Ecosystem-based, integrated watershed management to address climate change

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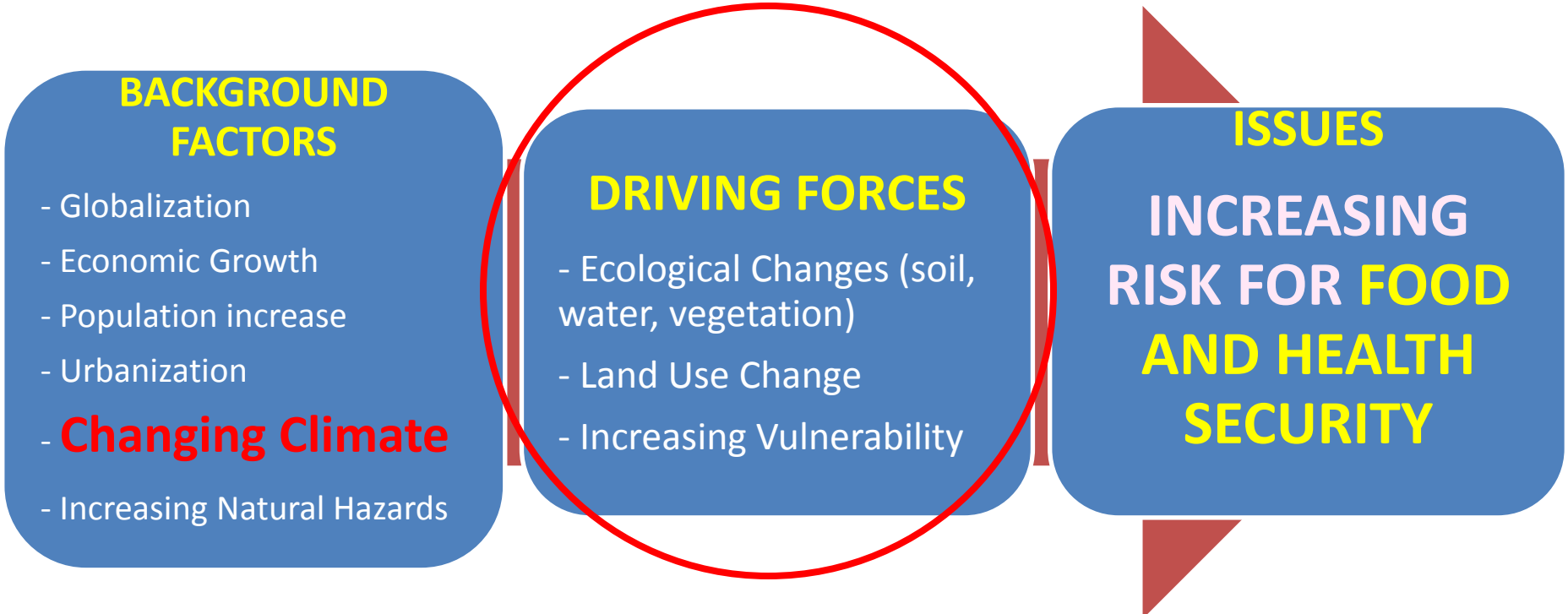
Background

- **The water quality of Laguna Lake, the largest freshwater lake in the Philippines, has significantly deteriorated due to pollutants from soil erosion, effluents from chemical industries, and household discharges. With rapid urbanization and increase in population pressure, all these have stressed the aquatic life (fish, shells, etc.) over the past several decades.**



Analysis of Land Use Patterns, Drivers & Impacts of Land Use Change in the Sta. Rosa-Silang Subwatershed

Damasa B. Magcale-Macandog, Maria Noriza Q. Herrera, Dalton Erick S. Baltazar, J.L. Balon, Kathreena G. Engay, Ozzy Boy S. Nicopior, Donald A. Luna, Christian P. dela Cruz, Ma. Charisma Malenab, Milben A. Bragais, Maria Francesca O. Tan

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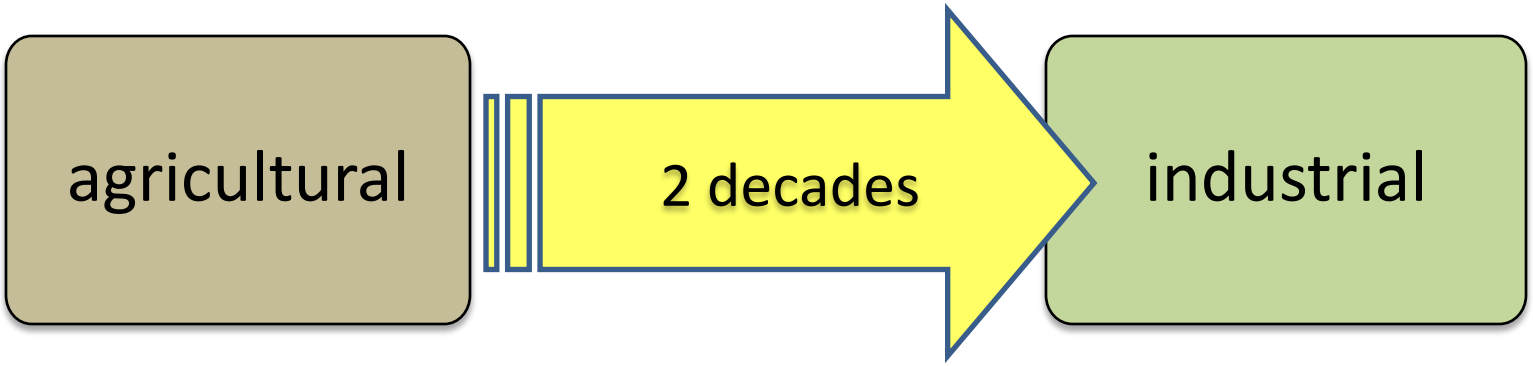
STA. ROSA SUBWATERSHED

had undergone an **abrupt shift** in economic-base



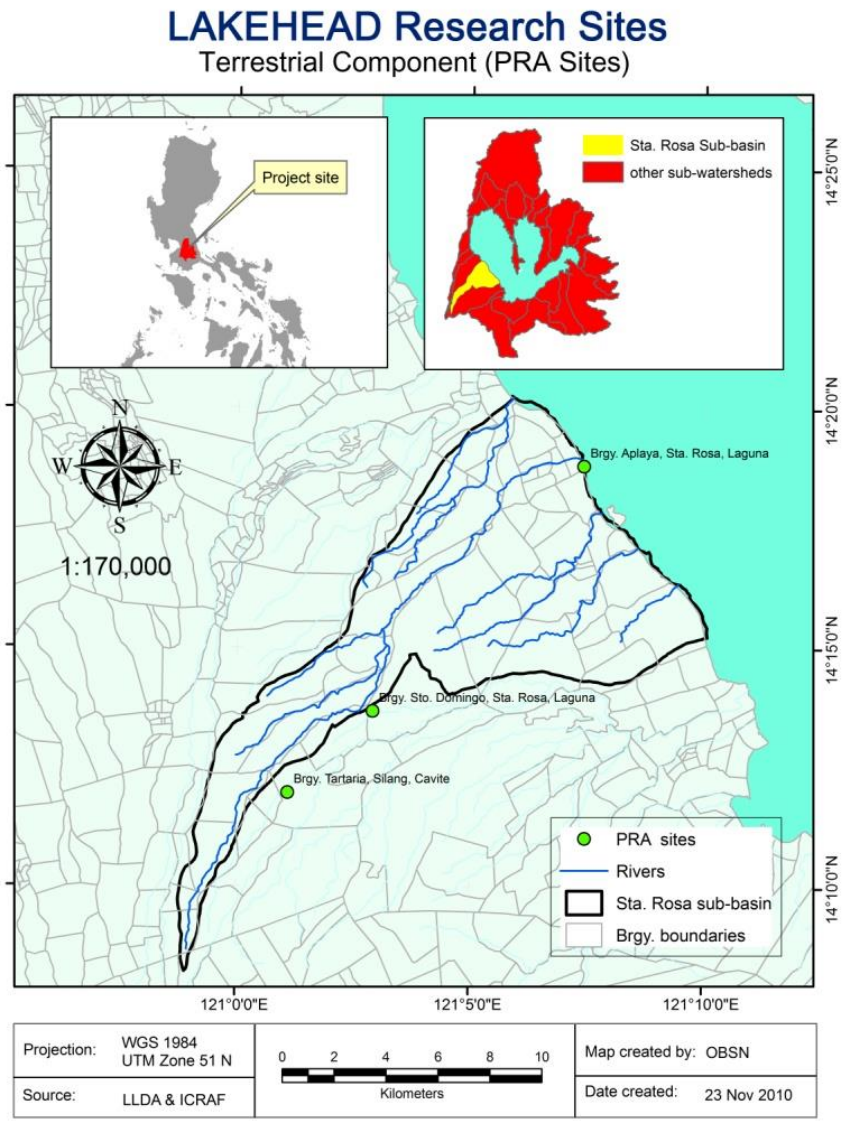
Change largely attributed to:

- ❑ industrialization
- ❑ rapid urbanization

Specific Objectives

- **To analyze changes in the type, intensity, extent, distribution and patchiness of land cover types in Sta. Rosa sub-watershed in the past 30-40 years.**

- **To investigate and document drivers and impacts of land use change in the subwatershed.**



Identified Sites for Participatory Rural Appraisal in the Sta. Rosa Sub-watershed

- Brgy. Tartaria, Silang, Cavite – upstream
- Brgy. Sto. Domingo, Sta. Rosa City, Laguna – midstream
- Brgy. Aplaya, Sta. Rosa City, Laguna – shoreline

Participatory Rural Appraisal (PRA) Activities in the Sta. Rosa Watershed

VILLAGE TRANSECT

Brgy. Tartaria (Upstream)

- Generally undulating topography
- Farming community
- Multi-storey Agroforesty
- Soil erosion, high soil acidity, land and river pollution and poverrty

Brgy. Sto Domingo (Mid stream)

- Flat
- Varied income source
- Industrial + residential community
- Vegetable gardens
- Solid wastes and water pollution

Brgy. Aplaya (Shoreline)

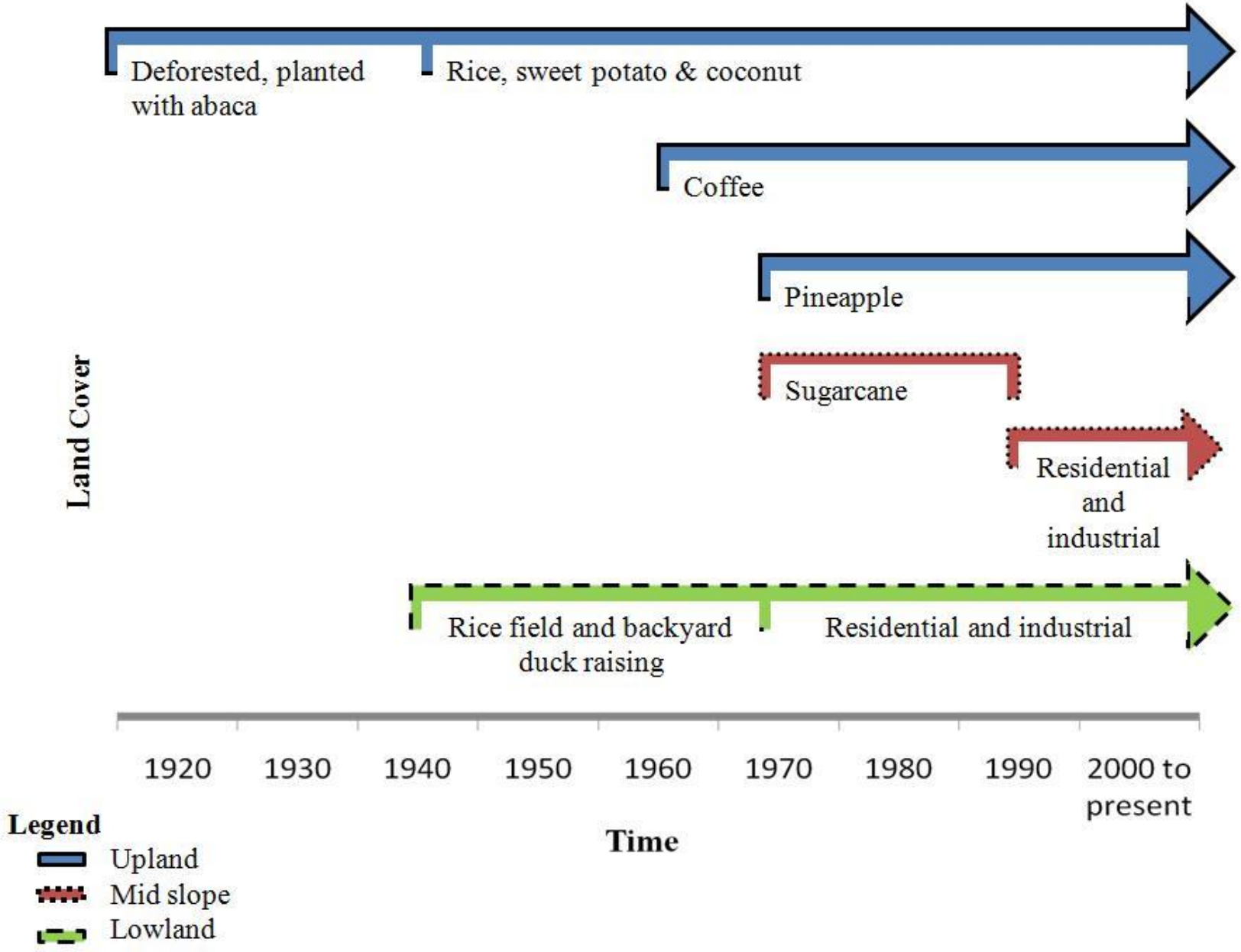
- Flat topography
- Fishing community
- Fishing
- Lake pollution and poverty

LAKE

Land-use Changes

Through Time

Sta. Rosa Subwatershed

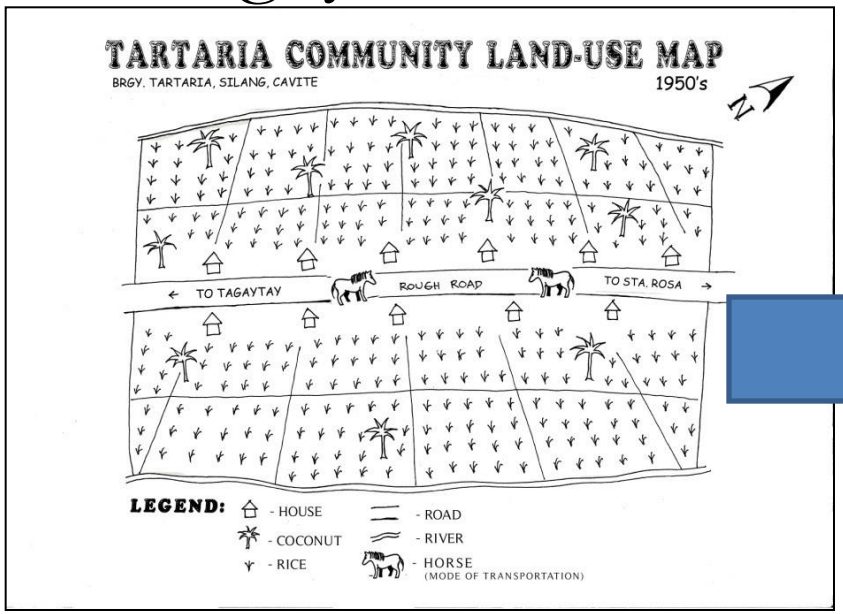


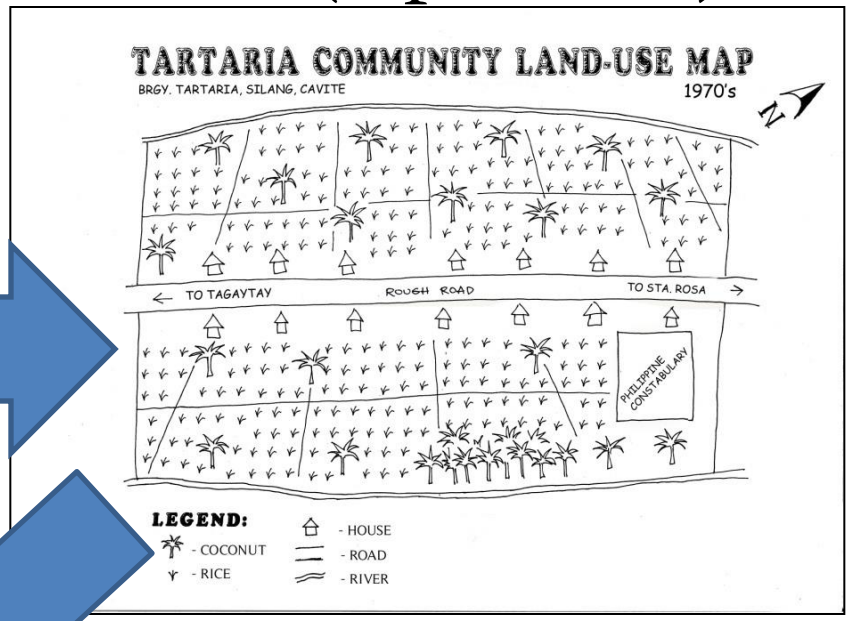
Findings: Sites differed in land use and land-use conversion

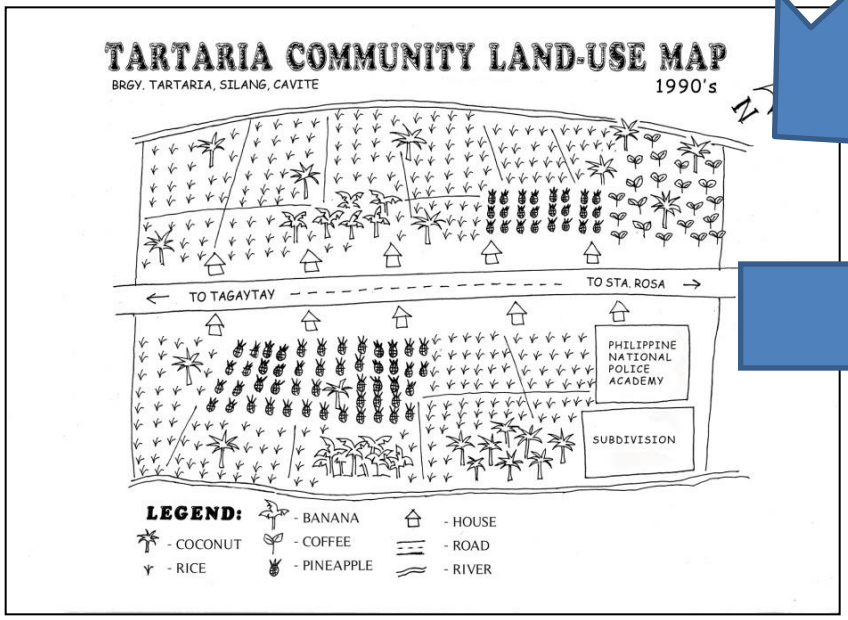
- **upstream** = agricultural/ agroforestry
- **midstream** = undergoing conversion from agricultural to residential-industrial
- **lakeshore** = predominantly residential

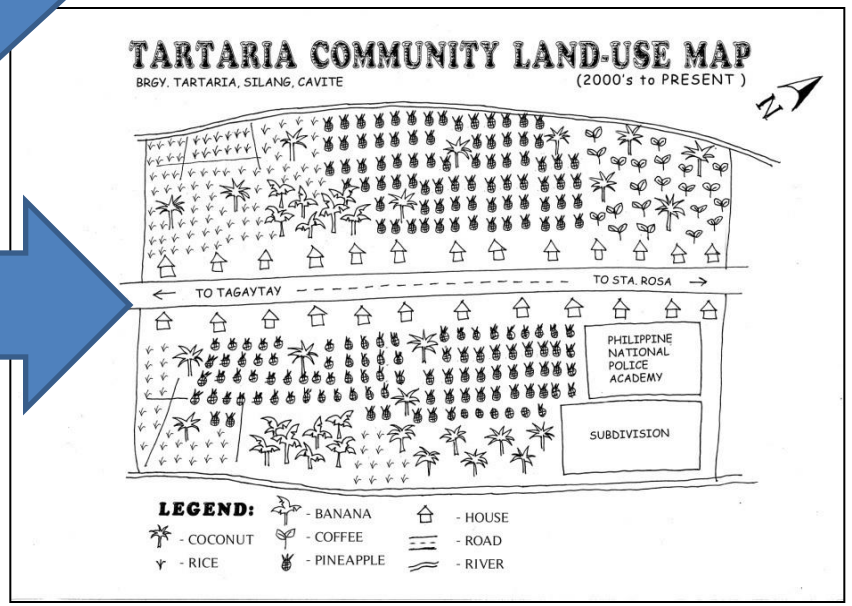
Participatory Reconstruction of Community Land-use Maps

Barangay Tartaria, Silang, Cavite (Upstream)

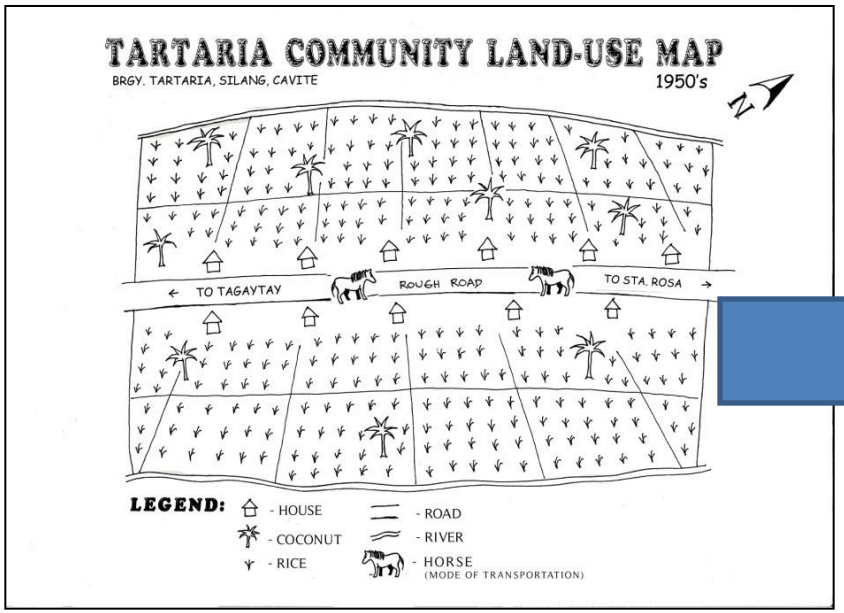


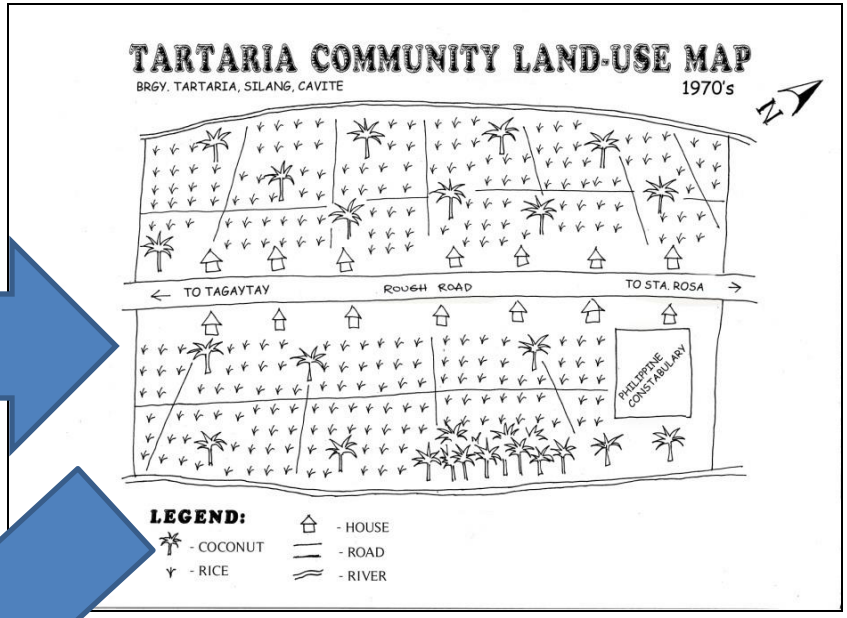


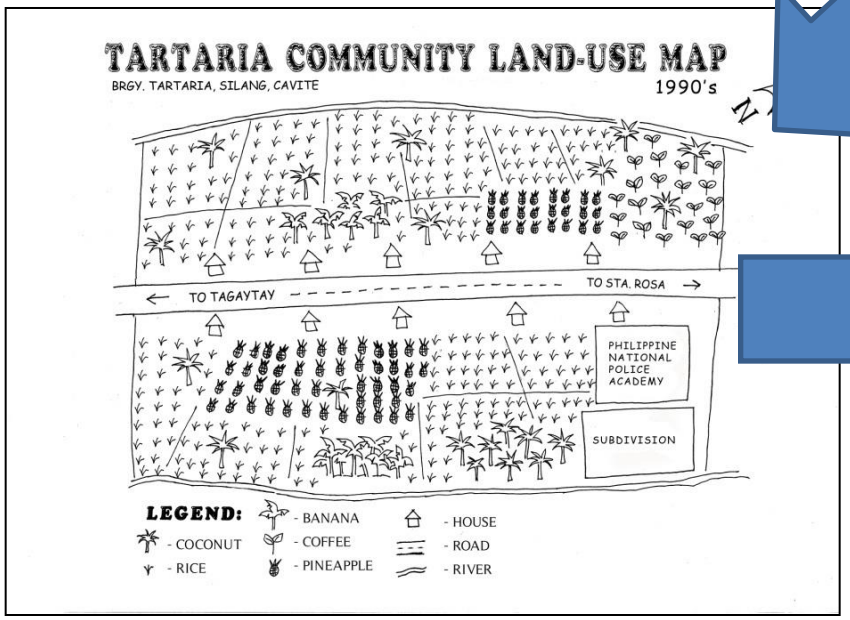


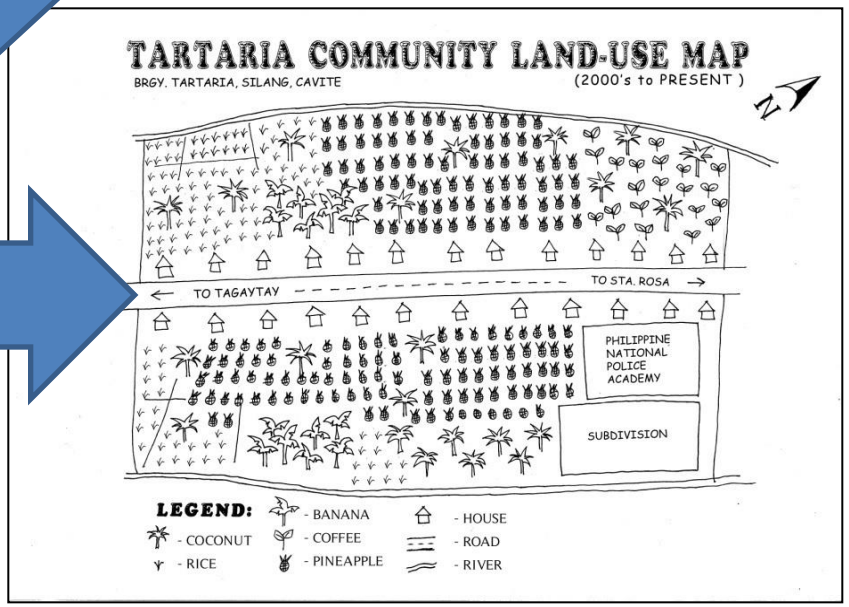


Barangay Sto. Domingo, Sta. Rosa City, Laguna

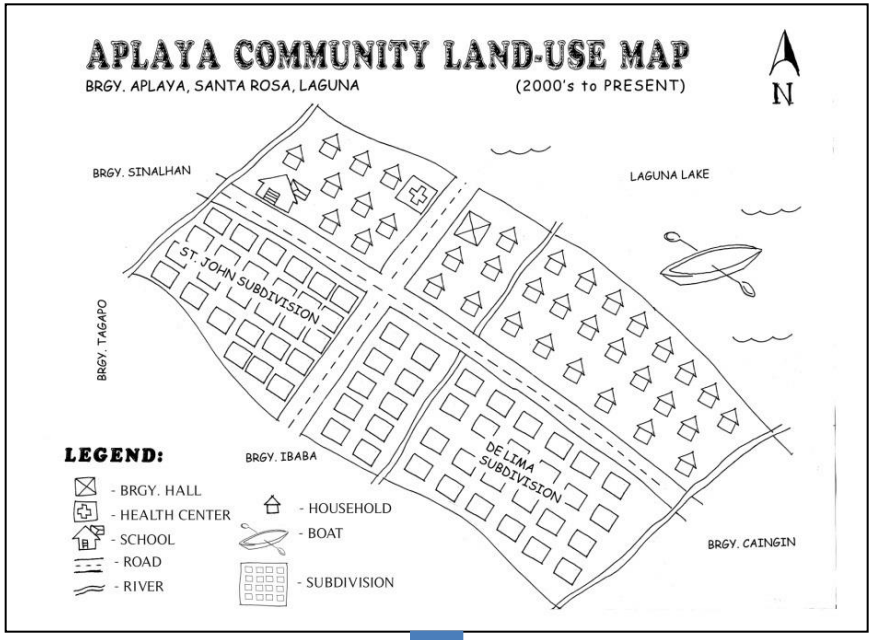


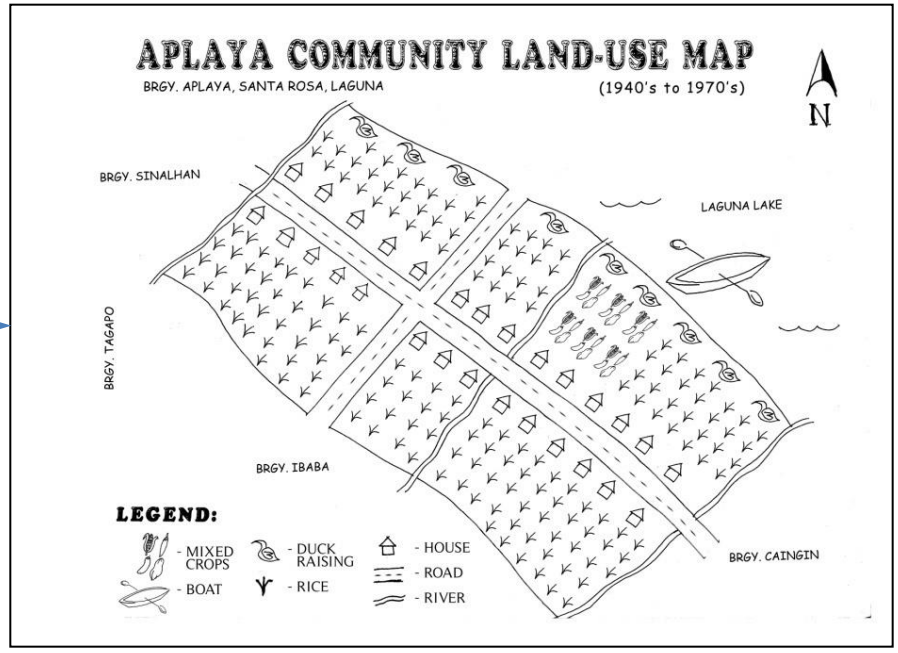






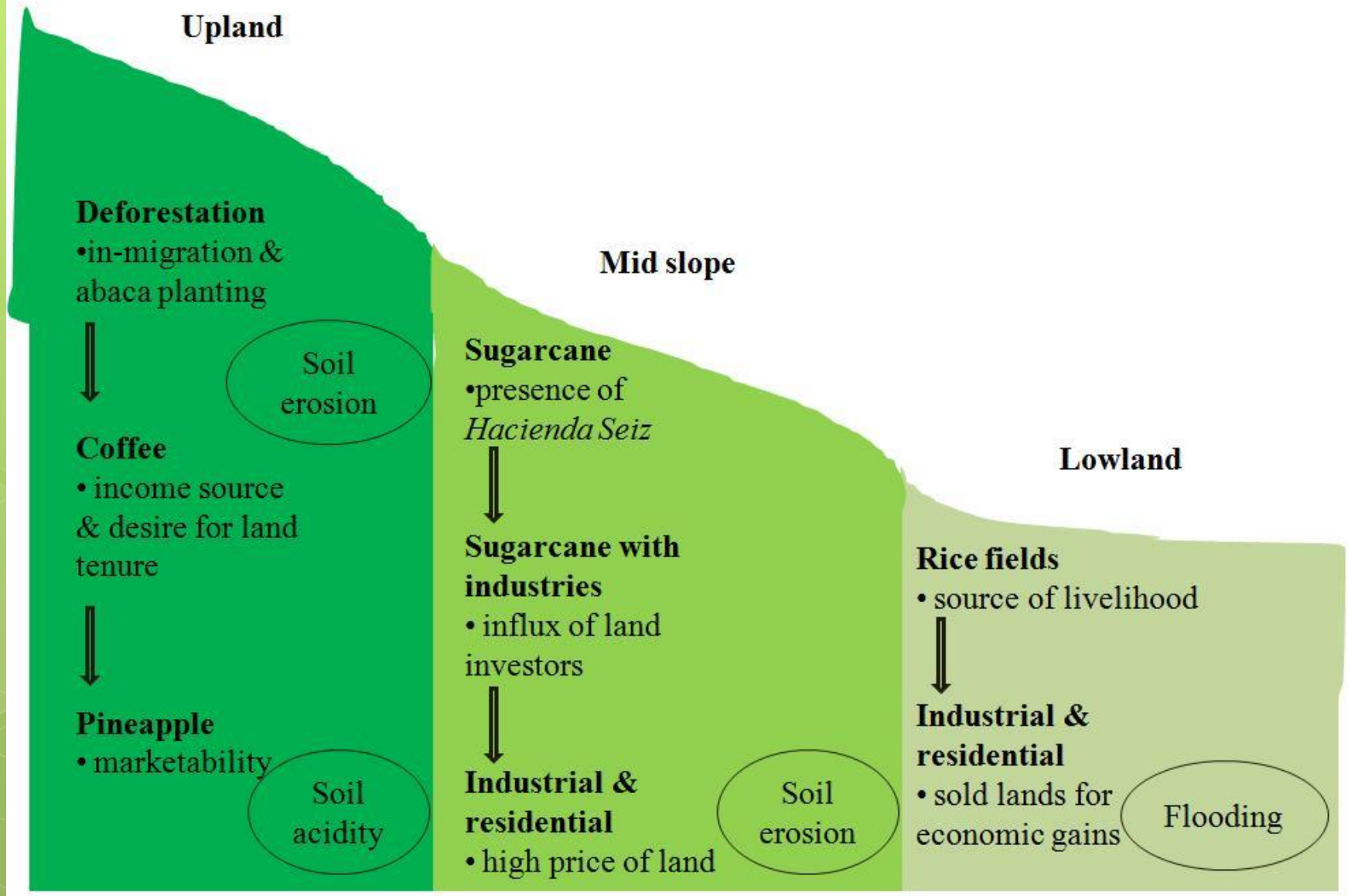
Barangay Aplaya, Sta. Rosa City, Laguna





Drivers-Impacts of Land-use Changes

Sta. Rosa Subwatershed



Sta. Rosa Sub-basin

Agricultural wastes

Soil erosion

Industrial wastes (heavy metals from factories)

Domestic wastes

LAGUNA LAKE

Agricultural and Agroforestry Systems and their Impacts on the Environment: The Case of Silang- Santa Rosa Subwatershed

Dr. Damasa M. Macandog[2], Maria Francesca O. Tan[2], Dalton Erick S. Baltazar[2], Maria Noriza Q. Herrera[2] and Dr. Ryohei Kada[1]

[1]Project Leader, LakeHEAD Project, Research Institute for Humanity and Nature, Kyoto, Japan
[2]University of the Philippines Los Baños, College, Los Baños, Laguna, Philippines

Objectives

- To document biophysical profile of agricultural and agroforestry farms in the Silang-Santa Rosa subwatershed.
- To document the frequency and quantity of fertilizer and pesticide application to agricultural and agroforestry crops in Silang-Santa Rosa subwatershed.
- To assess the environmental impacts of fertilizer and pesticide application in agriculture and agroforestry systems in Silang-Santa Rosa subwatershed.

Methodology

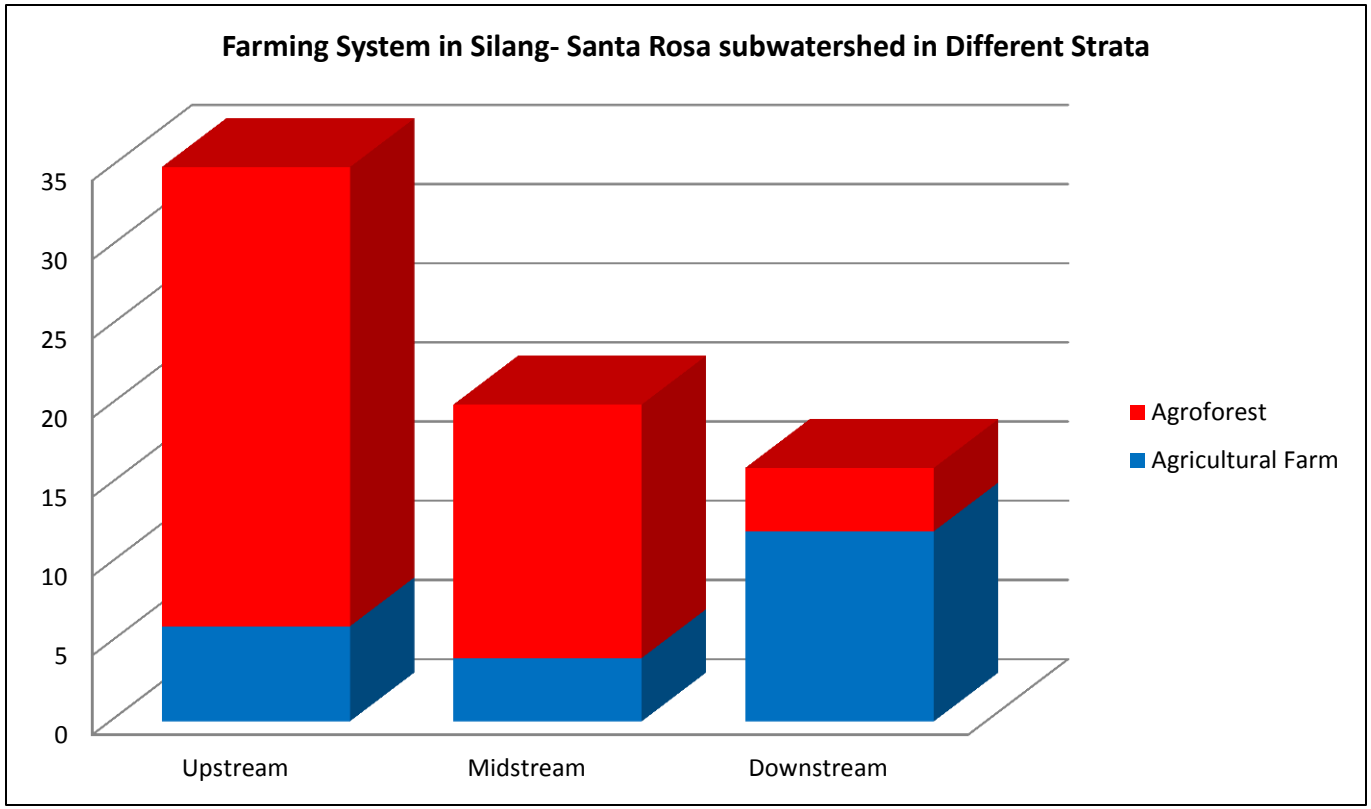
❖ Farm survey

1) biophysical characteristics
2) tenurial conditions
3) farming input and output allocations
4) labor utilization
5) fertilizer and pesticide application details
6) environmental impacts of the agricultural and agroforestry systems in the watershed

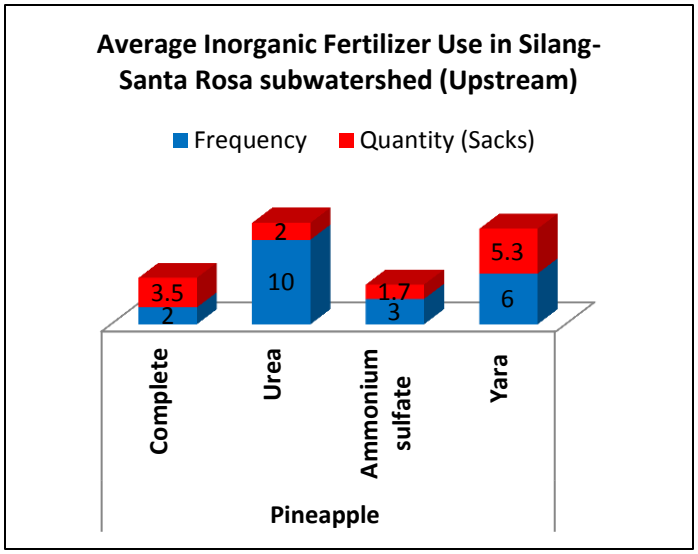
❖ Soil and Ground water sampling - analysis

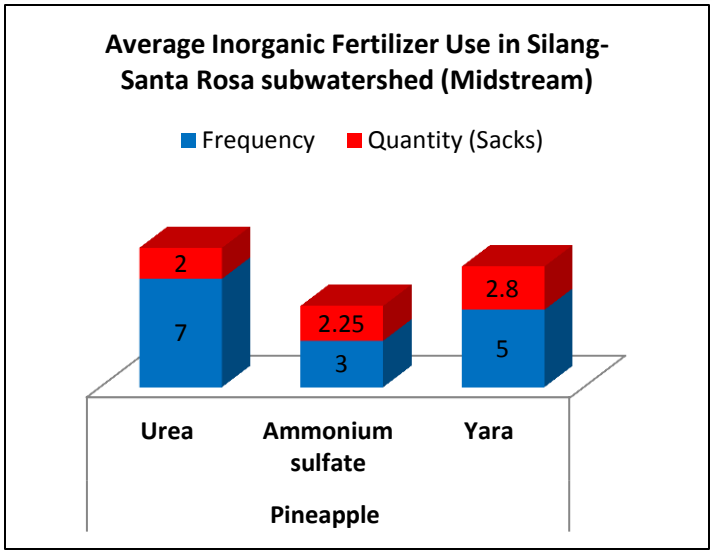
RESULTS

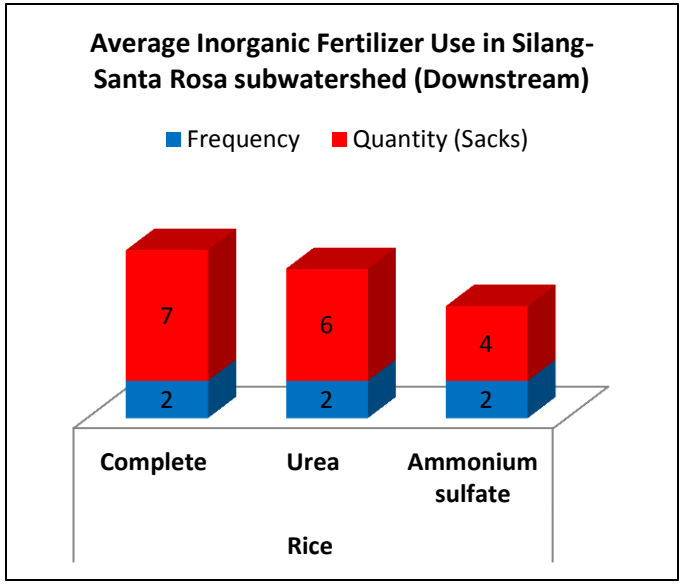
Farming System



Inorganic Fertilizer Use in Silang-Santa Rosa subwatershed



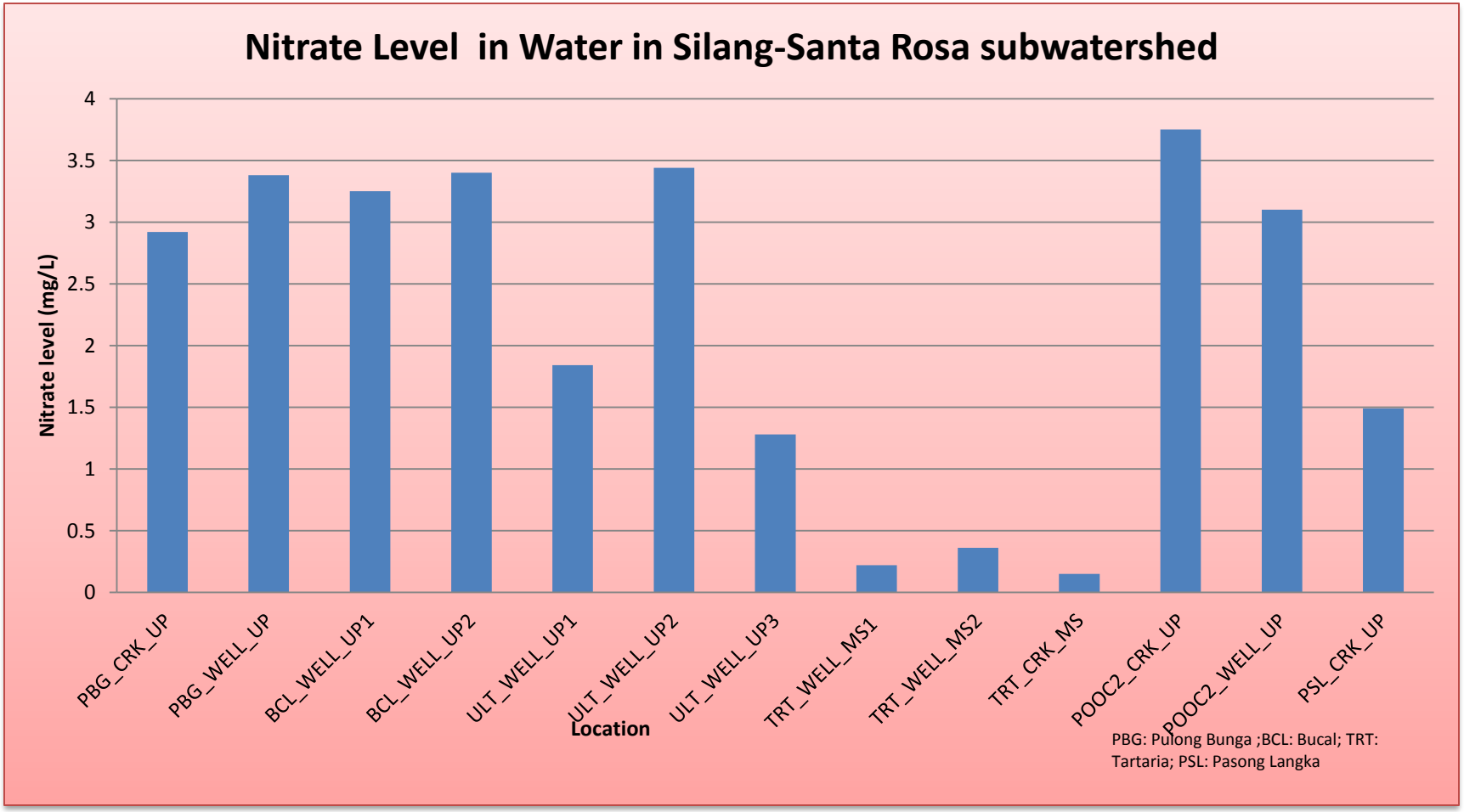




Pesticide Use in Silang-Santa Rosa subwatershed

SUBWATERSHED	CROP	PESTICIDE	ACTIVE INGREDIENT	FREQUENCY (per cropping season)	QUANTITY (L/ha)
Silang- Santa Rosa	Pineapple	Roundup	Glyphosate	1	1

Nitrate level in Ground Water in Silang-Santa Rosa subwatershed



US EPA standard limit for drinking water = 10 mg NO_3/Li

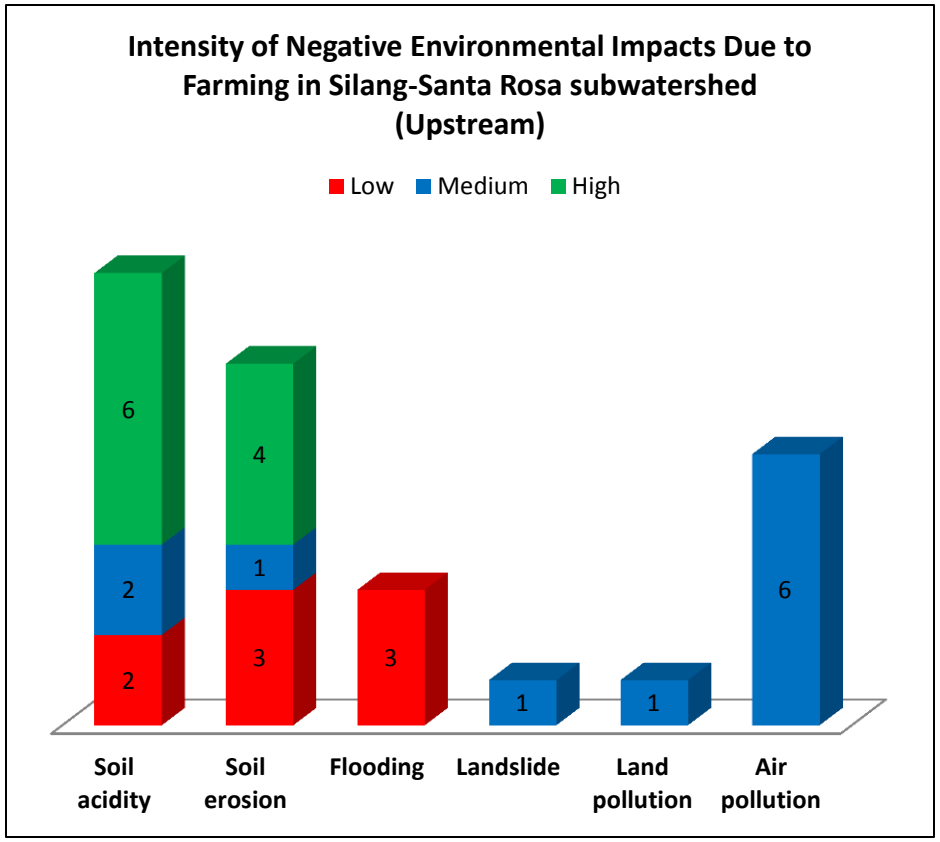
Results and Discussion: Organochlorine Pesticides (OCP) in Silang-Santa Rosa subwatershed

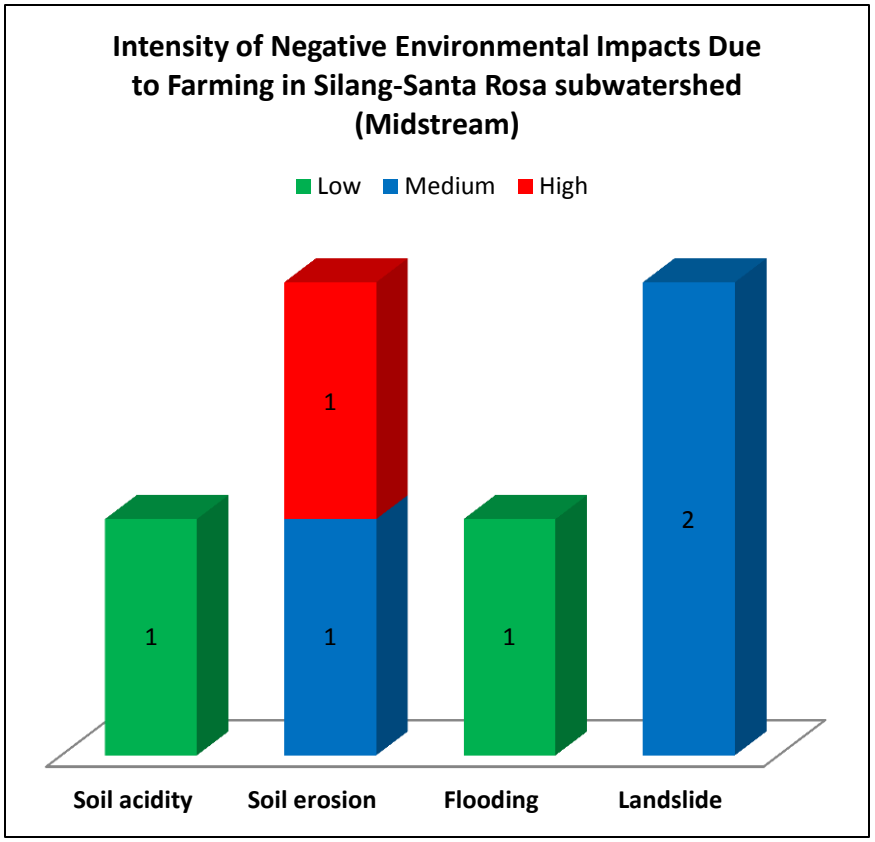
OCP	PBG_3_2_UP	PBG_2_3_UP1	BCL_7_14_UP
Alpha - BHC, ug/kg	<0.01	<0.01	<0.01
Lindane, ug/kg	<0.01	<0.01	<0.01
Beta - BHC, ug/kg	<0.01	<0.01	<0.01
Delta - BHC , ug/kg	<0.01	<0.01	<0.01
Heptachlor, ug/kg	<0.02	<0.02	<0.02
Aldrin, ug/kg	<0.02	<0.02	<0.02
Heptachlor Epoxide, ug/kg	<0.02	<0.02	<0.02
g-Chlordane, ug/kg	<0.02	<0.02	<0.02
a-Chlordane, ug/kg	<0.04	<0.04	<0.04
4,4 DDE, ug/kg	<0.01	<0.01	<0.01
Endusulfan 1, ug/kg	<0.02	<0.02	<0.02
Dieldrin, ug/kg	<0.04	<0.04	<0.04
Endrin, ug/kg	<0.04	<0.04	<0.04
4,4 DDD, ug/kg	<0.02	<0.02	<0.02
Endusulfan 11, ug/kg	<0.01	<0.01	<0.01
4, 4 - DDT, ug/kg	<0.04	<0.04	<0.04
Endrin Aldehyde, ug/kg	<0.02	<0.02	<0.02
Methoxychlor, ug/kg	<0.02	<0.02	<0.02
Endusulfan Sulfate, ug/kg	<0.02	<0.02	<0.02
Endrin Ketone, ug/kg	<0.02	<0.02	<0.02
Toxaphene, ug/kg	<1.0	<1.0	<1.0

PBG: Pulong Bunga; BCL: Bucal

***Soil samples were collected last June 2013 in Silang, Cavite within 2 inches of soil surface, 2weeks to 1 month after pesticide application

Environmental Impacts of Farming in Silang-Santa Rosa subwatershed





Conclusion

❖ **SILANG-SANTA ROSA SUBWATERSHED**

- Characterized by agroforests with the dominance of pineapple in the upstream and midstream areas
- More inorganic fertilizer use over pesticides for pineapple
- Ammonium sulfate, urea and yara are commonly used inorganic fertilizers
- Observed negative impacts are soil acidity, soil erosion and floods
- Nitrate and OCP levels of ground water and streams are below the USEPA standard limits

Floral and Soil Arthropod Biodiversity of Agroforestry and Agricultural Systems in the Upland Areas of Silang, Cavite, Philippines

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[1]Institute of Biological Sciences, University of the Philippines Los Baños, College, Laguna 4031

[2]Research Institute for Humanity and Nature, Kyoto, Japan

Objective

- To assess plant and soil arthropod diversity under various agroforestry and agricultural systems in Silang, Cavite

Methodology

Flora

Farm Selection

- Reconnaissance survey of agroforestry and agricultural systems in the upstream and midstream areas
- Selected 8 agricultural and 15 agroforestry systems from 7 barangays/villages

Data collection and sampling:

- Eight 10m x 10m quadrats were established within each agricultural and agroforestry systems
  - Tree species (Diameter at breast height (DBH), merchantable height, total height, diameter of crown)
  - Weeds, grasses, seedlings, shrubs

Data analysis:

- Shannon and Simpson's diversity indices
- Shannon evenness index

Margaleff's richness index

Methodology

Soil arthropod

Soil sampling:

- Collected composite soil and litter samples from same sampling plots as the flora analysis

Sample processing:

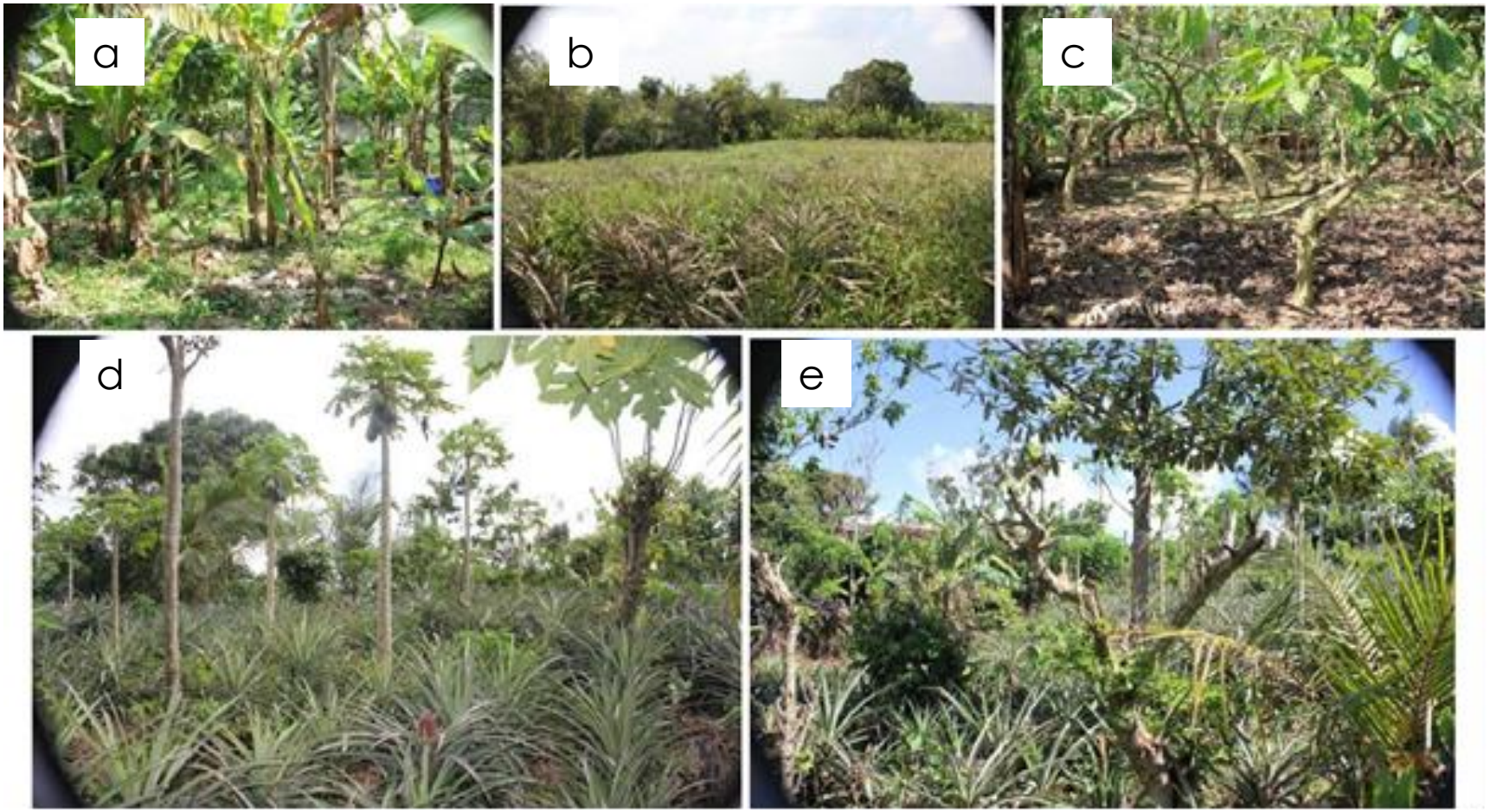
- Soil and leaf litter samples were placed in Berlese funnels for 3-5 days
- Insects were preserved in containers with 95% ethanol

Identification and data analysis:

- Insects were identified to the family level

RESULTS

Agricultural systems



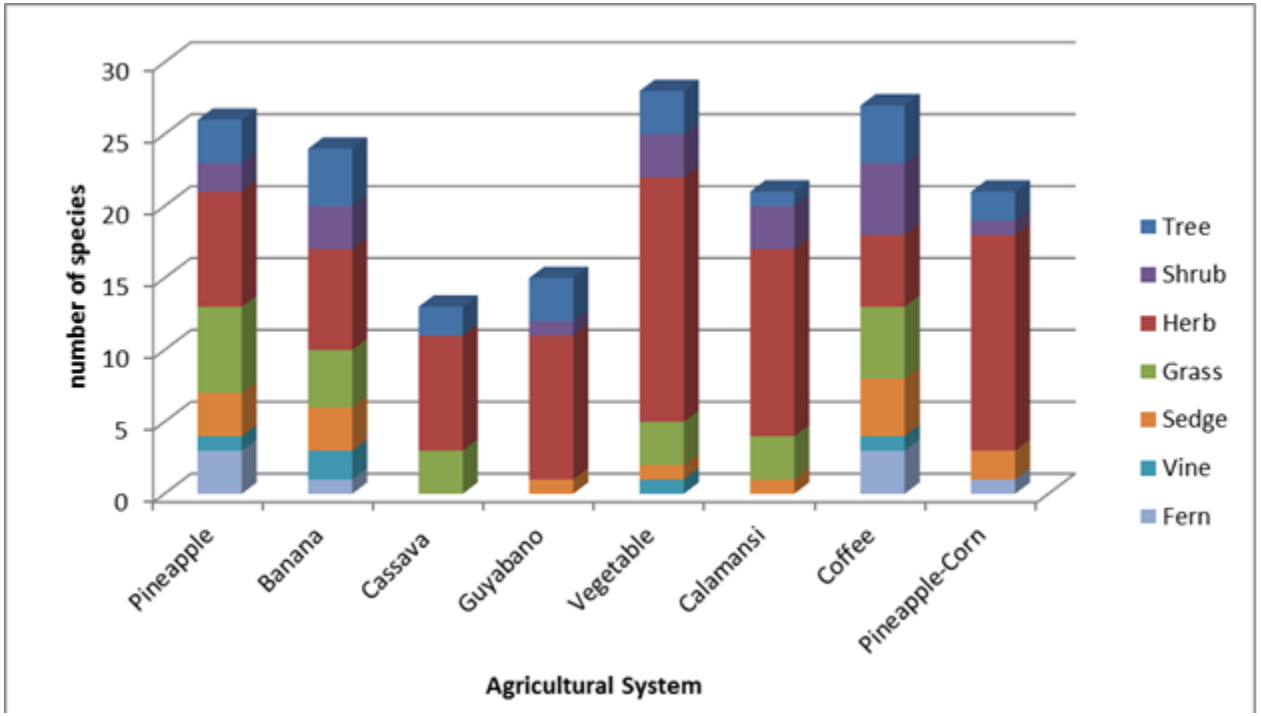
a) banana, b) pineapple, c) coffee; and agroforestry systems:
d) papaya-pineapple, e) coffee-pineapple

Species Richness based on Plant Growth Habit

Table 1. The number of species representing the various growth habits recorded in agroforestry and agricultural systems in Silang, Cavite.

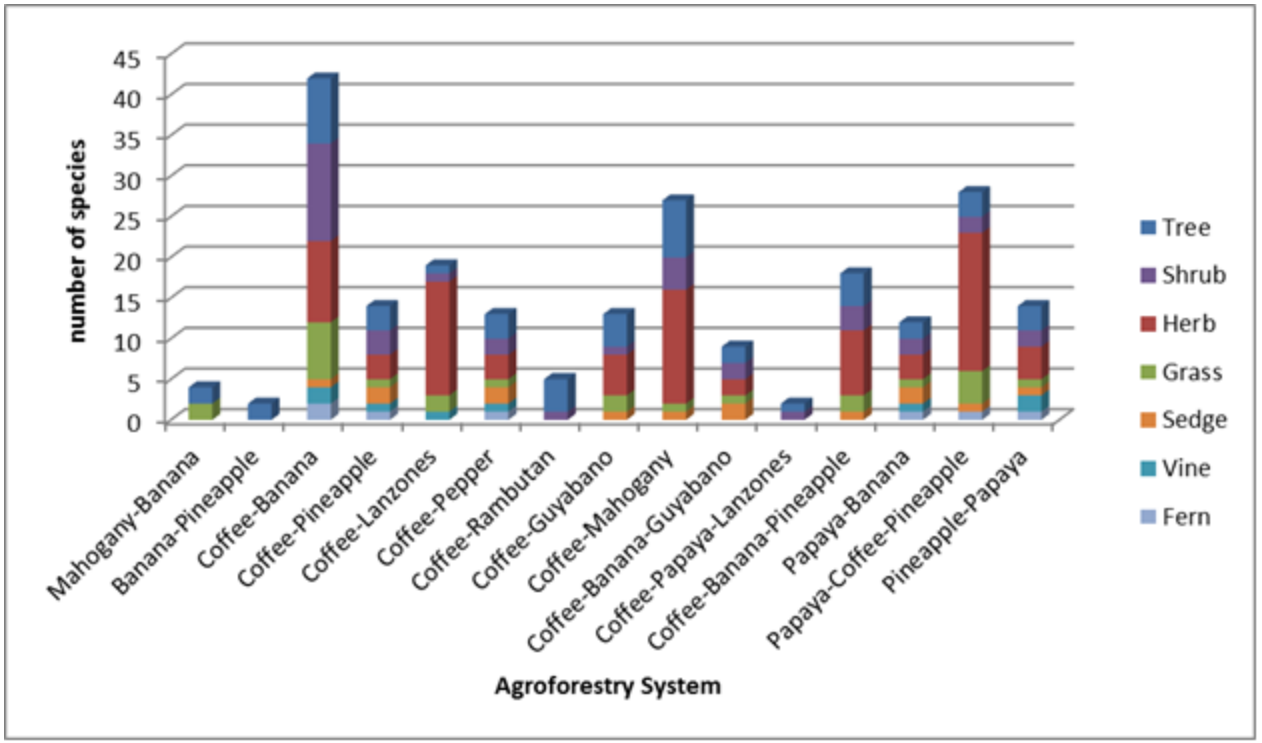
Growth Habit	Agroforestry Systems	Agricultural Systems	Total
Tree	**29**	21	34
Herb	44	**53**	66
Grass	**13**	11	16
Shrub	**13**	10	15
Vine	**3**	2	3
Sedge	**2**	1	2
Fern	**5**	4	8
Total	**109**	102	144

Species Richness of Various Agricultural Systems



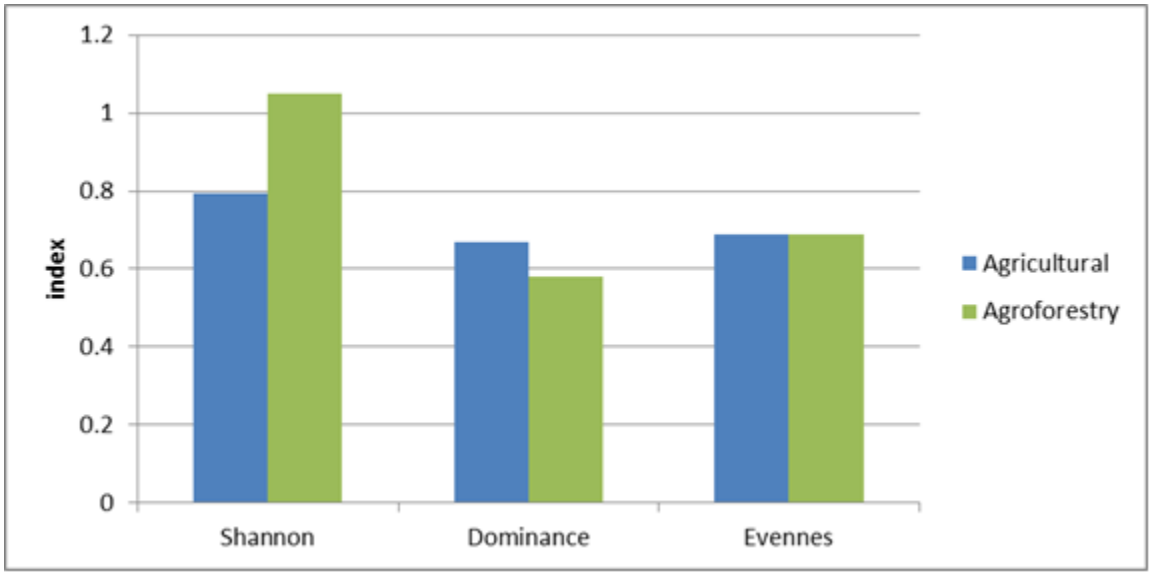
- Vegetable agricultural system has highest number of species and highest richness of herbaceous species
- Pineapple has highest number of grass species
- Coffee has more shrub species

Species Richness of Various Agroforestry Systems



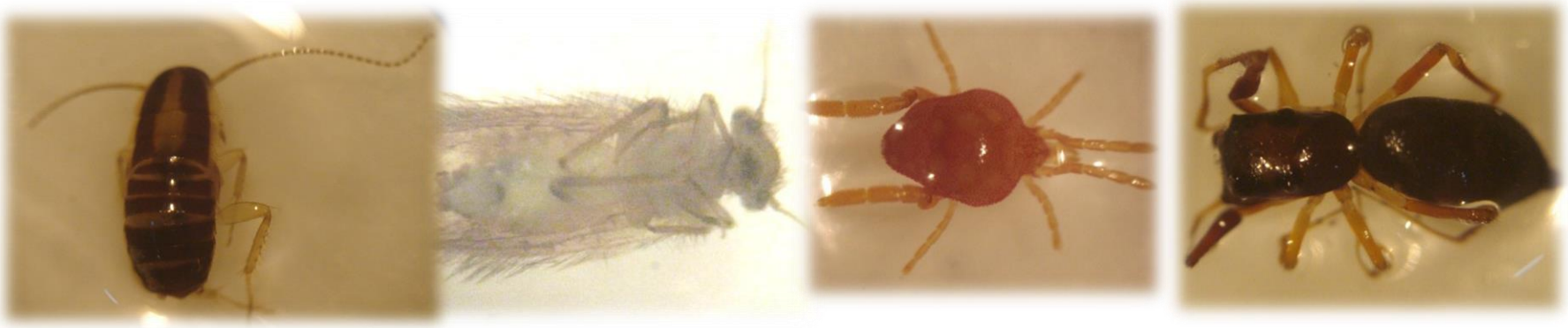
- Total number of trees and shrubs in agroforestry were higher than agricultural systems
- Coffee-banana agroforestry system has the highest species richness
- Papaya-coffee-pineapple system has the highest number of herbaceous species

Biodiversity Indices of Emergent Species



- **Shannon diversity index** - agroforestry systems have higher biodiversity of emergent species
- Higher **Simpson's Dominance Index** of agricultural systems - certain emergent species are dominant in agricultural systems
  - i.e. banana, guyabano and coffee agricultural systems
- **Evenness index** is equal for both - uniform relative abundance of different species in both systems

Soil Arthropod Diversity



Soil arthropods

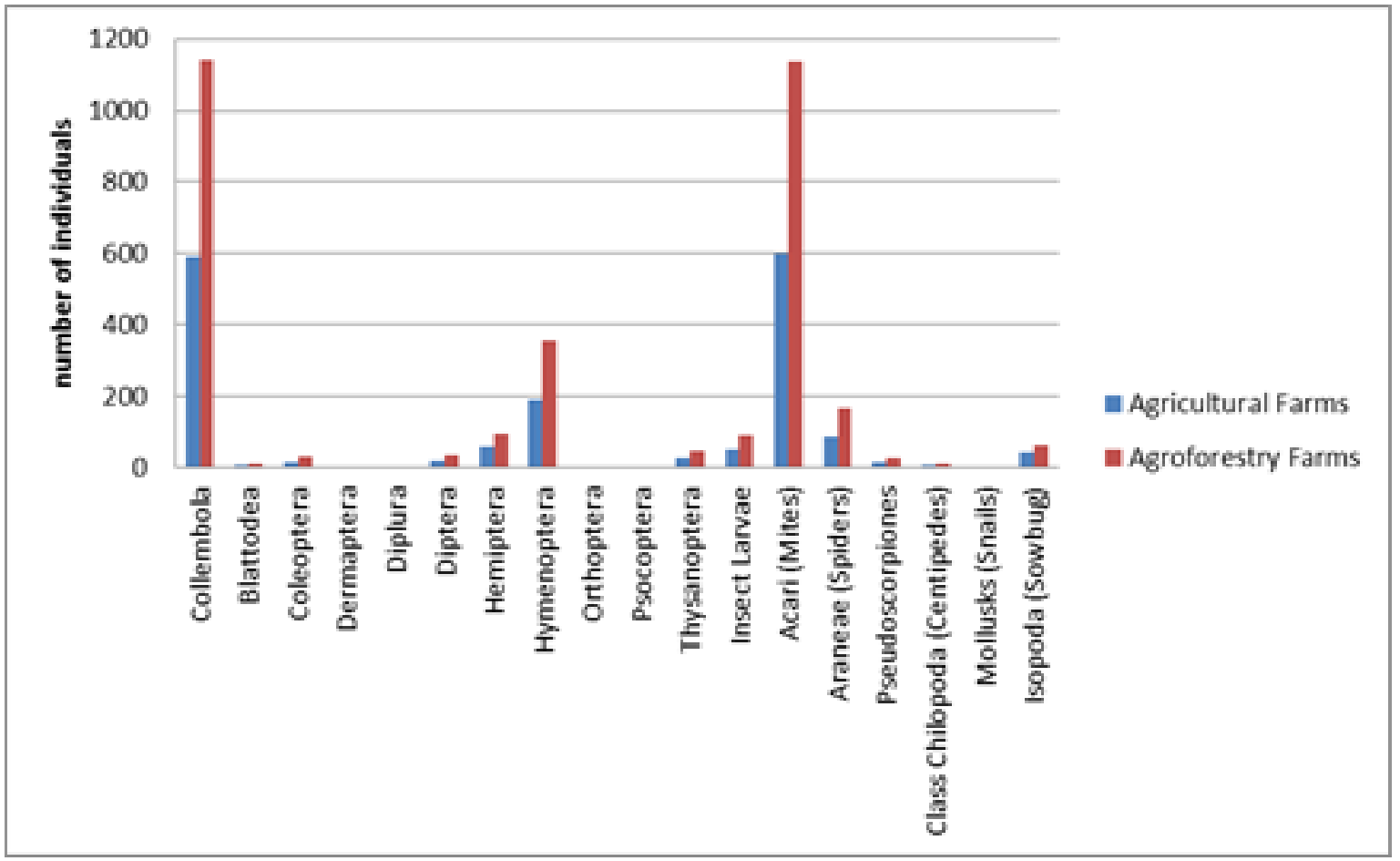


Fig. 6. The number of insect individuals belonging to various insect orders recorded in agroforestry and agricultural farms in Silang, Cavite

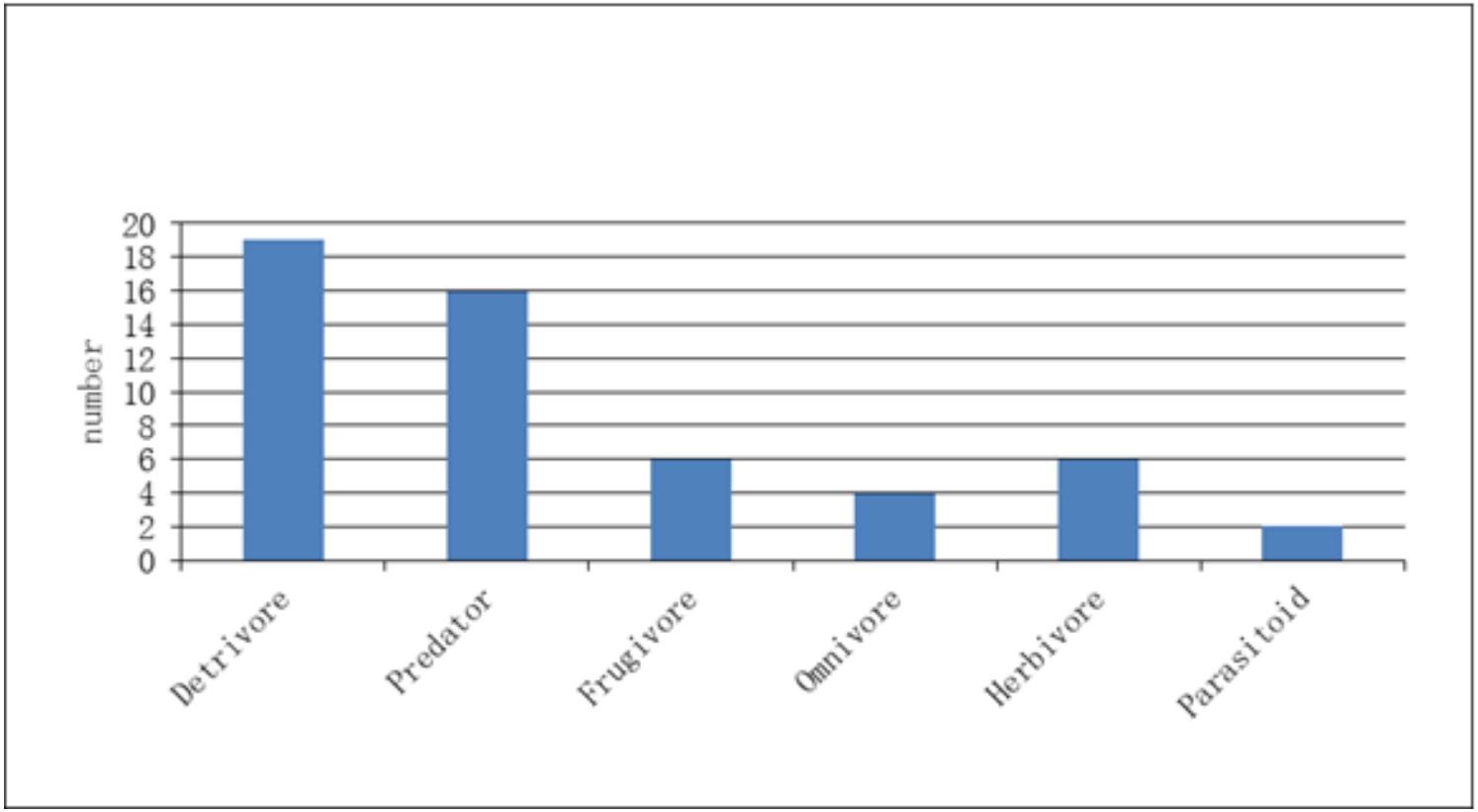


Fig. 7. The number of arthropod species and their ecological functions in the agroforestry and agricultural systems in the Silang, Cavite.

Conclusion

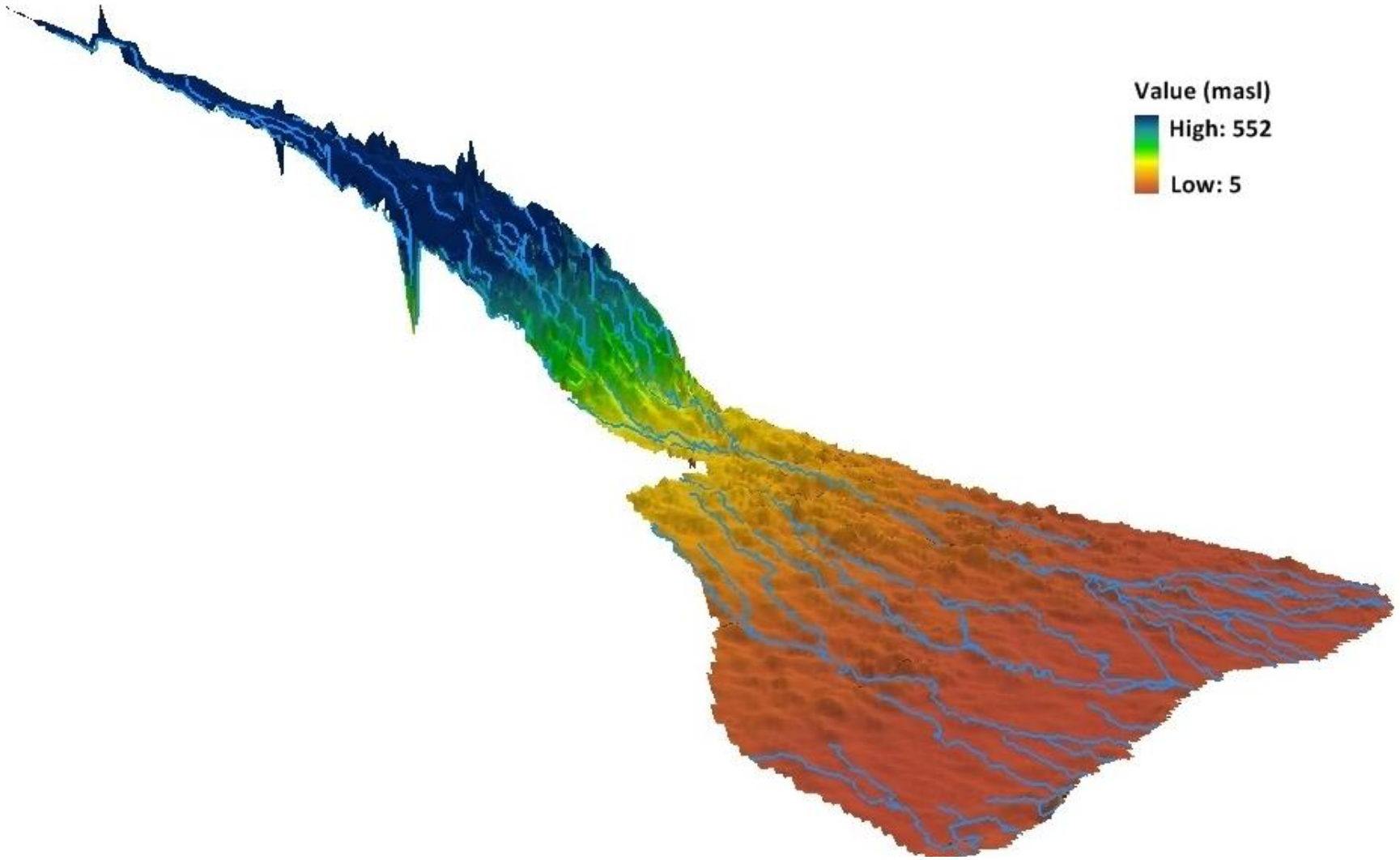
- Agroforestry systems have higher floral and soil arthropod species richness and diversity than agricultural systems

Geophysical Characteristics and Erodibility Assessment of the Silang-Santa Rosa River System

Damasa M. Macandog
Jacquelyn Miel
Mic Ivan V. Sumilang
Donald Luna

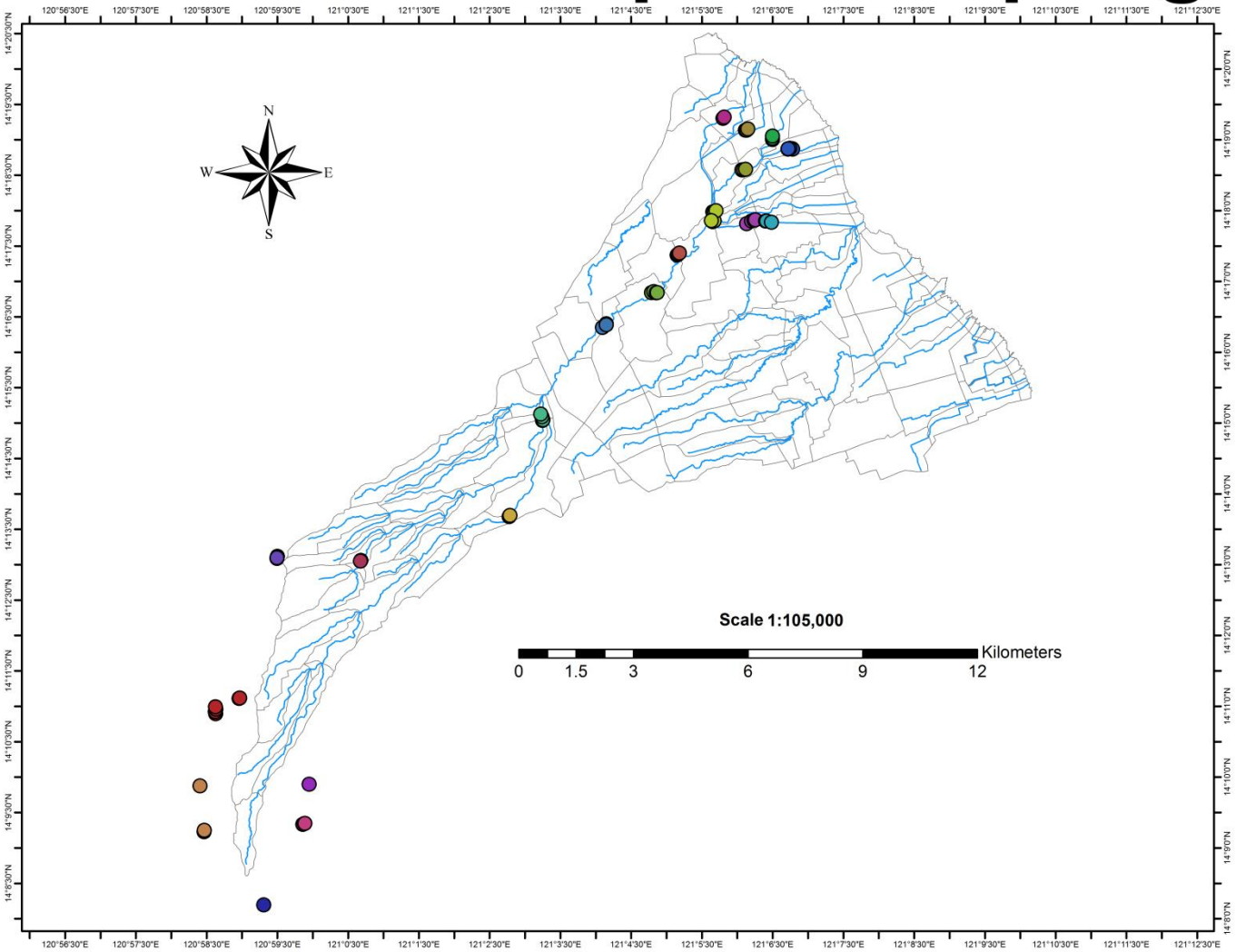
Objective

To develop an ecological profile for the Silang-Santa Rosa River and its riparian vicinity to meet the needs of development planning, and design an environmental program for the sustainable development of the resource



3D map of the Silang-Santa. Rosa Sub-watershed

Location Map of Sampling Points



Legend

Sampling

- 13
- 33
- 36
- 39
- 40
- 41
- 42
- 47
- 48
- 50
- 53
- 54
- 60
- 62
- 69
- F
- H
- L
- MI
- PA
- PM
- PN

River

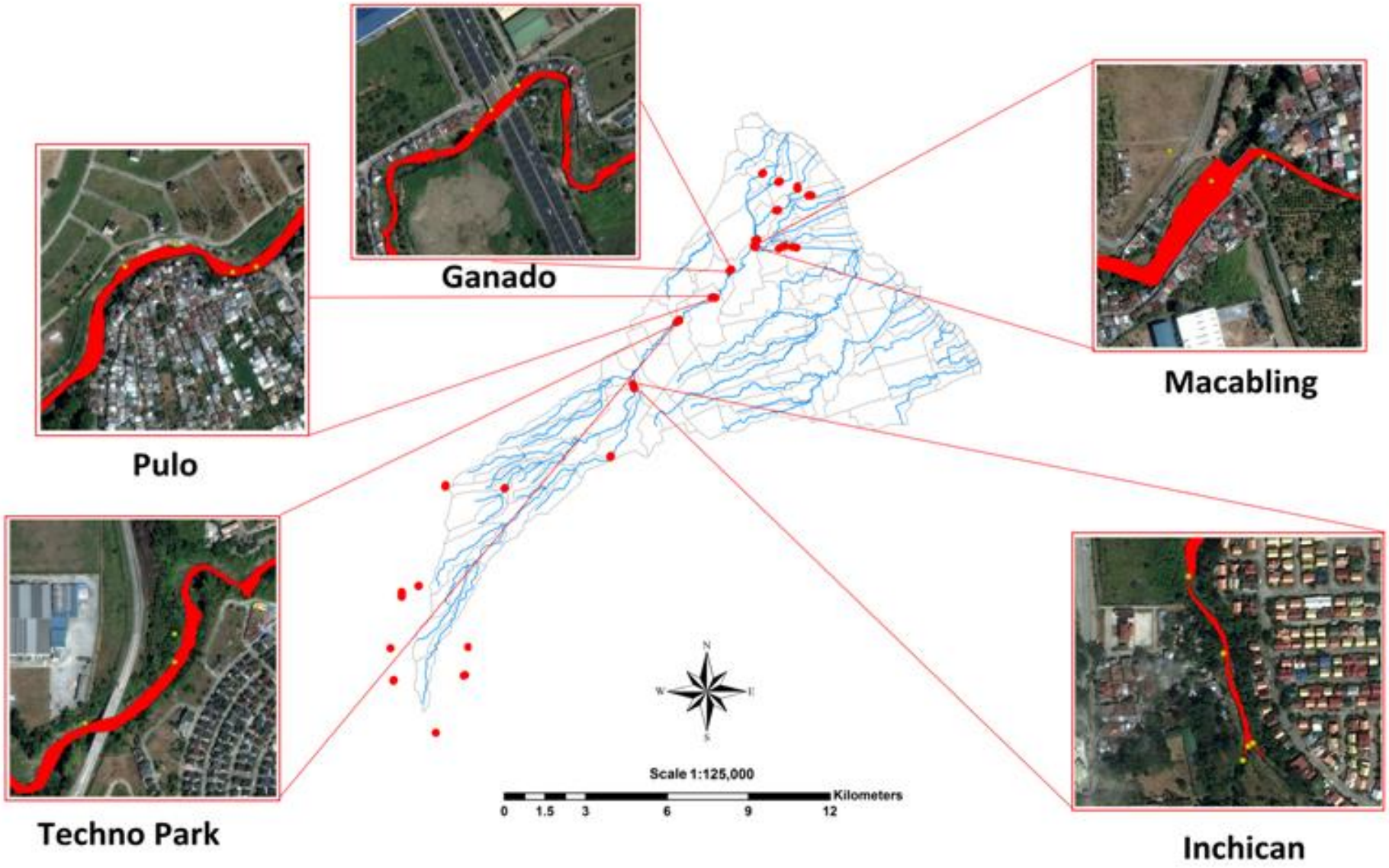
Sub-Watershed Boundary

Date Created: January 26, 2012

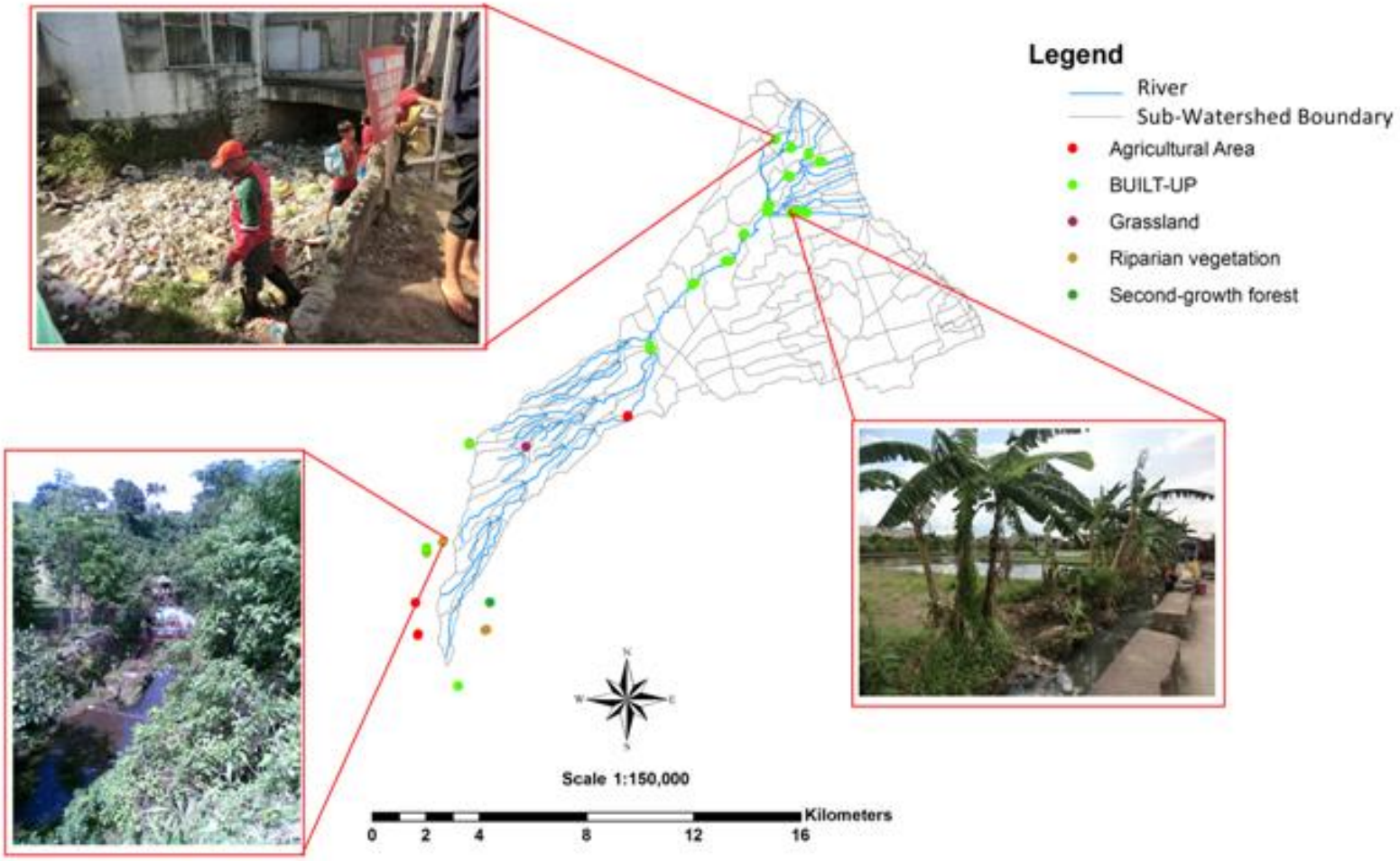
Created by:

IBS-UPLB

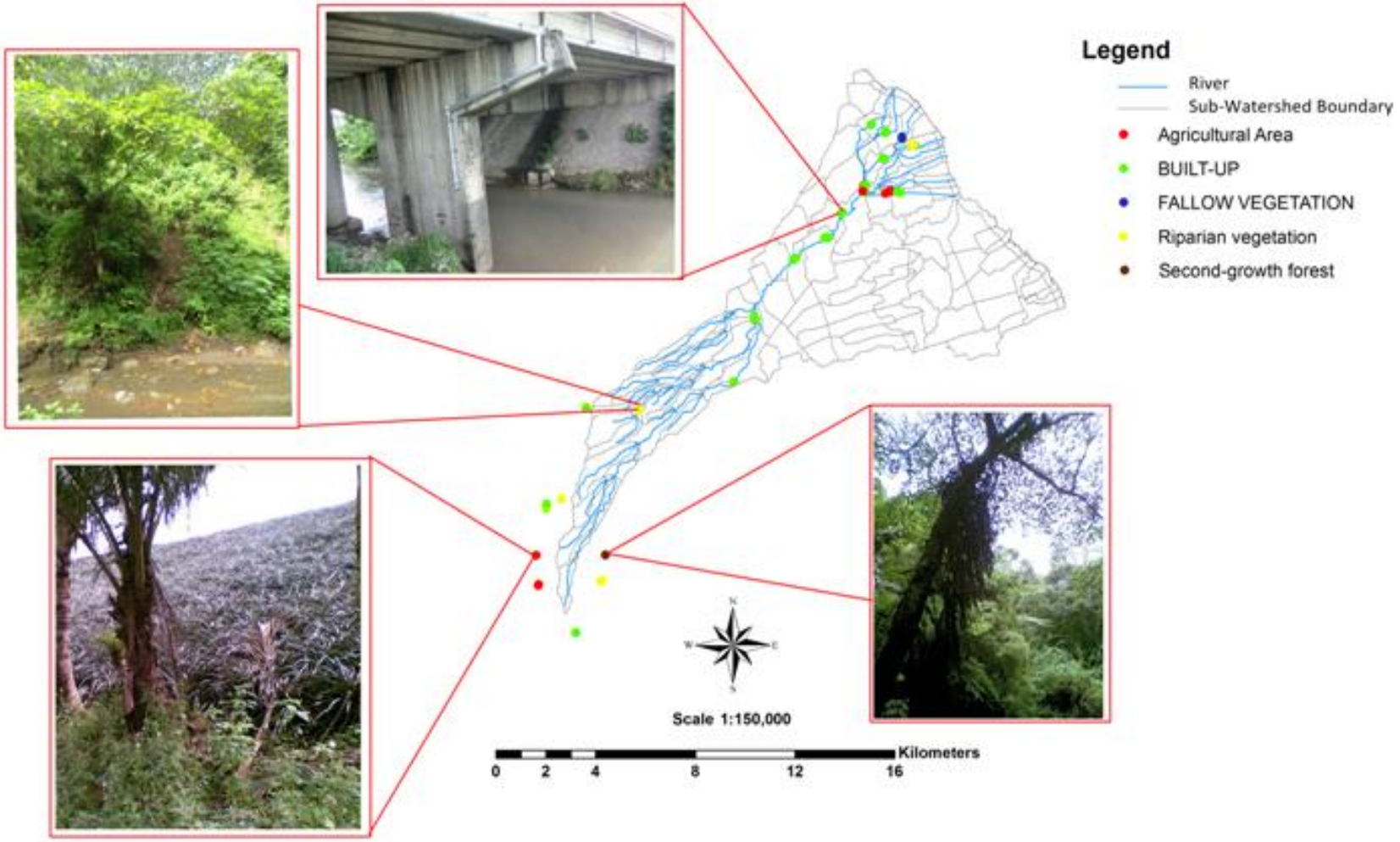
Morphology and Land Use of the Selected Portions of Silang-Santa Rosa River



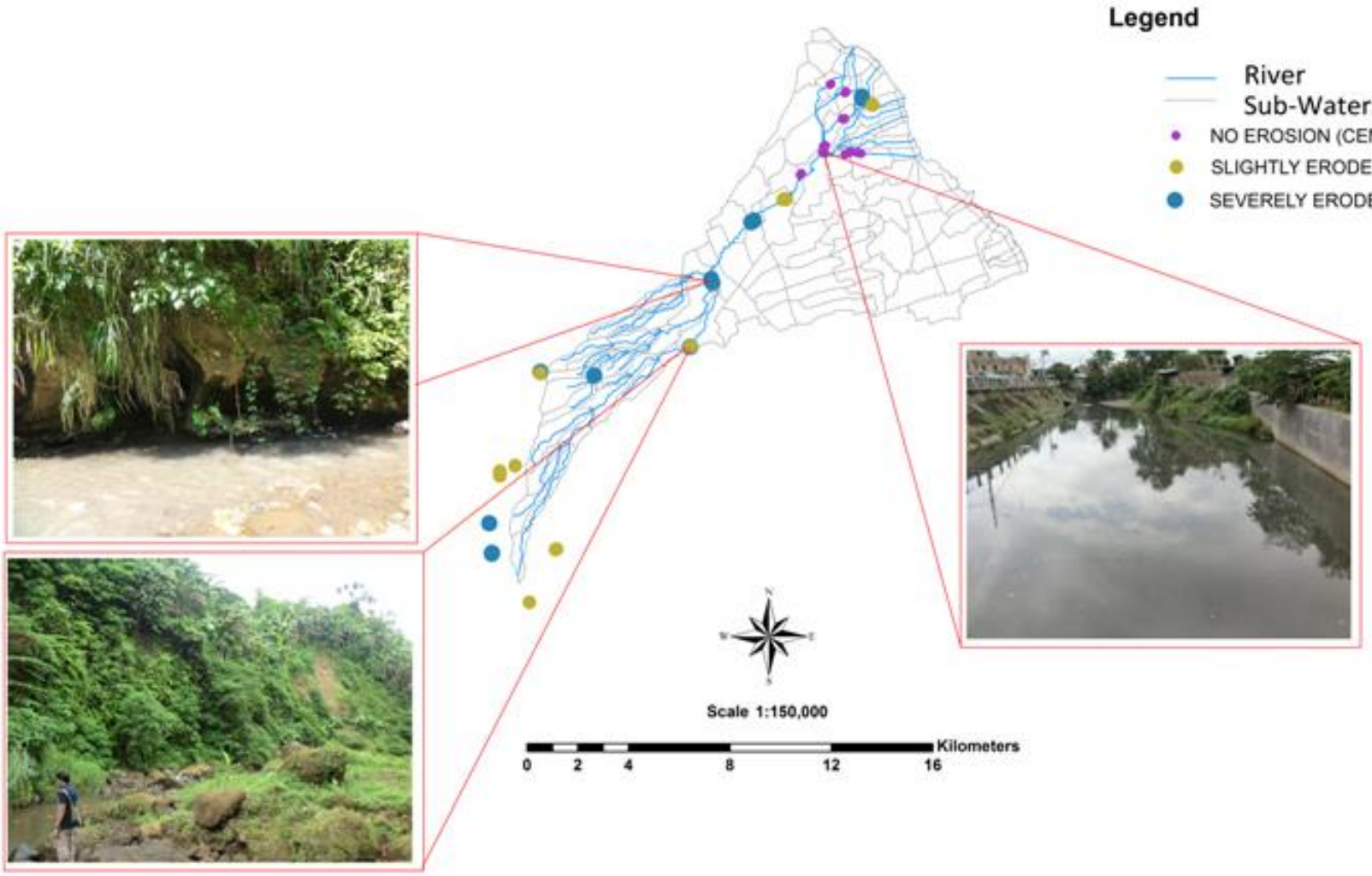
General Land Use on Easment Sides (Left Side)



General Land Use on Easment Sides (Right Side)

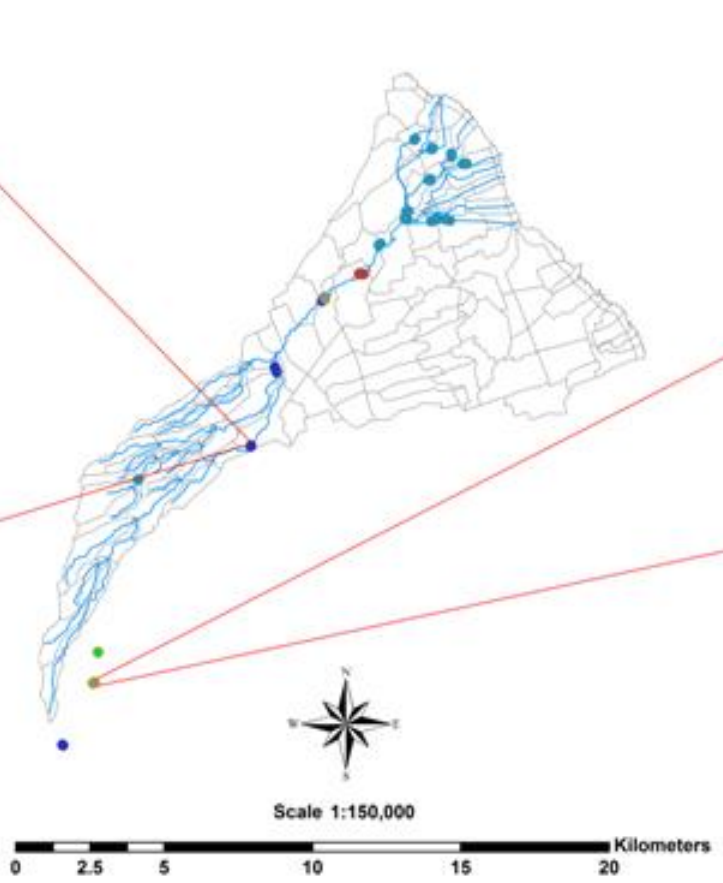


Riverbank Erosion Status Left Side

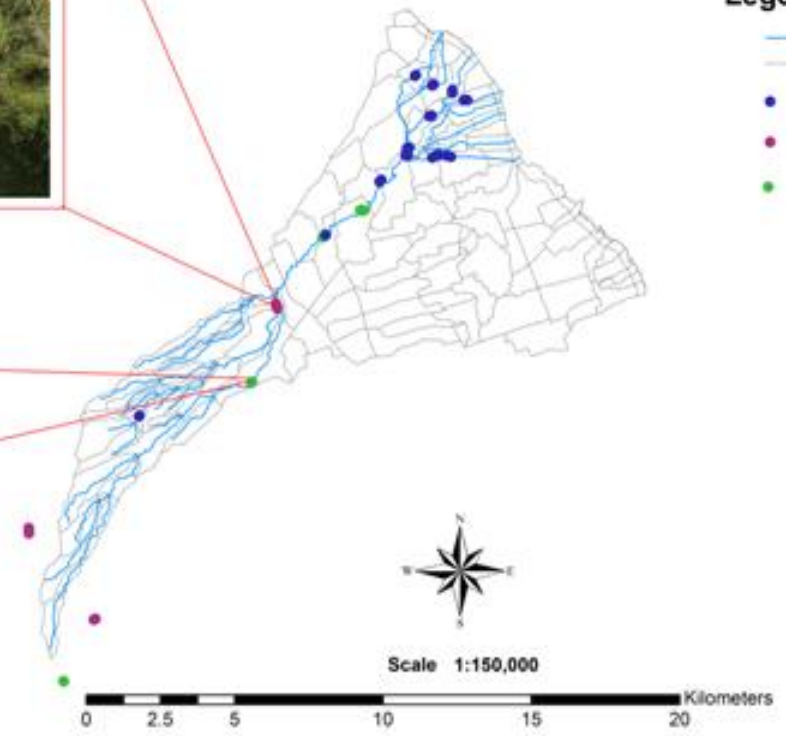


Riverbank Erosion Status Right Side

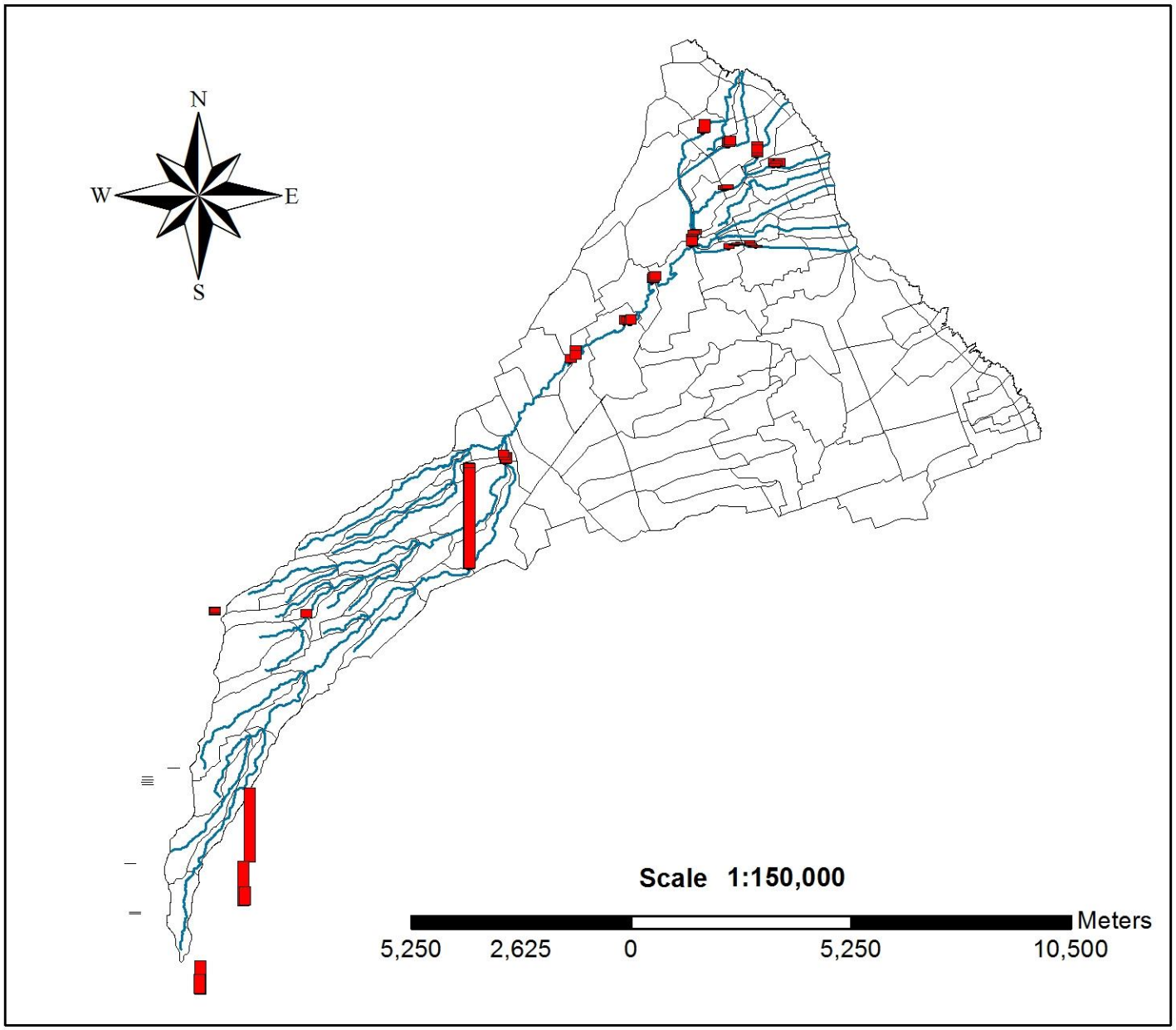
Rock Formations Left Side



Rock Formations Right Side



RIVER DEPTH MAP



Legend

- RIVER_DEPT
- Silang-Sta. Rosa River
- Sta. Rosa Subwatershed

Projection: WGS84 / UTM Zone 51 N
Created on: 02-08-12
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NATURE OF RIVERBED MATERIAL MAP

N
W
E
S

Legend

- BOULDERS
- BOULDERS/PEBBLES
- BOULDERS/SEDIMENTS
- CEMENTED
- PEBBLES
- PEBBLES/BOULDERS/SEDIMENTS
- PEBBLES/CEMENT
- PEBBLES/SAND
- PEBBLES/SAND/BOULDERS
- PEBBLES/SILTS/SAND
- SEDIMENTS
- SILT
- Silang-Sta. Rosa River
- Sta. Rosa Subwatershed

Scale 1:150,000

5,800 2,900 0 5,800 11,600 Meters

Projection: WGS84 / UTM Zone 51 N
Created on: 02-08-12
Created by:
Institute of Biological Sciences, UPLB

PRESENCE OF SPRING MAP

N
W
E
S

69
54
62
60
53
48
42
50
40
39
36
33
13
MI
H
PA
L
PM
PN
F

Scale 1:150,000

5,000 2,500 0 5,000 10,000 Meters

Legend

spring

PRESENCE_O

- NONE
- PRESENT
- Silang-Sta. Rosa River
- Sta. Rosa Subwatershed

Projection: WGS84 / UTM Zone 51 N
Created on: 02-08-12
Created by:
Institute of Biological Sciences, UPLB

MITIGATING MEASURES MAP

N
W
E
S

Scale 1:150,000

5,000 2,500 0 5,000 10,000 Meters

Legend

riverbed_utm1

MITIGATING

- CEMENTED
- CEMENTED/RIPRAP
- RIPRAP(COLLAPSED)
- SANDBAGS TO STABILIZE
- NONE
- Silang-Sta. Rosa River
- Sta. Rosa Subwatershed

Projection: WGS84 / UTM Zone 51 N
Created on: 02-08-12
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Flora

STATUS AND SPECIFIC RECOMMENDATIONS FOR REHABILITATION OR ENRICHMENT OF SELECTED PORTIONS OF THE STA. ROSA – SILANG RIVER SYSTEM and SUBWATERSHED

Informal Settlers

Inchican, Pulo

Observed Condition/s	Implication/s	Strategies/ Policy Options
• Informal Settlers encroaching along the easement and riverbank • Direct waste water discharges to the river • Unmanaged solid waste disposal • Residents usually take a bath and wash clothes at the area	• Residents are vulnerable to flooding and may result to loss of lives and properties • Source of water pollution due to waste water discharges and unmanaged solid waste disposal	• Relocation of informal settlers • Observing the use of buffer zones as part of the protected areas • Rehabilitation of easements and riverbanks

Concerns for land use and land use conversion

Ulat

Observed Condition/s	Implication/s	Strategies/ Policy Options
• Agricultural and other forest lands are being converted to subdivisions • Agricultural lands are being abandoned and sold to land developers 	• Unplanned land use and land conversion could lead to a disorderly form of development • Conversion of Agricultural and other forest lands into subdivisions could lead to the increase rate of soil erosion; contributor to watershed degradation which could affect the freshwater resources • Agricultural lands that are being abandoned and sold affects food security	• Creation of a comprehensive land use plan and zoning ordinance • Strict implementation and monitoring of policies related to land use and zoning ordinance • Giving incentives and assistance to farmers and agricultural land owners

Disposal of solid wastes Into the river

Pulo, Inchican, Ulat, Liip, Macabling dam, Balibago, Dila Salang Bago, City Hall Area

Observed Condition/s	Implication/s	Strategies/ Policy Options
• Nearby residents are throwing their garbage into the river	• Possible source of water pollution • Clog canals and tributaries that contributes to flooding	• Implementation of a proper solid and liquid waste management • Enforcement of the existing environmental policies • Protection through the creation of “Bantay Ilog”

Waste water discharges

Techno Park, Pulo, Liip, Salang Bago, Balibago, Dila, City Hall area

Observed Condition/s	Implication/s	Strategies/ Policy Options
• Discharges of water coming from households, subdivisions, industrial area	• Source of water pollution	• Construction of a centralized sewerage system facility for the whole Silang-Santa Rosa River Subwatershed • Implementation of a proper solid and liquid waste management • Enforcement of the existing environmental policies • Protection through the creation of “Bantay Ilog”

Severe Erosion

Sto. Domingo

Observed Condition/s	Implication/s	Strategies/ Policy Options
• Severe erosion at the sides of the river	• Erosion leads to water siltation that affects water quality and lessens the river's water holding capacity • People present at the area are at risk from landslides	• Easement and riverbank rehabilitation; construction of riprap and planting of native species of plants • Information, Education, Communication Campaign about hazards present at the area • Dredging of river beds

Ecotourism

Pasong Nangka

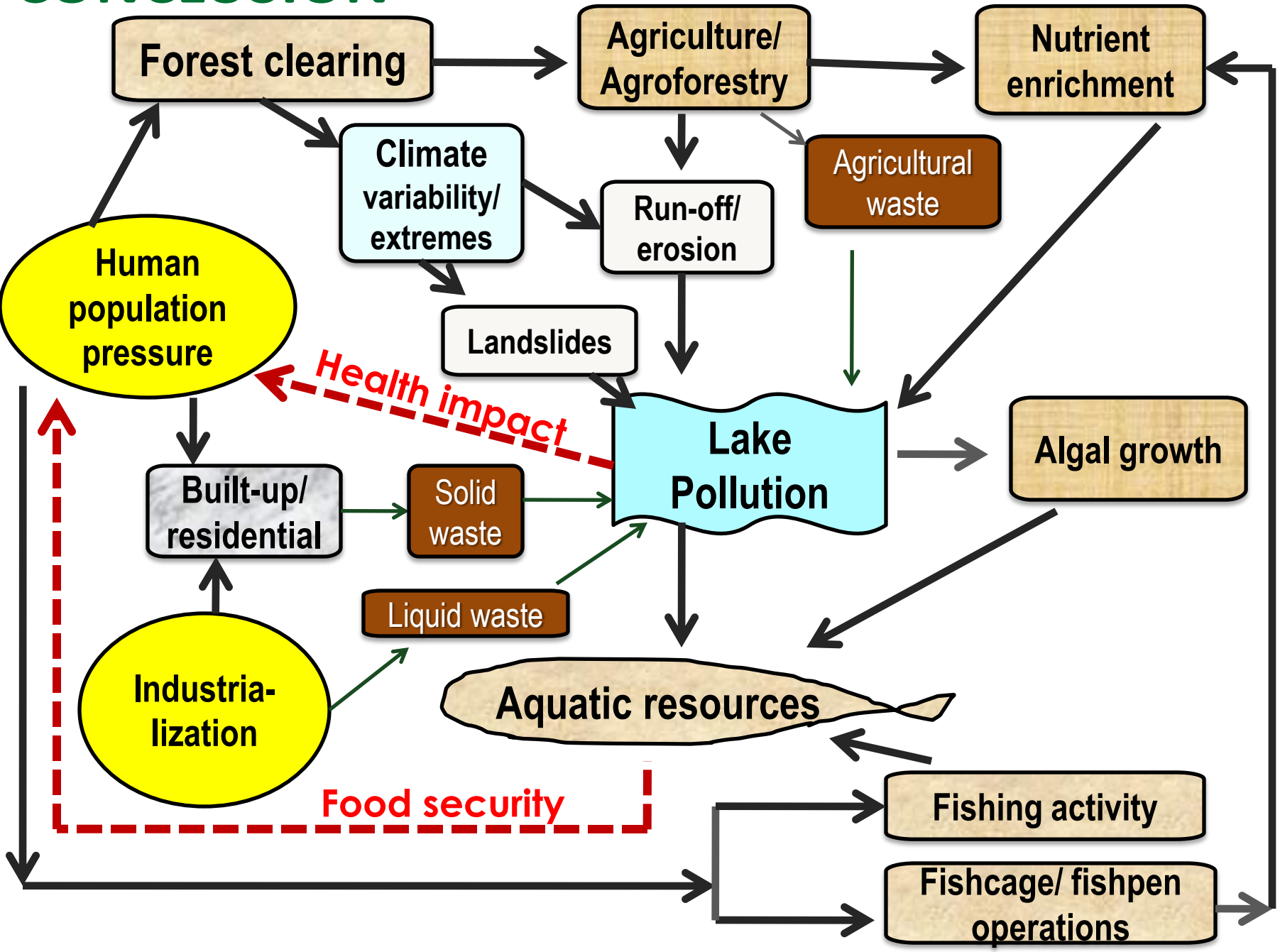
Observed Condition/s	Implication/s	Strategies/ Policy Options
• Observed to have ecotourism potentials • Minimal presence of solid wastes from the local tourists • Degraded stairways going down to the river	• Potential source of income through ecotourism • Possible source of solid and liquid waste	• Creation of local ecotourism plan that would enhance and limit the existing tourism activities (incorporated to Disaster Risk Reduction Management Plan, DRRMP)

Enrichment Zone

Techno Park

Observed Condition/s	Implication/s	Strategies/ Policy Options
• Presence of dense vegetation on both easement sides	• Lessens the rate of soil erosion • Helps maintain good water air and quality • Provides habitat for fauna	• Enhancement through planting of native species of plants • Protection through the creation of “Bantay Ilog”

CONCLUSION


Forest clearing
Agriculture/ Agroforestry
Nutrient enrichment
Climate variability/ extremes
Run-off/ erosion
Agricultural waste
Human population pressure
Landslides
Health impact
Lake Pollution
Algal growth
Built-up/ residential
Solid waste
Liquid waste
Industria-lization
Aquatic resources
Food security
Fishing activity
Fishcage/ fishpen operations

S3R2

Thank you very much