Agricultural Stressors of San Jorge Samar Watershed

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Abstract

The paper presented the current land use specifically agricultural use. The extent of agricultural utilization was correlated with flooding and erosional characteristics in the watershed and the river. Primary and secondary data were gathered through actual survey of the watershed, interviews, and maps from various offices mostly from the local government unit of San Jorge. Analysis of data revealed that one-third of the watershed used for agricultural purposes with rice farming of up to three times a year. It was shown that the uncontrolled agricultural activities influenced flood occurrence due to increasing runoff and reduction of rivers carrying capacity due to increased siltation.

Keywords: watershed, agricultural stressors, Samar, river flooding, erosion, siltation

I. INTRODUCTION

Watershed is a topographical delineated areas of land upon which rainwater can drain as surface runoff via specific stream or river stream to a common outlet point which may be a dam, irrigation system or municipal water supply take off or where the stream/ river discharges in a large river, lake or sea. It is a discrete geographical unit capable of providing water, timber or non-timber products. These products include food, fiber, minerals, medicine, and intangible goods such as aesthetic and wholesome environment with solar radiation, precipitation, land, labor, and capital as a major input.

There is a strong interdependence among the uplands, lowlands, and coastal areas within the watershed. Activities in the uplands affect the lowlands and coastal area (e.g., deforestation brings about siltation in rivers and coastal areas). While some developments in the lowlands have implications on the resources in the uplands (e.g., population growth and lack of employment opportunities in lowland areas encourage migration to the uplands).

Watershed has many uses. It may be a major site for residential, commercial, industrial, agricultural, education, experimental environment and forestland uses. Many of these uses are often conflicting and competing with each other for the limited watershed land resources. It is also a major source of nutrients and pollutants, which are deposited in lakes, coastal areas, lowland plains and rivers. The Philippines contains 419 river basin (Alvares Jr., 1985), including over five million hectares of watershed land rendered unproductive, degraded, and unstable due to inappropriate land use (Alvares Jr., 1985). This has given rise to soil erosion, sedimentation of downstream waterways, declining water quality, and possibly increased of localized flooding.

During the period of 1966 to 1983, the Philippines has sent a net decrease in total forest and woodland area of almost 29%. The causes of this deforestation and land degradation can be traced to increased demands of an expanding population. This results in increased: clearing of forest land for upland agriculture, grazing, fuelwood gathering, logging, mining and human settlement (Veracion 1985). Forest fires became frequently the result of some of these activities which further exacerbate the problem.

San Jorge is traversed and cut into almost half, east to west, by the San Jorge River (formerly Gandara River). Branching out from the San Jorge River southwest towards the municipalities of Tarangnan and Catbalogan are the Sapinit River and the Buenavista River. San Jorge river is a major inland body of water in the Municipality of San Jorge, Samar.

It can be noted that the municipality has many rivers and creeks, more or less distributed evenly throughout the whole area except Barangay Calundan that is located southwest of the municipality. These rivers and creeks serve as a source of water for the irrigation requirements of rice land, use for navigation, recreation, and for other domestic uses (MPDC, LGU-San Jorge).

In the history of San Jorge, it can be traced that San Jorge was naturally blessed with fertile soil for agricultural production. Due to its fertile valley and the agricultural lands along the Gandara – Blanca Aurora Rivers, which oftentimes overflow its banks, the fertility of the soil was maintained, and agricultural crops boomed. People from other places were lured to settle in this said barangay for farming ventures. This continuous influx of people caused the barangay to grow and progress.

At present, the municipality of San Jorge is still well known for its high agricultural production. The agricultural land comprises 12,140.77 hectares or 30.07% of the total land area of the municipality. As per data of the Municipal Agriculture Office, the first three major products produced by the farmers in the municipality are rice, corn, and vegetable. Majority of the farmers are now employing chemical fertilization and uses pesticides and insecticides for production (MPDC, LGU-San Jorge).

In this context, hence the researcher conducted an assessment of agricultural stressors of watershed in order to acquire baseline data for San Jorge, Samar watershed. The paper also presents the historical profile of the watershed including its ecosystem. Relationships between the agricultural stressors and occurrence of flood and accumulation of river sediments were also established.

II. METHODOLOGY

A. Research Design

The researcher employed technical descriptive regression-correlation research design.

The descriptive method was used in presenting the historical profile of San Jorge watershed. This is in terms of area in hectares, topography, hydrologic properties, hydraulic properties, geologic properties, biological properties, and the current ecosystem profile in terms of hydrology, vegetation, water quality, species and habitats, and human uses. Data on the levels of agricultural stressors and the levels of watershed stressors indicators along flood occurrence and soil erosion were also gathered through descriptive method.

The multiple correlation regression research design was used to determine the relationship among the levels of agricultural stressors and the levels of watershed stressor indicators along flood occurrence and soil erosion.

The researcher collected secondary data from the Local Government Unit – San Jorge, Samar. These are the Municipal Agriculture Office (MAO), Municipal Planning and Development Coordinator Office (MPDC-San Jorge), Philippine Atmospheric Geophysical and Astronomical Services (PAGASA), Department of Agriculture (DA), Department of Environment and Natural Resources (DENR), Bureau of Soils and Water Management (BSWM), National Mapping and Resource Information Authority (NAMRIA) and Department of Science and Technology (DOST) and conducted actual field reconnaissance to validate the data.

The statistical tools that were used include numerical mean, frequency counts and percentage and regression correlation.

B. Instrumentation

A structured questionnaire was used as a primary instrument in gathering data. The questionnaire was used as a guide in the interview to the sample respondents in each sample barangay. This was used to gather data on the ecosystem profile, levels of agricultural stressors and the levels of watershed stressors indicators along flood occurrence and soil erosion.

The questionnaire was divided into three main parts, namely: Part I – The Profile of the Respondent; Part II – Assessment of Agricultural Stressors; Part III – Assessment of Flood Occurrence Level; and Part IV – Assessment of Soil Erosion Level.

The study also employed other data gathering instruments such as unstructured interviews, documentary analysis, pictorials, and actual observation. These methods were used to describe, record, analyze, interpret, and find out some facts in order to come up with a more significant study.

C. Validation of Instrument

The researcher conducted a pre-testing of the questionnaire to nonrespondents but also farmers in San Jorge, Samar for validation and improvement of the instrument.

After the pre-testing of the questionnaire, enhancement and modification were made for a better result.

D. Sampling Procedure

The researcher used two sampling techniques in her conduct of the study, namely: Purposive Sampling and Stratified Random Sampling.

Purposive sampling was used to determine the barangays where data was gathered. The researcher determined nine barangays along San Jorge watershed. These barangays were chosen based on the following criteria: area devoted for agricultural production and dispersion of barangays along watershed. The barangays with the highest area utilized for farming were taken from the data of Municipal Agriculture Office, San Jorge, Samar. These are barangay Bay-ang, Matalud, Bungliw, Blanca Aurora, Cantaguic, Buenavista II, Rosalim, Lapaz, and San Juan. Below is the San Jorge map and the highlighted area in yellow color corresponds the sample barangays and the sample stations in red color along San Jorge river under study.

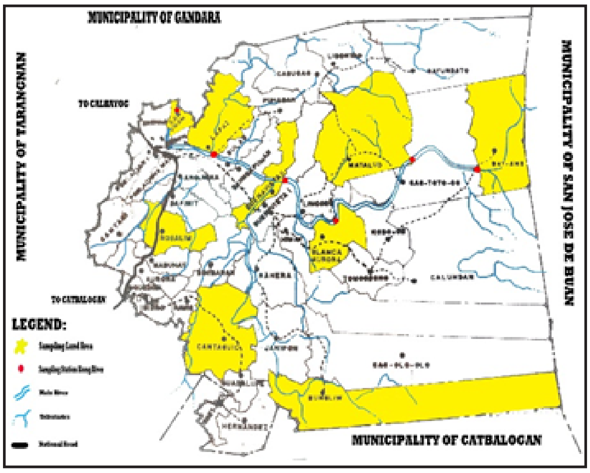

Figure 1. Map of Sampling Area of San Jorge Watershed

These stations were used to answer problem numbers 1, 2, 3, 4, and 5.

For problem number 1, most of the properties of the historical profile of San Jorge watershed were based on the secondary data except the hydraulic properties. For the hydraulic properties like the streamflow, depth of water bodies, river width, and the velocity of the river, samples were gathered from the stations along the main river of San Jorge. Samples were taken from the highest part of the main river from barangay Bay-ang, Matalud, Blanca Aurora, Buenavista II, Lapaz and down to San Juan. The depth of water bodies and velocity of the river, gathered three samples at the two sides and at the center of the river. While for the river width, three samples also were gathered at every station (see appendix B).

For the ecosystem profile, problem number 2, secondary data was utilized except hydrology and water quality where actual sampling was done in the sampling area. Three samples were measured for hydrology – the river width, river depth, and river's peak flows. For the water quality, three samples were also gathered in every station. One sample was obtained at the mid-part depth of the river, one at side and one at the river bottom.

Stratified random sampling was used to determine the respondents of the study based on the land area engaged in every crop as determined from MAO, San Jorge, Samar. In the sample barangays, respondents – the farmers and barangay officials were determined through Sloven's Formula. The data on the total number of farmers in the sample barangays were from the Municipal Agriculture Office (MAO), LGU-San Jorge.

The table below shows the number of farmers from the data of MAO, San Jorge, Samar and the corresponding number of respondents based on the computation using the Sloven's Formula. For Barangays with less than 100 farmers were taken as respondents

Data Gathering Procedure

The data gathering procedure started with documentary analysis from the different agencies such as the Local Government Unit (LGU) - San Jorge, Samar, Department of Agriculture (DA), Department of Environment and Natural Resources (DENR), NAMRIA, PAGASA, Bureau of Soil and Water Management (BSWM). Different barangays of San Jorge and the province of Samar were also included to gather secondary data.

Next procedure, the researcher conducted

Table 1.
Respondents of the Study

Sampling Area	Farmers	Respondents
Bay-ang	30	10
Matalud	119	41
Bungliw	30	10
Blanca Aurora	132	45
Cantaguic	54	19
Buenavista II	66	23
Rosalim	140	48
Lapaz	131	45
San Juan	70	24

an actual examination and interview in the area for field validation of the data gathered from different agencies.

Problem 1 is the historical profile of San Jorge watershed. For the area of San Jorge watershed in hectare, data from MPDC Office was utilized. Documents such as map and previous studies of San Jorge watershed were gathered as a reference. Actual visitation to the area was done too. For the topography of the watershed, map from NAMRIA was used. The data on hydrologic properties of the watershed such as rainfall, humidity, and temperature were gathered from PAGASA, Catbalogan, Samar for the past ten years. The hydraulic properties include stream flow, depth of water bodies, velocity of water and the witdth of the river were measured. The stream flow and the velocity were measured using the floaters method (see procedure at appendix A). The depth of water bodies was measured with the use of a measuring stick, gathering data were done at the two extreme sides of the river and the center of each station. The river width was measured with the use of measuring tape and gathering three samples in every station. The geologic properties include soils and rocks. For the type of soil and rocks, secondary data was utilized from the MPDC Office, San Jorge, Samar. For the biological properties like the flora and fauna in the watershed both from land and water used secondary data from Department of Environment and Natural Resources (DENR). Ocular survey was done.

To gather data on problem 2, the ecosystem profile, both from secondary and primary data were used. The data on vegetation, species and habitats and human uses of the watershed were based on the secondary data and was validated on actual field visitation. For the hydrology, data was gathered from the river of the watershed such as the river width and the same data was utilized from the data generated in problem 1 for the hydraulic properties of the river. Water quality parameters on the river were determined based on the standard parameters set by the DENR on the DENR Administrative Order (DAO) No.34, the beneficial use of the river. As identified, the river is under the Class C classification. The following data were determined: temperature both in air and water, electrical conductivity, pH, dissolved oxygen, turbidity, coliform, and pesticides content. Data were gathered through getting three water samples in each station. The three water samples were collected in the area where the stream flows were measured. Containers were sealed using a packaging tape to avoid displacement and contamination. Each bottle was labelled with the corresponding information. This information was station, date, and time of collection. To prepare the sampling containers, empty mineral water bottles were sterilized using distilled water while washing to avoid contamination. The water samples that were collected from the San Jorge river were analyzed at the EVRMC, Tacloban City.

In problem 3, the researcher conducted an interview with the use of a structured questionnaire to gather data on the level of agricultural stressors.

In problem 4, interview was also conducted to gather data on the level of a watershed stressor indicator along flood occurrence in terms of frequency of occurrence and area affected. Actual inspection in the area was also performed.

In problem 5, actual test was conducted to gather data on the level of a watershed stressor indicator along soil erosion in terms of soil loss and sediment yield.

Photographs were taken in the watershed for documentation.

Statistical Treatment of Data

The data gathered was tabulated, organized, analyzed, and interpreted using means, and frequency counts. Relationships were drawn using regression analysis.

III. RESULTS AND DISCUSSION

A study was conducted to determine the levels of agricultural stressors of San Jorge watershed and the levels of watershed stressors indicators along flood occurrence and soil erosion. Moreover, this study found out the relationships of the levels of agricultural stressors to the levels of watershed stressors indicators. This is along flood occurrence and relationships of the levels of agricultural stressors to the levels of watershed stressors indicators along soil erosion in the watershed. Historical profile was also gathered from the different concern agencies like in MAO, San Jorge, MPDC Office, San Jorge, DA-RIARC, San Jorge, CENRO and PENRO, Catbalogan, Samar, DENR, Tacloban City, and in NAMRIA, Tacloban City. Ecosystem profile was also established, and actual test in the field was done to verify the secondary data gathered.

A. Historical Profile

The historical profile of San Jorge watershed revealed that the land area is equivalent to 40,369.57 hectares. San Jorge is considerably mountainous with the highest elevation of 500 meters above mean sea level. Approximately, half or 45.94 percent of the area is under moderately steep slope, and 10.90 percent only is under plain slope. An annual rainfall of 245.2 mm, annual mean temperature of 27.2 ^{O}C and 83% relative humidity are the hydrologic properties of the area.

Shown on Table 1 is the profile of San Jorge River at six sampling station. The river has a maximum streamflow of 141.50 m3/s at barangay Bay-ang and lowest at barangay Lapaz of 26.42 m^3/s.

Most of the soil in San Jorge watershed is Catbalogan clay loam equivalent to 47.97%, 41.67% Paroan clay loam, 7.40% San Miguel clay loam and rarely Bigaa loam of only 2.96% can be found in San Jorge watershed. As to rocks, majority of the rocks in San Jorge are metamorphosed rocks. The timber

Table 2.
Human Uses of San Jorge watershed

Human uses	Area in hectare	% of the Total Area
Agricultural	12,140.77	30.07
Residential	70.32	0.174
Recreational	2.08	0.0052
Business	1.46	0.0036
Institutional	1075.27	2.66
Others	5.2	0.0128

Table 1.
The Hydraulic Properties of San Jorge Watershed

Stations along Main River	Depth of water bodies (m)	Velocity (m/s)	River width (m)	Stream flow (m3/s)
Bay-ang	7.37	1.0	19.2	141.50
Matalud	7.66	0.25	21.5	41.17
Blanca Aurora	7.38	0.33	20.3	49.44
Buenavista II	6.75	0.25	21.7	36.62
Lapaz	5.67	0.20	23.3	26.42
San Juan	6.52	0.33	26.2	56.37

Table 3.
Type of Farming per Crop

Major Crops	Farmers	Type of Farming	
		Conventional	Non conventional
Rice	66	9	57
Vegetables	48	10	38
Corn	54	25	29
Rootcrops	30	8	22
Fruit trees	45	33	12

Table 4.
Flood Occurrence and Agricultural Areas Affected

Crop	Agricultural Area Affected in hectares	Frequency of Flooding/ year
Rice	434.79	3
Vegetables	151.0	3
Corn	52.0	3
Rootcrop	64.0	2
Fruit trees	49.8	2

species like G-melina and majogany are the major timber. Fruit trees are coconut, caimito,and santol. Bamboo is the flora sufficiently available in the area. Parrot, tukmo, crocodile, snake and *tabile* are the wild animals always seen in San Jorge watershed.

B. Ecosystem Profile

As to the ecosystem profile of San Jorge watershed, the vegetation of the area are classified as 35.07% agricultural, 59.57% forest, and 1.89% grassland. As to hydrology, the average depth of the river is 6.89m, velocity 0.39m/s, 22.03 m river width, and 58.69m^3/s streamflow of the water bodies. As to species and habitats, the following are the land species: human with a population of 16,057, animals classified as wild and domestic, and plants classified as agricultural, timber and fruit trees. The human uses of the watershed are agricultural, residential, recreational, business, institutional, etc. Mainly for agriculture is the use of San Jorge watershed which is equivalent to 30.07%.

C. Levels of agricultural stressors

The levels of agricultural stressors are in terms of the following: area occupied per crop, farming, farm implements used, farm chemicals used, and the frequency of farming. Most of the areas in San Jorge were occupied for 43.90% rice production. Next is 18.60% for fruit trees, for vegetables is 15.40%, followed by 8.90% for corn, and the least utilize for 8.30% root crops which comprises the total agricultural area. Most farmers adopt non-conventional or the contour type of farming equal to 71.00% while the 29.00% adopt a traditional way of farming. As to farm implements used, almost equal farmers used hand tractor to carabao in farming an operation with a percentage of 42.00% and 58.00%, respectively. Obviously, farmers in the area used different chemicals for fertilization, against insects and pests and killed or suppressing the emergence of weeds. For the frequency of farming, crops are classified as the number of times the respondents till the soil for re-planting. For rice production, majority of the respondents, cultivate the area twice a year, twice a year for vegetable production, and once for rootcrops.

D. Flood Occurrences

The flood occurrences in the watershed were in terms of area affected and the frequency of flooding. Based on the result of the interview, it was on rice area equivalent to 434.79 ha that has the great area affected by flooding. As to the frequency of flooding, most of the respondents answered thrice a year.

E. Soil Erosion

For the soil erosion, in terms of soil loss, it was the fruit trees which have the highest soil loss equal to 2.40 Mg/ha/year the lowest is on rootcrop which has a soil loss

Table 5
Sediment Yield in San Jorge watershed

Crop	(I) Rainfall mm	(N) Curve Number	(S) Diff. of Rainfall-Runoff	(Q) Mean Annual Runoff, mm	(SY) Sediment Yieldton/km2/ year SY=0.042(Q)1.18
Rice	245.2	85	44.824	198.560	21.62
Vegetable	245.2	84	48.381	195.388	21.21
Corn	245.2	83	52.024	192.207	20.80
Rootcrops	245.2	83	52.024	192.207	20.80
Fruit trees	245.2	91	25.121	217.434	24.06

of 1.15 Mg/ha/year. For the sediment yield, it was also the fruit trees with the highest sediment yield of 24.06 ton/km2/ year.

The analysis conducted revealed different levels of a significant relationship to different agricultural stressors. The area occupied per crop reveals a significant relationship both to flood occurrence and soil erosion. As to the type of farming, the conventional farming has no significant relationship to flood occurrence and soil erosion while nonconventional farming has a high significant relationship to flood occurrence but low significant relationship to soil erosion. The frequency of farming has both high significant relationship to flood occurrence and soil erosion. The farm implements used revealed significant relationship to flood occurrence and soil erosion. And for the chemicals used in farming, it revealed high significant relationship to flood occurrence and soil erosion.

IV. CONCLUSIONS AND RECOMMENDATIONS

The following were conclusions derived from the analysis conducted from the study:

Almost a third of the San Jorge watershed is used for agriculture. The rest of the watershed are forest covered.

The agricultural stressor of San Jorge watershed includes rice farming up to three times a year with a majority employing non-conventional farming including the use of chemicals in farming.

Study shows that uncontrolled agricultural activities influence flood occurrence attributed to increased water runoff and increased river siltation.

This means that control measures such as the use of environment-friendly farming methodologies be employed to minimize the impact of agricultural activities.

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