebrates, sorting and grouping of the animals collected would be helpful in determining the numbers of the organisms.

Sensitivity is measured using Pollution Tolerance Index (PTI). It is computed using the succeeding formula:

$$SCI = \frac{\text{total of all group scores}}{\text{total number of different types}}$$

Where the total of all group scores were based on the following identified macroinvertebrates:

Group 1 Intolerant to pollution	**Group 2 Moderately intolerant to pollution**	**Group 3 Fairly intolerant to pollution**	**Group 4 Tolerant to pollution**
Stonefly	Caddisfly	Blackfly	Worms
Dobsonfly	Mayfly	Midget	Leeches
Snipefly	Damselfly	Sowbug	Lung snails
	Dragonfly	Scud	Bloodworm
	Crayfish	Snails with gills	Midge
	Cranefly		
	Clam/Mussel		
Formula for PTI			
(a) Number of typesx1 =	(b) Number of types x 2 =	(c) Number of types x 3 =	(d) Number of types x 4 =

Note: The identification of the type of macroinvertebrates shall be aided with taxonomic keys.
(a) + (b) + (c) + (d) = Total of all group scores

The total of all group scores also provides a water quality value.

APPENDIX C
Sampling Date and Location

Sampling Site No.	Date of Sampling	Time of Sampling	Description	Coordinates
W1	Nov. 23, 2014	9:20 AM	Confluence of creek from the SWIP and Pinacanauan River	16°59'21.33"N 121°58'16.06"E
W2	Nov. 23, 2014	10:35 AM	Sta. Filomena SWIP	16°59'16.91"N 121°58'56.6"E
W3	Nov. 23, 2014	3:07 PM	Natural Lagoon	16°59'17.67"N 121°59'17.81"E
W4	Nov. 23, 2014	2:19 PM	Pinacanauan River	16°59'27.2"N 121°59'38.1"E
W5	Nov. 23, 2014	4:05 PM	Upstream of Pinacanauan River	16°59'21.72"N 121°58'16.50"E
So1	Dec. 13, 2014	4:40 PM	Corn field area in Brgy. Mallabo, San Mariano	N16 59.571 E121 59.256
So2	Dec. 13, 2014	5:04: PM	Corn field area in Brgy. Mallabo, San Mariano	N16 59.467 E121 59.334
So3	Dec. 13, 2014	5:43 PM	Rice field in Brgy. Lukban, Benito Soliven	N16 59.651 E121 58.982
So4	Dec. 13, 2014	6:09 PM	Rice field in Brgy. Lukban, Benito Soliven	N16 59.715 E121 58.619
So5	Dec. 14, 2014	11:49 AM	Brgy. Santa Felomena, SM Corn field without Liquid Fertilizer from Bio-ethanol plant	N16 58.045 E121 59.576
So6	Dec. 14, 2014	12:31 PM	Brgy. Santa Felomena, SM Corn field with Liquid Fertilizer from Bio-ethanol plant	N16 58.074 E121 59.449

APPENDIX D

Raw Water Quality Parameter Values

Sampling Site	Parameter						
	Temperature (°C)	**Dissolved Oxygen** (mg/L)	**Turbidity** (NTU)	**Conductivity** (µS/cm)	**pH**	**BOD** (mg/L)	**Stream Velocity** (m/s)
W1	25.1	7.9	21.8	97.3	8.2	1	0.5882
	25.1	7.9	24.3	96.4	8.1	<1	0.6667
	25.1	7.7	22.9	96	8.1	2	0.6667
W2	28	15.4	33.2	223.7	9.2	8	-
	28.3	15.1	26	224	9.2	7	-
	27.8	15.8	25.3	228.8	8.9	-	-
W3	30.3	0.3	220.9	256.1	8.5	36	-
	29.3	0.3	221.6	259.4	8.4	38	-
	27.2	0.2	221.5	256.4	8.5	34	-
W4	26.1	8.6	18.7	95.7	8.2	<1	0.1923
	26.1	8.3	18.1	95.9	8.1	1	0.2083
	26.1	8.3	22.5	95.8	8.1	2	0.137
W5	26.7	8.5	13	94.1	8.4	1	0.1235
	26.7	8.4	21.7	94	8.3	<1	0.1351
	26.7	8.4	19.1	94.4	8.3	<1	0.1351

APPENDIX E

Reported complaints of the residents of Bry. Mallabo

On July 19, 2012, Barangay Captain William Aggabao of Brgy. Mallabo, San Mariano, Isabela had a dialogue with Mr. Luis O. Villa-Brille, Vice President/Resident Manager of Green Future Innovations, Inc. to discuss the community's concerns regarding the operation of the biofuel plant being hosted by the said Barangay.

Among the issues raised by Brgy. Captain Aggabao is the environmental impact of the operation of the biofuel plant that resulted to the series of fish kill. The latest fish kill happened in July 2013. Residents claim the foul odor has caused stomach aches, asthma and headaches and have disrupted their sleep mostly among children. The unpleasant smell has already reached the town center, Isabela State University campus, public market and other populated areas near the bioethanol plant.

The artificial lagoon where the vinasse (also known as vinasse and waste slop) is collected overflowed during heavy rainfall, contaminating the potable water supply of the community and damaging adjacent farmlands. Nearby residents surrounding the plant also complained of the smoke and fly ash continuously emitted by the plant reaching their residences and farm areas, soiling newly washed clothes and even affecting their food. Residents also complain that the waste water released to surrounding farmlands had a very unpleasant smell; contaminated grasslands used as pasture lands and damaged crops and fruit trees. Mr. Villa-Abrielle of GFII promised that the company will address the problem.

The biofuel plant was forced to temporarily shut down its operation in August 2012 due to various problems arising from the biofuel operation. The company has operated since May 2012 but its bio digester became fully functional only on December 2012 so it released its waste water directly to the natural and artificial lagoons which then found their way to the river systems. The plant has been operating without a permit from the Environmental Management Bureau (EMB) in violation of Republic Act (RA) 8749 (Philippine Clean Air Act of 1999) which states that all sources of air pollution subject to the Implementing Rules and Regulation must have a valid permit to operate issued by the EMB Regional Director. The company also violated Rule 27.1 of the Philippine Clean Water Act of 2004 which states that discharge permit must be secured for operating facilities that discharge regulated water pollutants. The company was forced to stop operations during the rainy season (from the end of August to the start of November).

By the year 2013, affected residents requested a dialogue with company officials and the LGU concerning the same problems again (offensive smell, fly ash, rented farms used as dumping area for toxic waste water). On Jan. 2014, one hundred seventy-seven (177) families from Brgy. Mallabo had had engaged the company and the Task Force Bioethanol that comprises government offices. During a dialogue on April 11, 2014 it was revealed that company efforts to mitigate the foul smell and ash fall by planting a few banana trees around the lagoons failed. Barangay officials inquired about the possible effects of the foul smell and ash fall on their health to which the provincial health officer promised to study morbidity records for the past three years in the affected barangays. The provincial agriculturist revealed that waste water from the plant needed to undergo one more month of decomposition before being used as liquid fertilizer. By July 2014 more than 30% of plant workers were retrenched. The company claims to have set up plantations in 6000 hectares but records show that this has been decreasing and reduced to about 3261 hectares only.

APPENDIX F
Photographs

Figure 1
A tank used to transport IBCP's vinasse, disguised as "organic liquid fertilizer," to farms for disposal.

Figure 2
A hose disposing off dark-colored vinasse to a farm land.

Figure 3
A volunteer scientist testing water quality in Sta. Filomena Small Water Impoundment Project (SWIP) feared to be affected by the plant's operation.