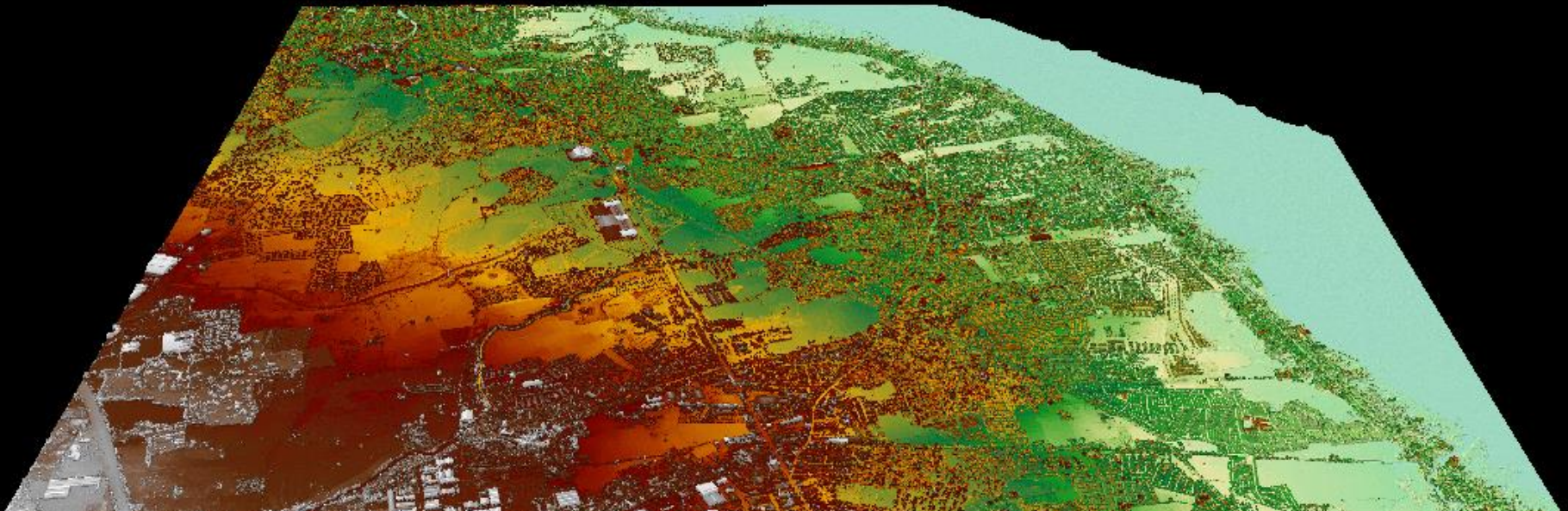




Low Carbon Asia Research Network (LoCARNet) 4th Annual Meeting
International Conference of Low Carbon Asia
Positive Action from Asia – Towards COP21 and Beyond
11-13 October 2015
DoubleTree Hotel, Johor Bahru, Malaysia



EVALUATION OF THE RESILIENCY of the **SILANG-SANTA ROSA** **SUBWATERSHED Laguna, Philippines**



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Paula Beatrice M. Macandog¹, Akio Onishi², Henry Scheyvens² and Linda C. Creencia³**

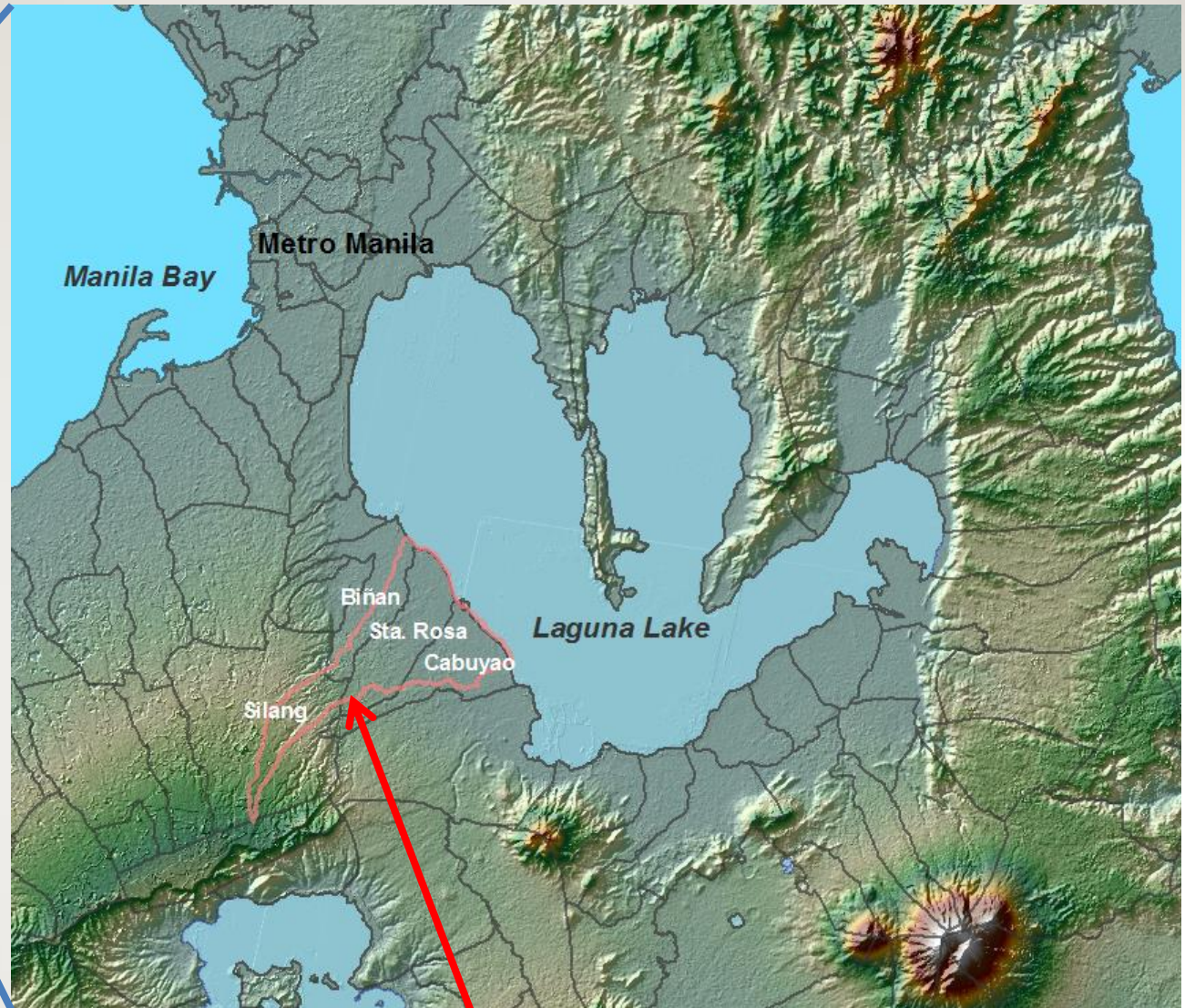
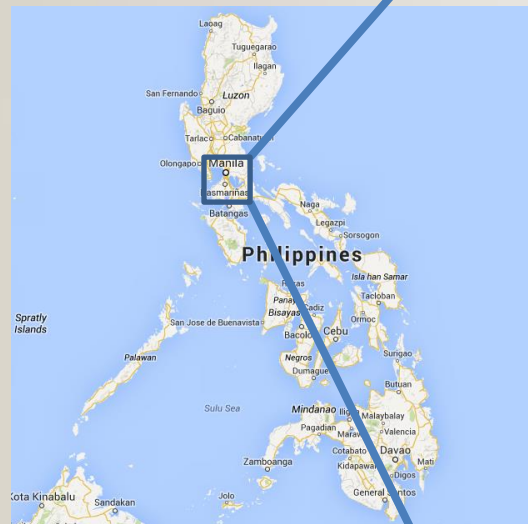
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²Institute for Global Environmental Strategies, 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115, Japan

³ENRO, Sta. Rosa City, Laguna, Philippines

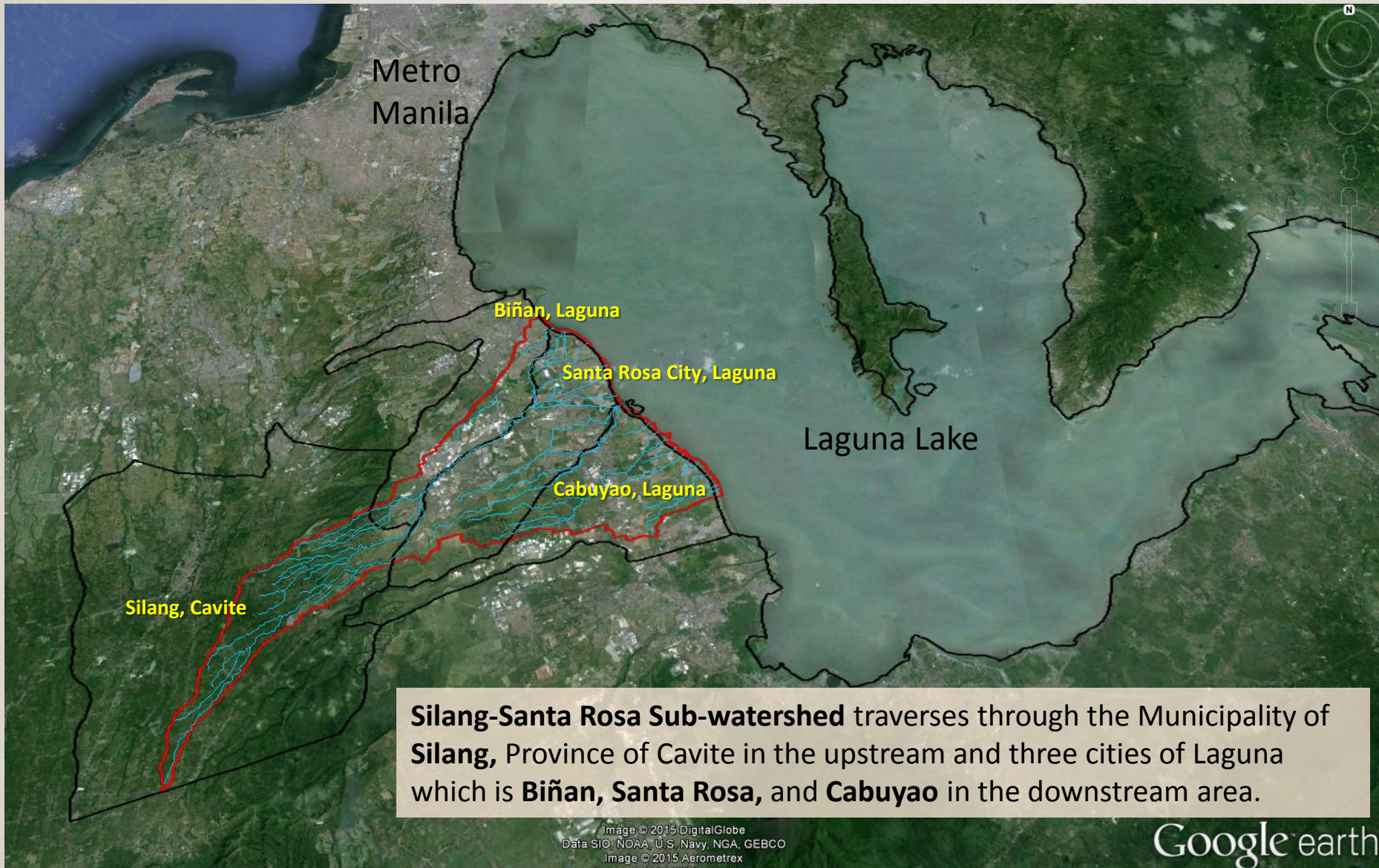
*Corresponding author's email: dmmacandog@gmail.com

Study area: **Silang-Santa Rosa Subwatershed**



Silang-Santa Rosa Subwatershed, Philippines

Administrative Boundary



Administrative Profile

Municipality of Silang, Cavite:

- it is a landlocked- first class municipality with 64 barangays and mainly depends on agricultural economy
- it serves as a vital recharge area for the Watersheds of Laguna which drain to the Laguna Lake and adjacent towns of Cavite that drains into Manila Bay (WWF Hydrogeology study)

City of Biñan, Laguna:

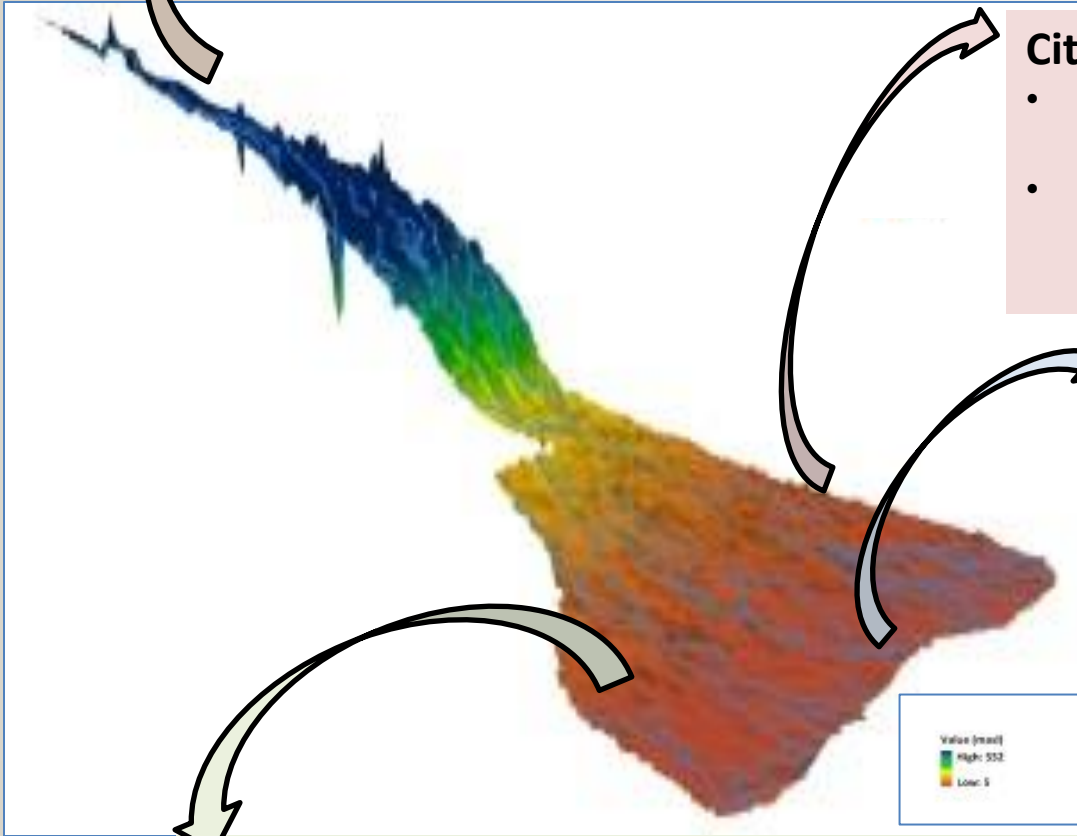
- a first class component city with 24 urban barangays
- some of the Philippines' largest industrial estates and export processing zones can be found in the area

City of Sta. Rosa, Laguna:

- predominantly a suburban residential community of Metro Manila with 18 barangays
- numerous commercial, industrial, and business establishments (in the western part)
- residential areas and subdivisions, schools, industrial zones and various business establishments (in the eastern side)

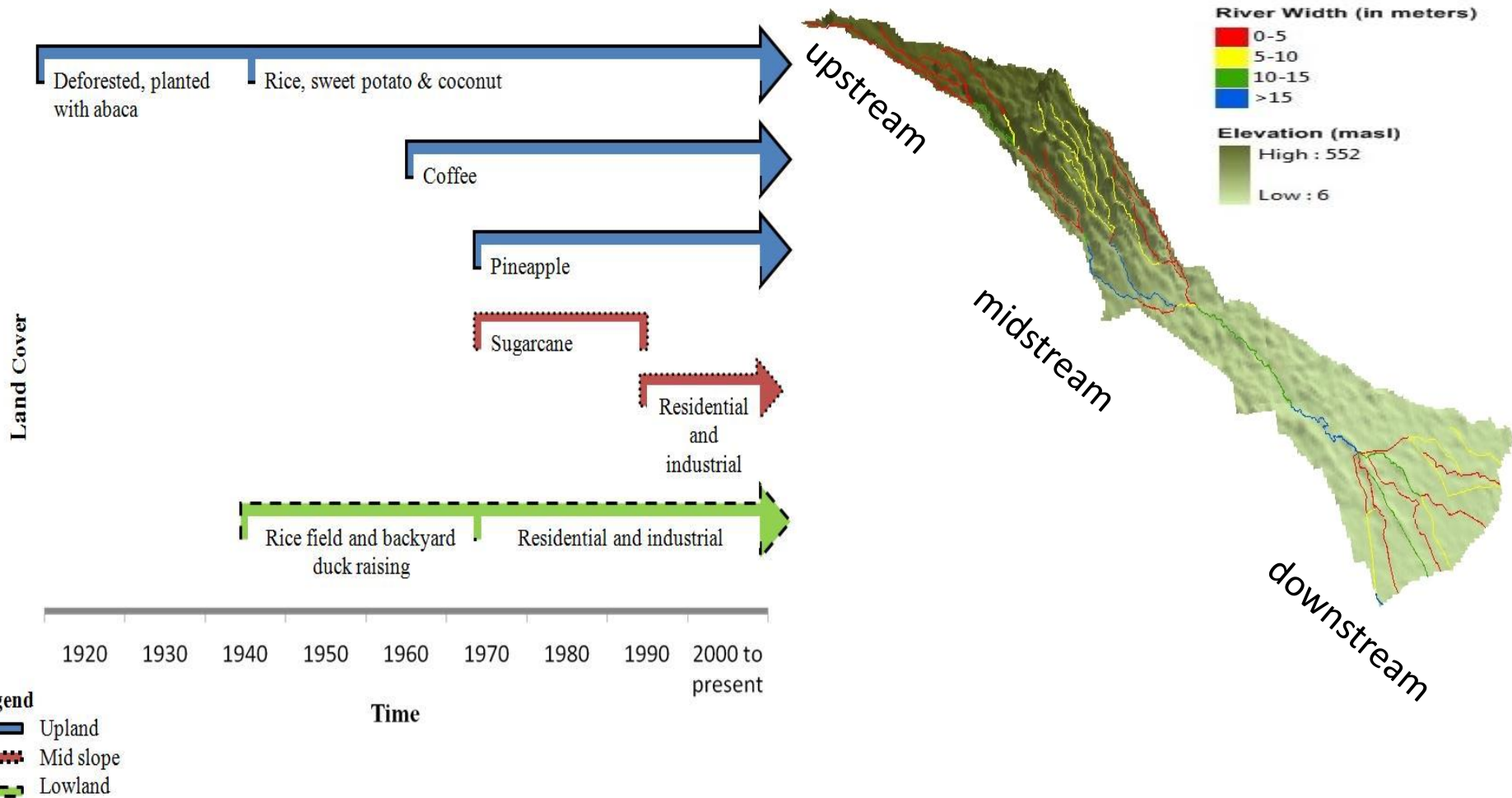
City of Cabuyao, Laguna:

- a first class city with 18 barangays and formerly known as the "Richest Municipality in the Philippines" because of the large number of migrants working in the town's industrial estates
- there are still productive ricelands in the area

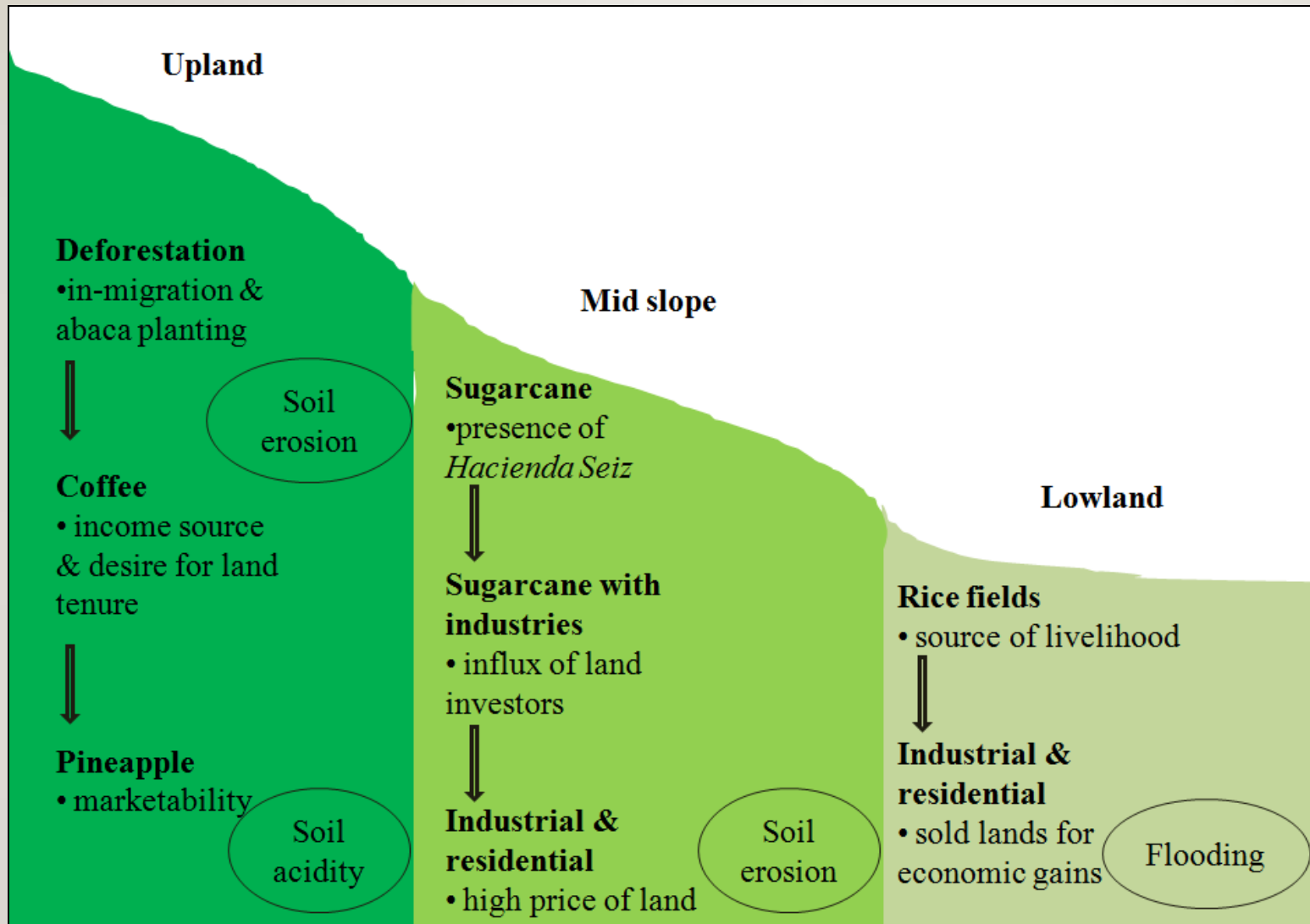


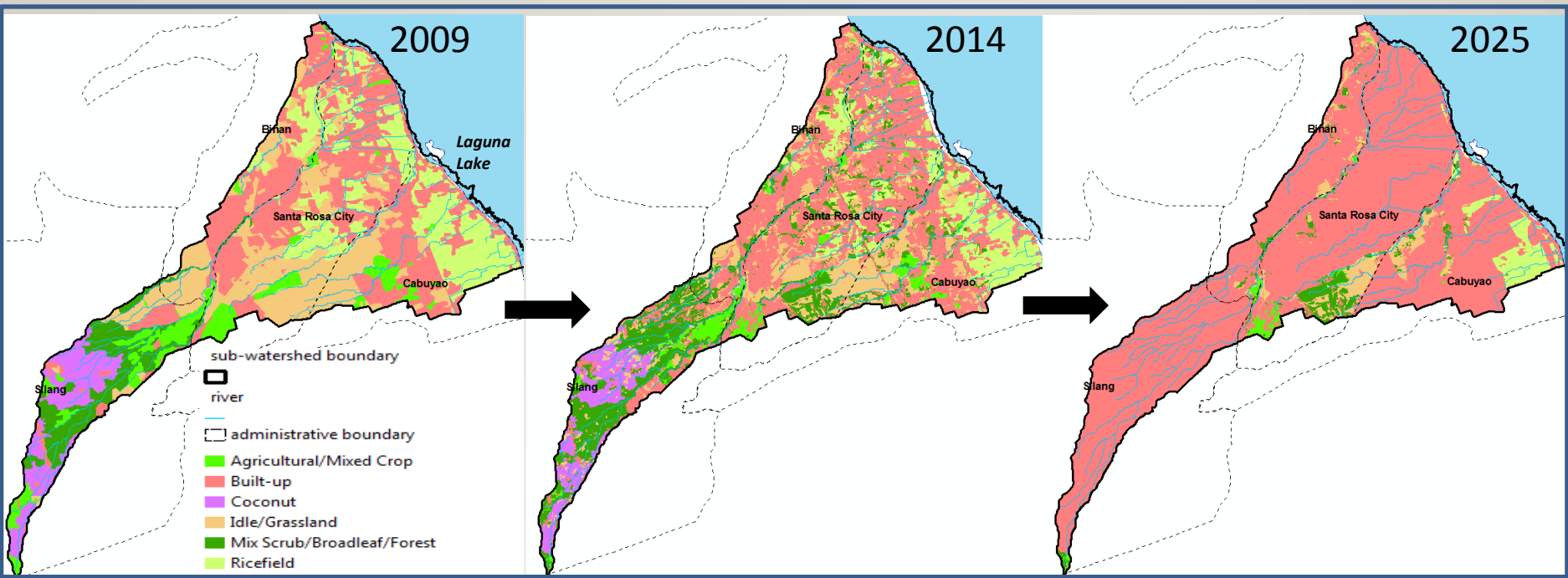
Land Use Change

The Subwatershed is experiencing rapid land conversion due to increasing population

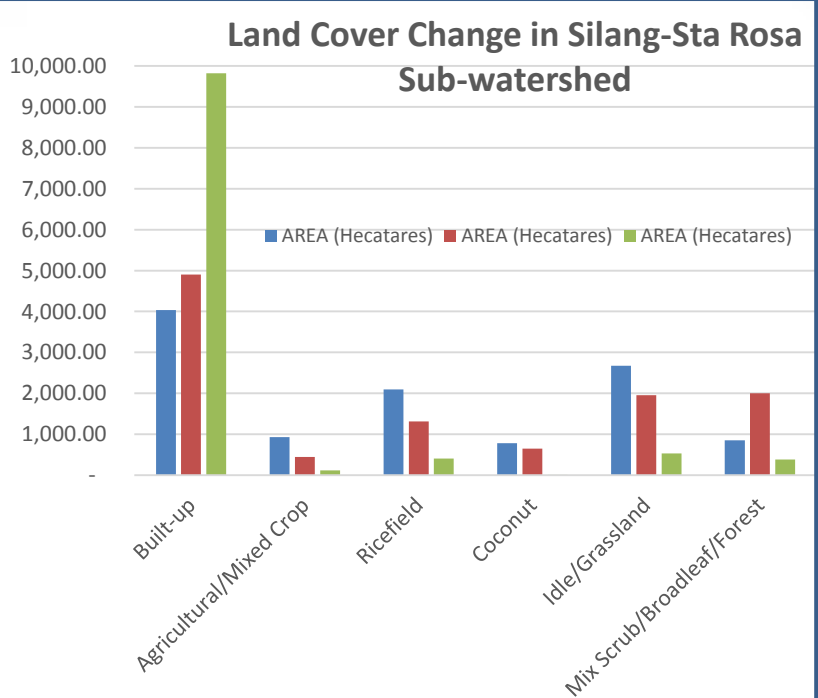


Drivers and impacts of land cover change





LAND COVER	AREA (Hectares)		
	Year 2009 (source: WWF-Philippines)	Year 2014 (Current)	Year 2025 (Future Plan based from PRA)
Built-up	4,031.02	4,904.81	9,823.59
Agricultural/Mixed Crop	930.26	441.92	113.40
Ricefield	2,097.90	1,309.94	405.62
Coconut	783.02	644.16	0.02
Idle/Grassland	2,675.97	1,951.19	530.03
Mix Scrub/Broadleaf/Forest	853.48	2,004.92	383.21



Land Conversion in the Downstream Area



Year **2007 & 2014**
Orthophotos in the
downstream
barangays of Sta.
Rosa experiencing
Land conversion from
Rice fields to
Subdivisions

Portion of Downstream Area experiencing Flooding from a 5 meter increase in the Lake's water level



Recent Flooding in the City of Santa Rosa

Year	Typhoon	No. of Affected Barangays
------	---------	---------------------------

2008	Frank	4
------	-------	---

2009	Nando	3
------	-------	---

2009	Ondoy	8
------	-------	---

2009	Santi	8
------	-------	---

2010	Basyang	4
------	---------	---

2011	Pedring	4
------	---------	---

2012	Habagat	10
------	---------	----

2012	Ofel	10
------	------	----



Recent Flooding in Luzon (2012 Habagat)



Major flood disasters and related damages and losses as brought by typhoons in 2006 and 2009 in Laguna region

Low lying urbanized areas, like the City of Santa Rosa have suffered flooding in the recent typhoon events

Major disasters	Casualties			Damaged houses		Damage to Agriculture (in PhP)
	No. dead	No. injured	No. missing	Totally	Partially	
Typhoon (Milenyo)-Flood (September 2006)	162	462	47	59,339	149,470	1,543,938,006
Typhoon (Ondoy)-Flood (September 2009)	172	311	9	6,690	67,204	514,269,778
Typhoon (Santi)-Flood (October 2009)	16	52	2	4,371	30,981	79,250,000

(Source: RDRRMC, 2011)

We need to Mainstream CCA – DRR in the CLUP and CDP...

- To provide information and analysis on hazard prone areas and extent of people, physical and natural assets at risk;
- To provide the necessary DRRM and CCA measures that need to be included in the developments plans and adopted for implementation;
- To produce a viable and risk sensitive and responsive CLUP and CDP.

Legal Mandates for Mainstreaming CCA and DRR

- **Republic Act 9729 or the Climate Change Act of 2009** - Section 14 on *Local Climate Change Action Plan* states that “The **LGUs** shall be the **frontline** agencies in the formulation, planning and implementation of **climate change action plans** in their respective areas, consistent with the provisions of the Local Government Code, the Framework, and the National Climate Change Action Plan
- **RA 10174 “Peoples Survival Fund Act”** - policy of the State to “systematically **integrate the concept of climate change** in various phases of policy formulation, development plans, poverty reduction strategies and other development tools and techniques by all agencies and instrumentalities of the government”
- **Republic Act 10121 or “Philippine Disaster Risk Reduction and Management Act of 2010** - section 2 “**Mainstream disaster risk reduction and climate change** in development processes such as policy formulation, socioeconomic development planning, budgeting, and governance, particularly in the areas of environment, agriculture, water, energy, health, education, poverty reduction, land-use and urban planning, and public infrastructure and housing, among others.”



Adapted from Creencia (2014) presentation entitled “Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience “



Communities will adapt to climate change and disasters by...

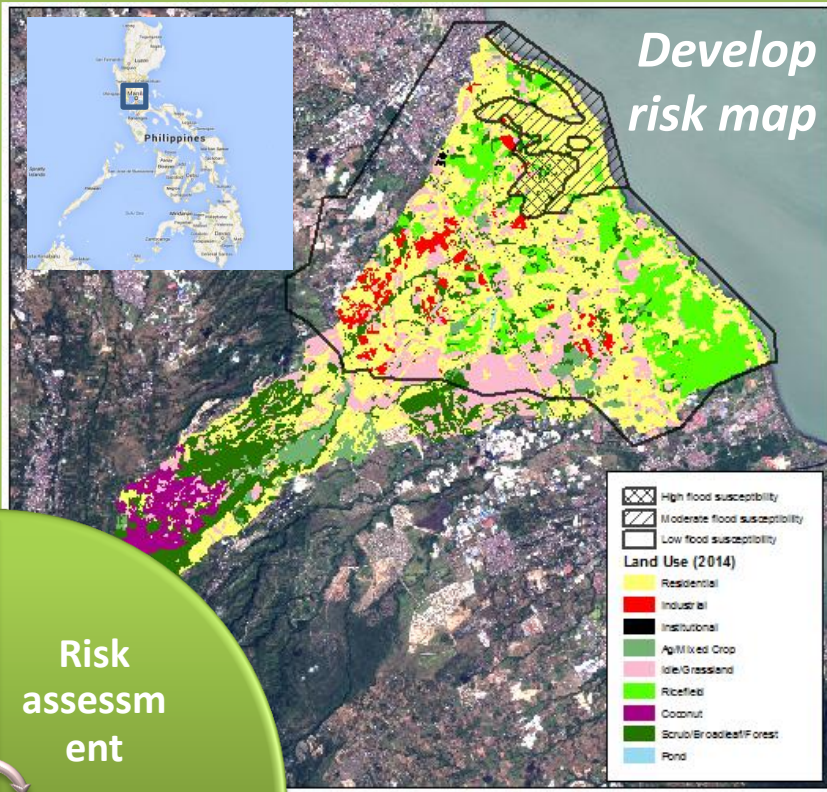
1. Preparing and updating the CLUP,
2. Building structures that will withstand the expected hazard,
3. Developing a disaster preparedness plan,
4. Relocating people from high risk areas,
5. Educating and providing outreach programs, and
6. Public Participation and consciousness-raising strategies

(Source: HLURB Presentation of Comm. Hornilla in terms of Local CCA – DRR adaptation)

Through the IGES/UPLB project, we aim to make our land-use, climate sensitive

Supporting local governments: Silang-Santa Watershed, Philippines

Stakeholder consultation

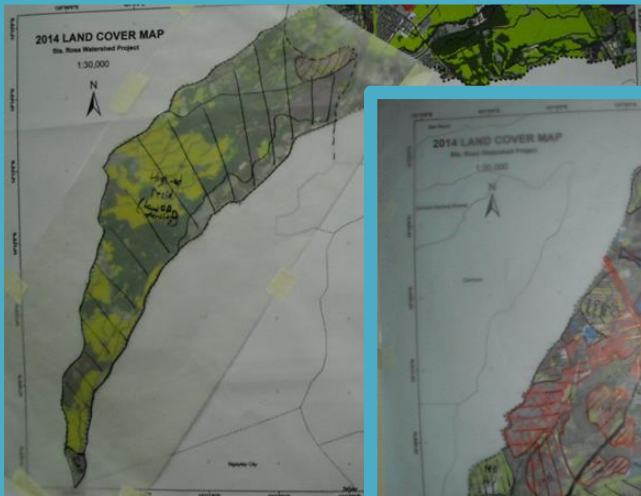


Scenario analysis

Risk assessment

Land-use improvement

Climate measure



Devise actions

Measures for CCAM

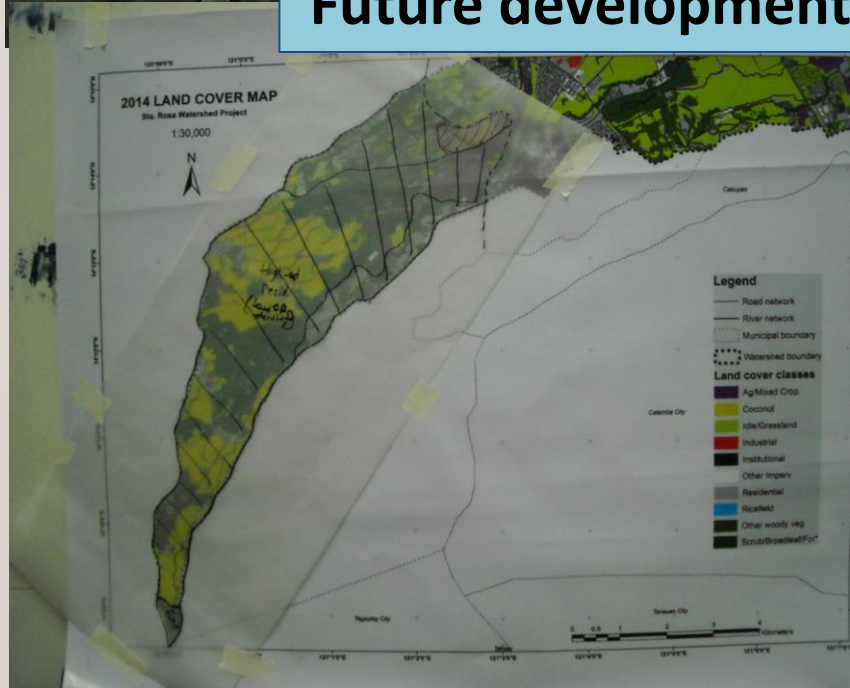
- PLANT PERFORMANCE SPECIFICALLY TO CONTROL/REDUCE OVER THE WATERSHED AREA:**
 - REPLANT AND CLEAR AND/OR PLANT SPECIES THAT ARE SUITABLE TO THE WATERSHED AREA.
 - SET UP BUFFER ZONE IN UPTOWN PLANT AREA.
 - CONDUCT ENVIRONMENTAL IMPROVEMENT PLAN.
 - RE-PLANTING.
 - ERUDATE CULTIVATION.
- SPRING INFILTRAL SETTLEMENTS CARRYING CREEK:**
 - SMALL ROCK.
 - REGULAR CLEARING OF CREEK.
 - SMALL ROCK.
- REPLANT FLORA ALONG TAPALAN DE BAY:**
 - SMALL ROCK.
 - REGULAR CLEARING OF CREEK.
 - SMALL ROCK.
- RELOCATION OF INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA:**
 - RELOCATION OF INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
 - RELOCATION OF INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
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 - RELOCATION OF INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
- UPGRADING OF THE DISCHARGE SYSTEM IN POND/TERMINAL WATERSHED:**
 - UPGRADING OF THE DISCHARGE SYSTEM IN POND/TERMINAL WATERSHED.
 - UPGRADING OF THE DISCHARGE SYSTEM IN POND/TERMINAL WATERSHED.
- RELOCATE AND/OR DISPLACE INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA:**
 - RELOCATE AND/OR DISPLACE INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
 - RELOCATE AND/OR DISPLACE INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
- MAINTAIN INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA:**
 - MAINTAIN INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
 - MAINTAIN INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
- ADOPTION OF GREEN BUILDING DESIGN:**
 - ADOPTION OF GREEN BUILDING DESIGN.
 - ADOPTION OF GREEN BUILDING DESIGN.
- RELOCATION OF INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA:**
 - RELOCATION OF INFILTRAL SETTLEMENTS ALONG SUBSIDIARY/TERMINAL WATERSHED AREA.
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- UPGRADING OF THE DISCHARGE SYSTEM IN POND/TERMINAL WATERSHED:**
 - UPGRADING OF THE DISCHARGE SYSTEM IN POND/TERMINAL WATERSHED.
 - UPGRADING OF THE DISCHARGE SYSTEM IN POND/TERMINAL WATERSHED.
- RIVER CLEAN-UP AND CLEARING:**
 - RIVER CLEAN-UP AND CLEARING.
 - RIVER CLEAN-UP AND CLEARING.
- RIVER BANK STABILIZATION:**
 - RIVER BANK STABILIZATION.
 - RIVER BANK STABILIZATION.
- RECONSTRUCTION OF THE UPTOWN AREA:**
 - RECONSTRUCTION OF THE UPTOWN AREA.
 - RECONSTRUCTION OF THE UPTOWN AREA.
- STOP OVERSTOCKING:**
 - STOP OVERSTOCKING.
 - STOP OVERSTOCKING.
- CONDUCT IMPLEMENTATION OF ENVIRONMENTAL IMPROVEMENT PLAN (EIP):**
 - CONDUCT IMPLEMENTATION OF ENVIRONMENTAL IMPROVEMENT PLAN (EIP).
 - CONDUCT IMPLEMENTATION OF ENVIRONMENTAL IMPROVEMENT PLAN (EIP).

Improve plans

Devise actions

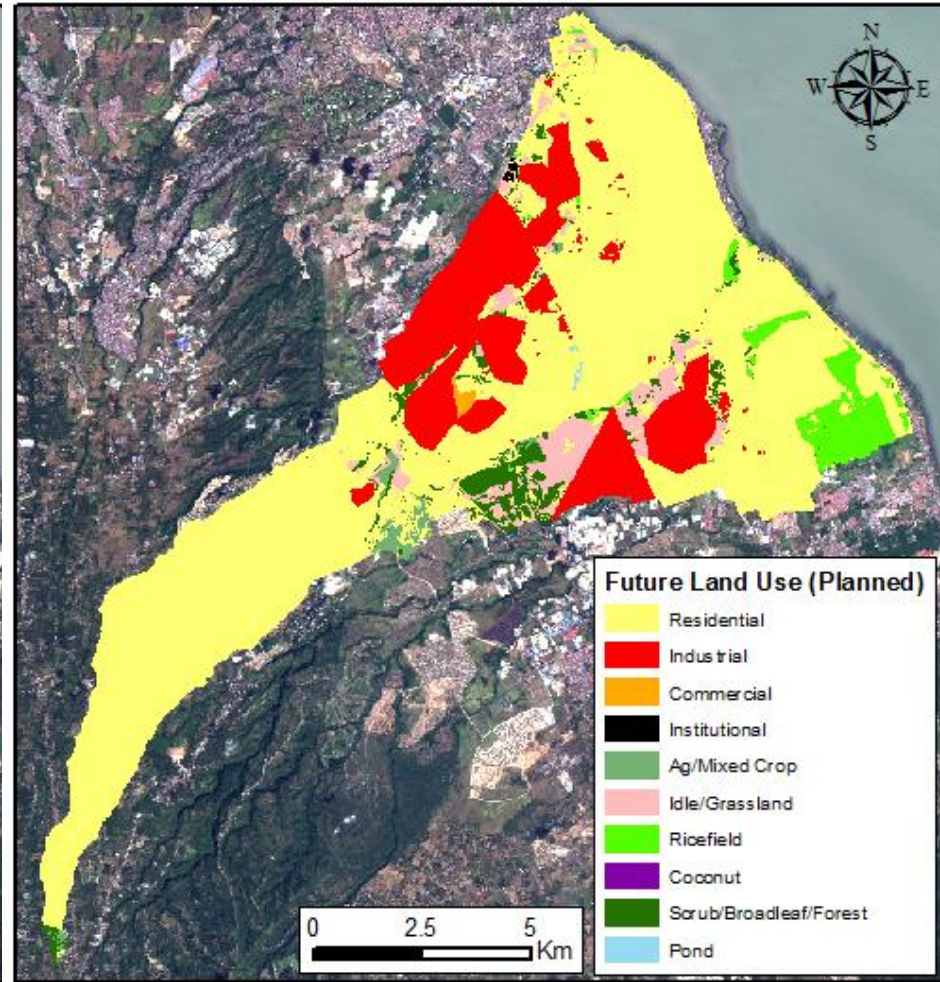
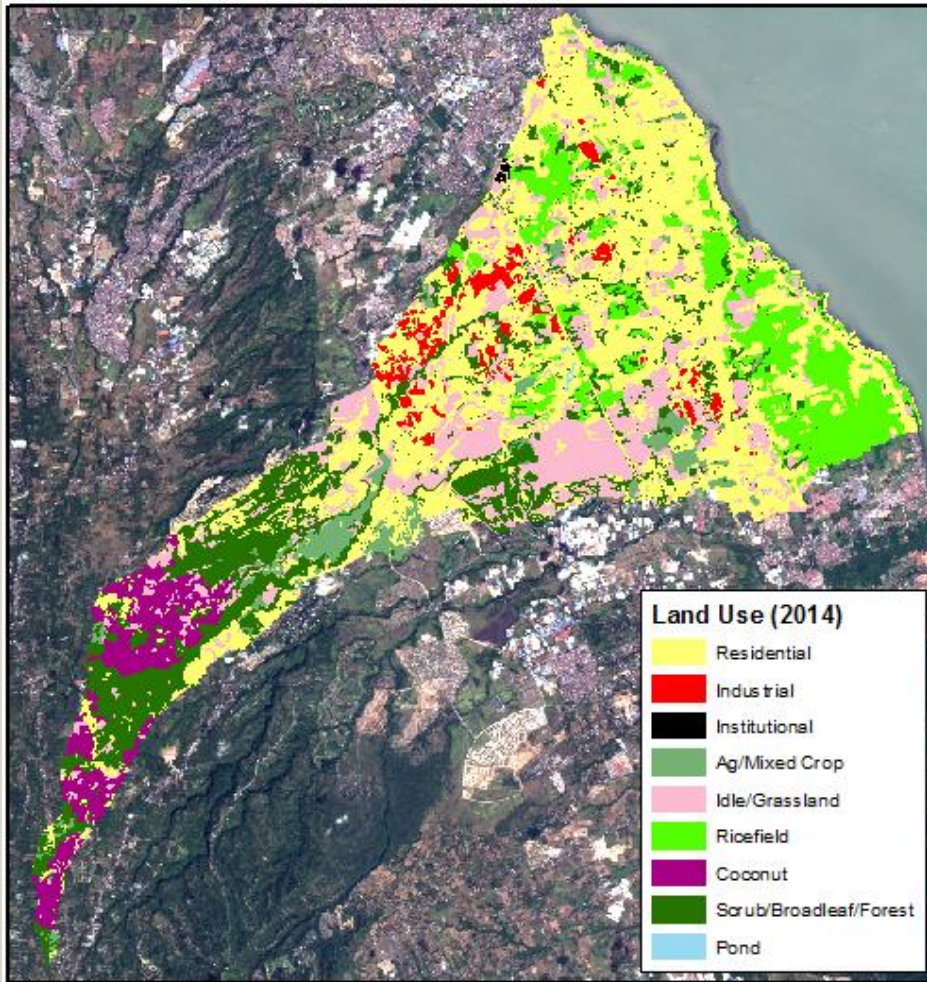


Consultation with local governments: Future development & land-use planning



Current Land Use (2014)

Future Land Use Plan (2025)*

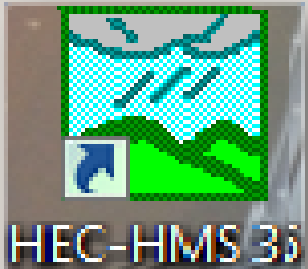


*Future land use plan map based on the results of a participatory land use mapping session with representatives from four local government units (LGUs)

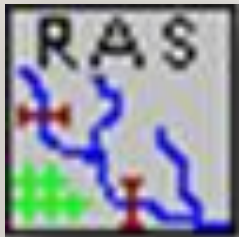
FLOOD MODELLING



Generation of Basin Model using ArcGIS10
with HEC-GeoHMS and HEC-GeoRAS extensions

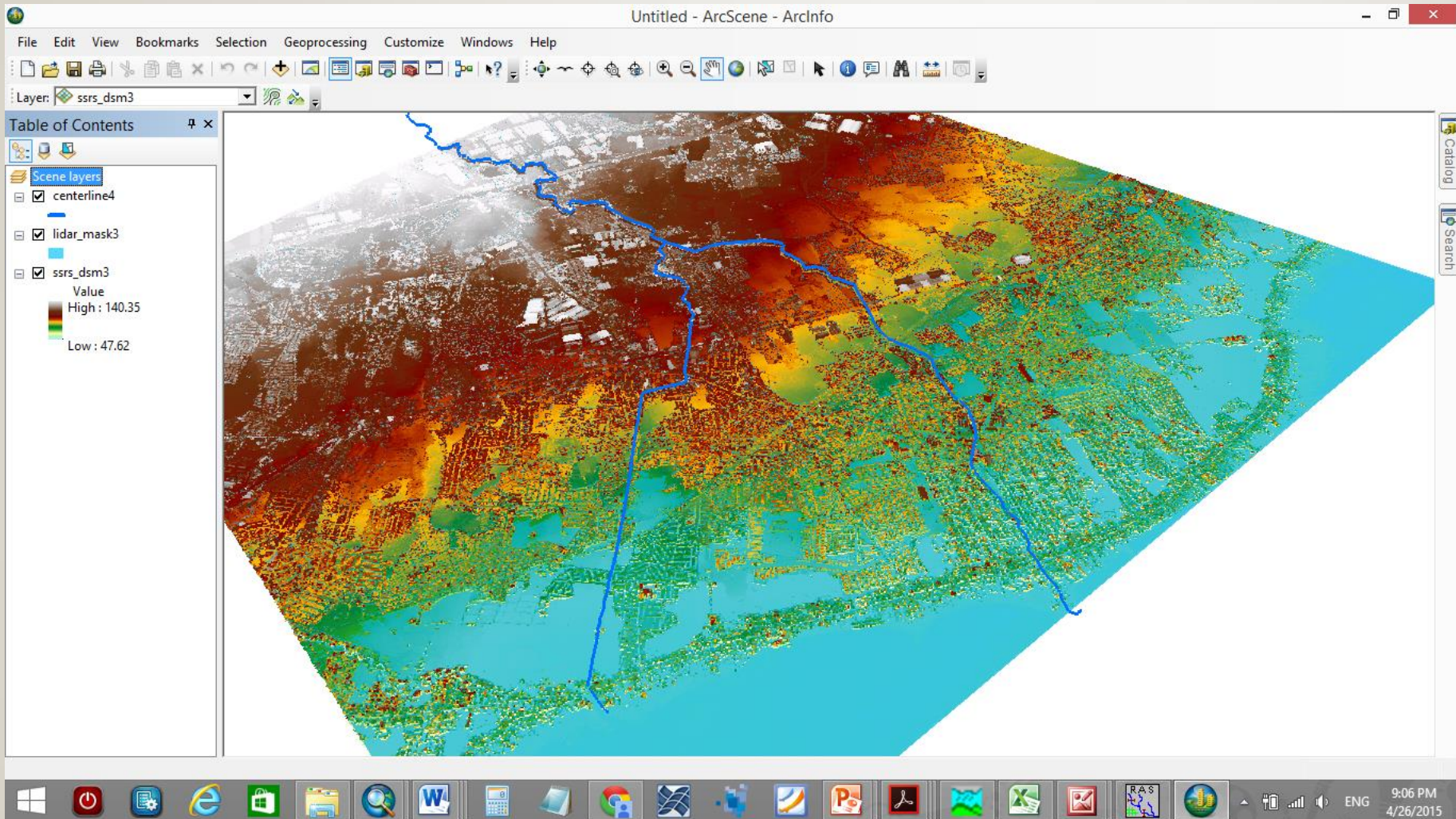


Generation of Rainfall-Runoff Curve
using HEC-HMS :
Hydrologic Engineering Center - Hydrologic Modeling System



Generation of Flood Model using HEC-RAS :
Hydrologic Engineering Center - River Analysis System

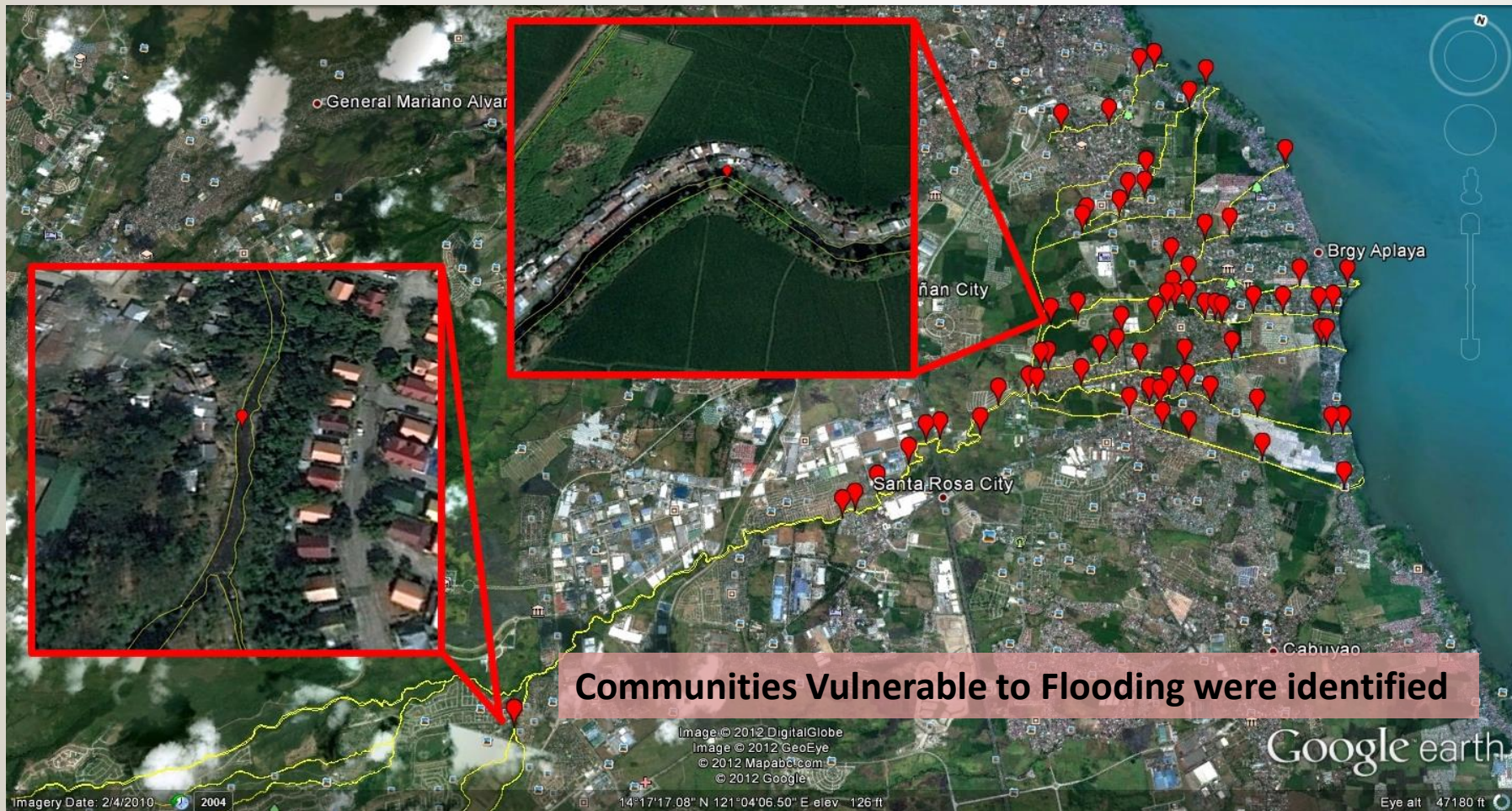
#5 Visualization using RAS Mapper or ArcScene



S3R2

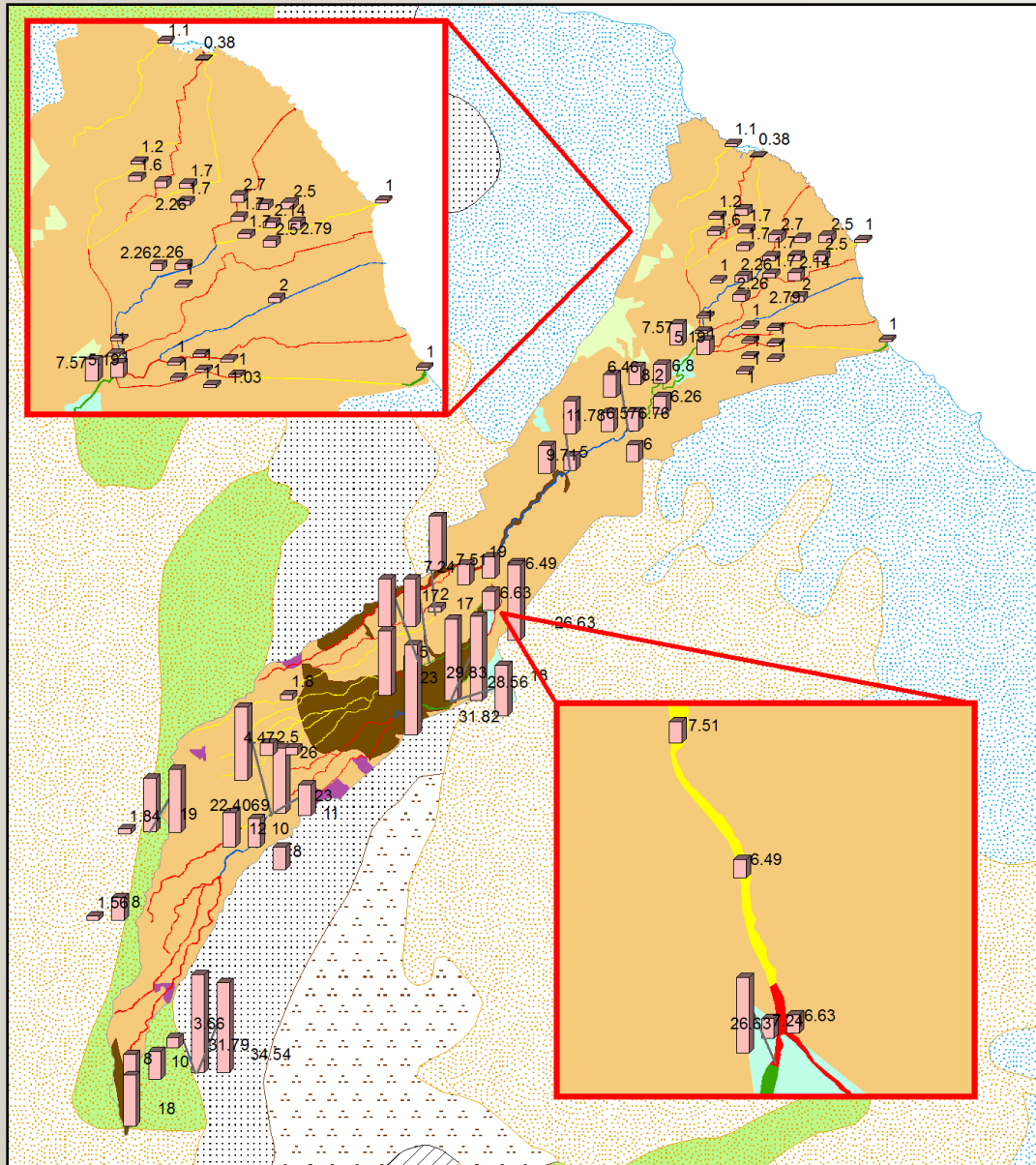
Ecological Profile of the Silang - Santa Rosa River and a Program for the Restoration/Rehabilitation of its Degraded Streams

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.



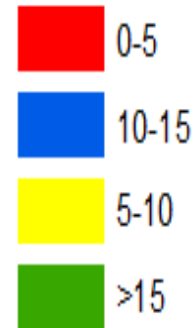
Potential Flood Prone Areas were identified

based on Slope, River Depth, Width, and Hydraulic Conductivity (K)

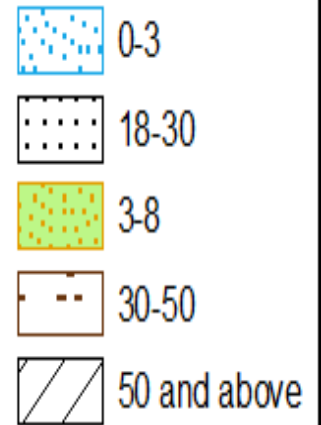


Legend

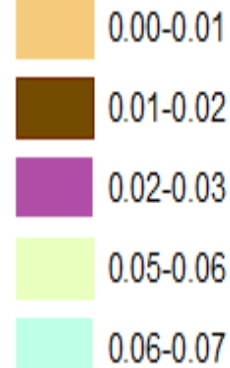
River Width



Slope



K-Value



River Depth



ACTIONS MADE BY THE CITY OF SANTA ROSA

Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience "

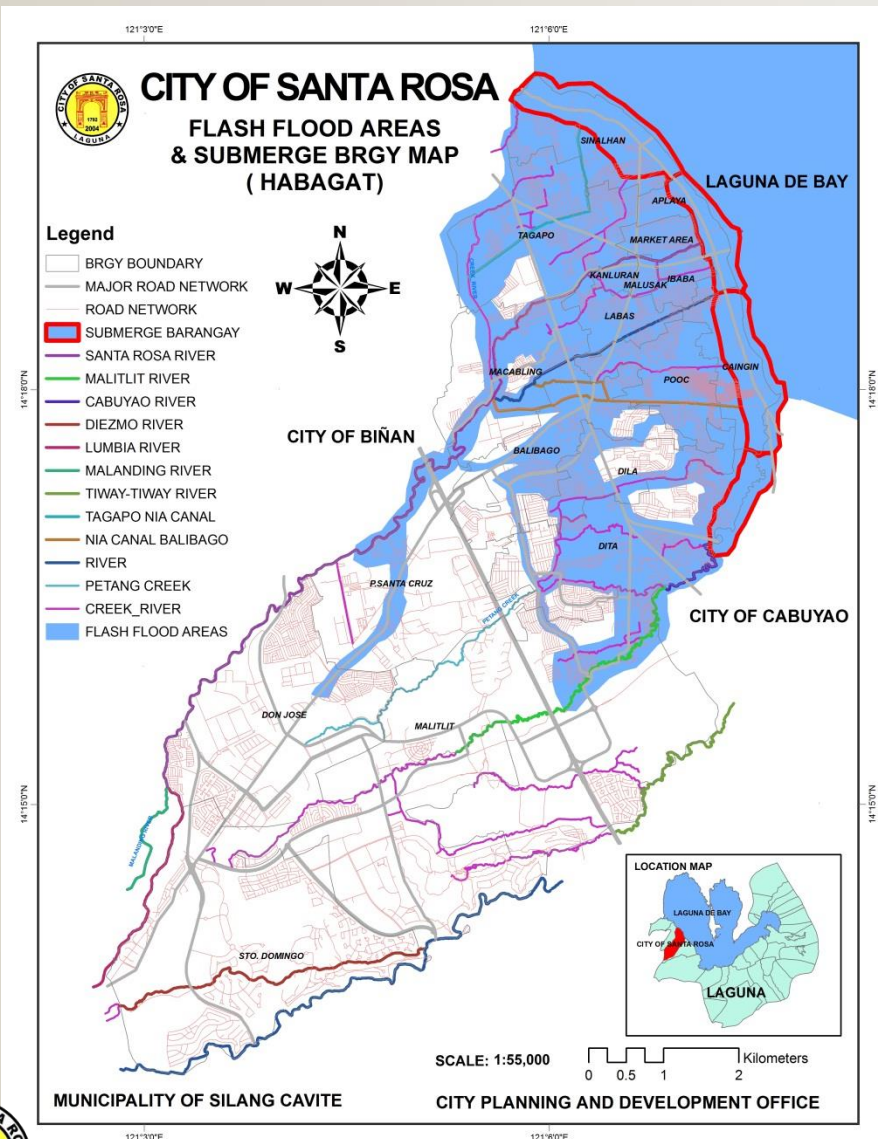


RISK ASSESSMENT

Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience "



City of Santa Rosa – Flood Hazard Map



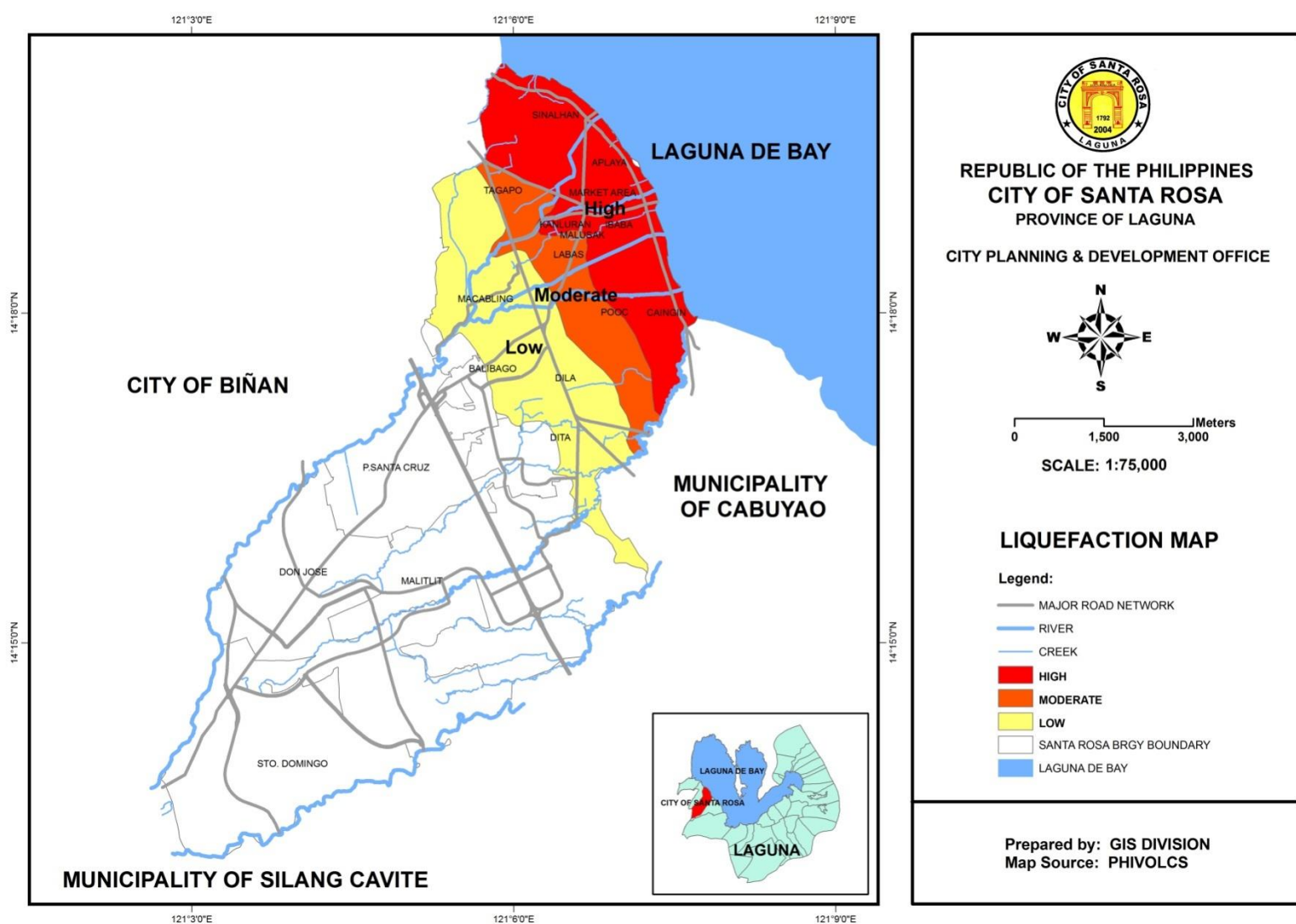
- Almost half of the land area of the city experience flashflood during the rainy seasons
- In the case of Typhoon Ondoy, wherein the water level in the lake was elevated, the coastal barangays experienced month-long flooding



Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience "



City of Santa Rosa – Liquefaction Map



Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience "



CONDUCTED A GHG EMISSION INVENTORY

GHG Inventory Report for the **City of Santa Rosa** (Community Level)

September 2012



Prepared by:

Erlinda C. Creencia

Maria Amor A. Salandanan

Jason M. Bunyi

Rizalina E. Germino

Nory Gazel C. Magsombol

With support from:



Climate Change & Clean Energy Project

Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience"

➤ **CONDUCT SEVERAL STUDIES**
i.e. HYDROLOGY AND
FLOOD ANALYSIS

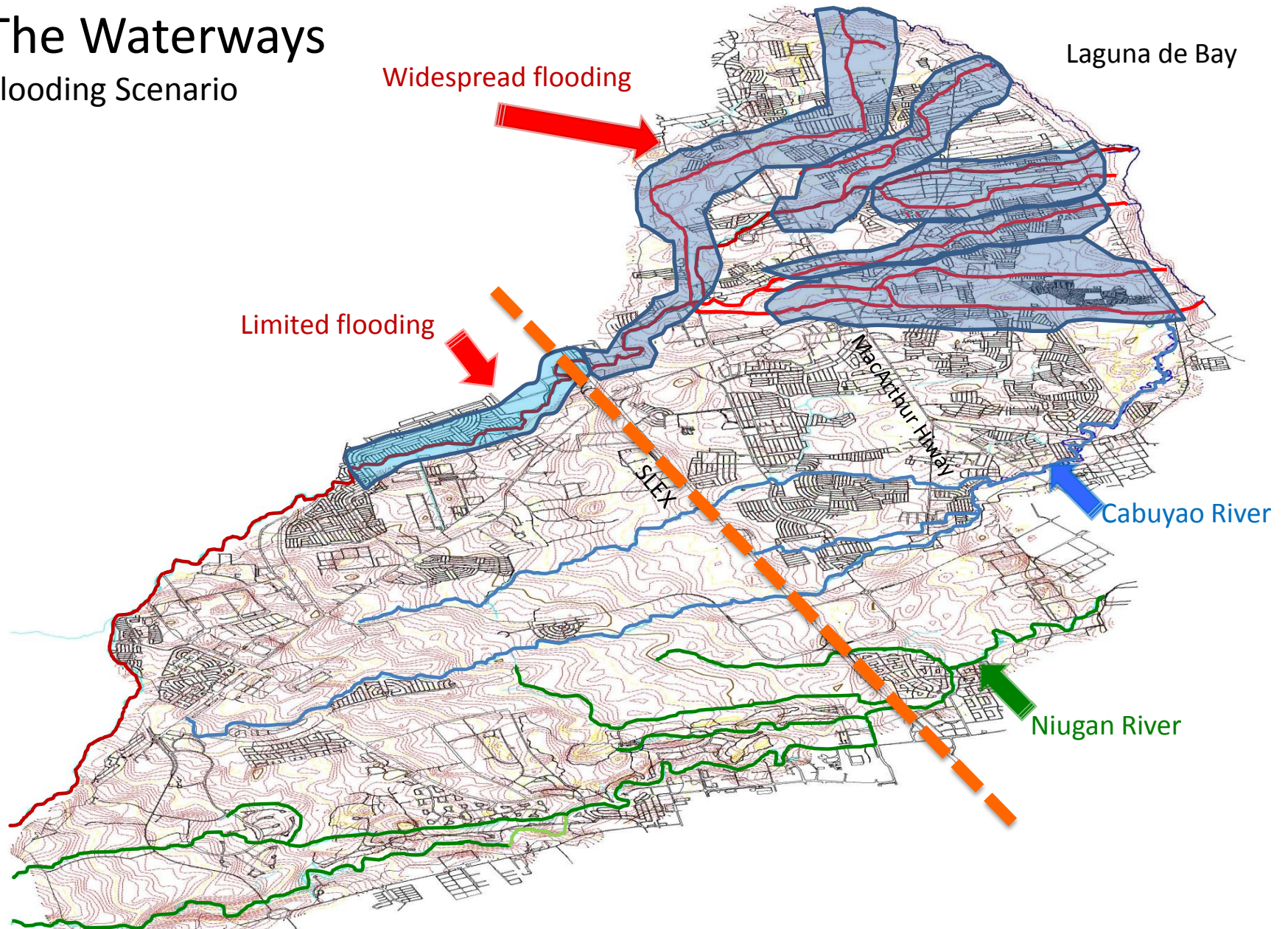
➤ **FLOOD CONTROL AND**
DRAINAGE MASTER PLAN

Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience "



The Waterways

Flooding Scenario



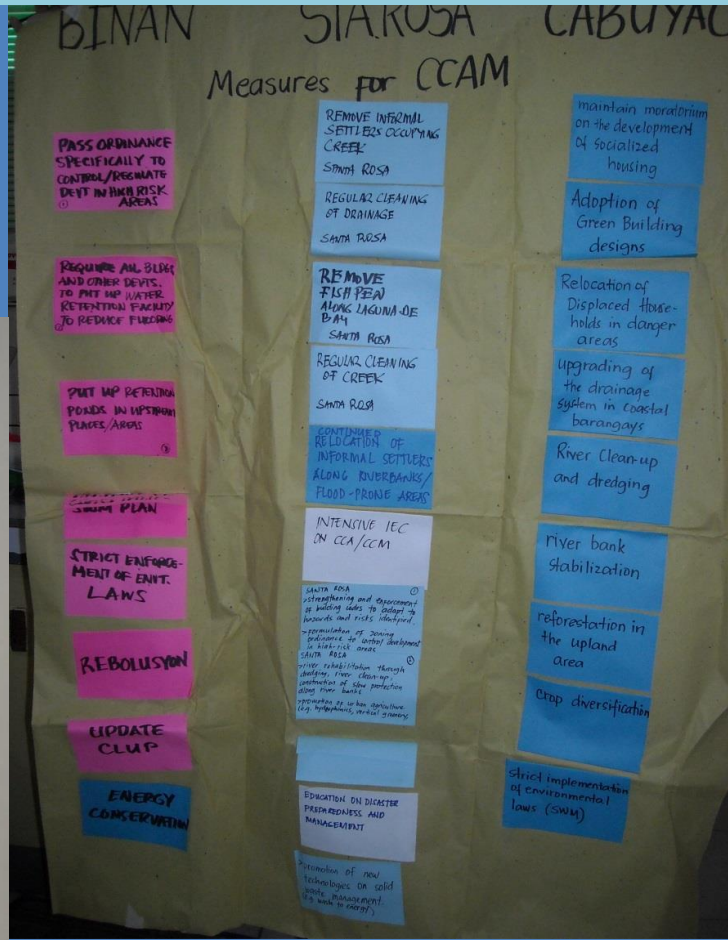
Adapted from Creencia (2014) presentation entitled "Improving land-use for integrated climate action: an approach taken at the local level in the Philippines – the Santa Rosa experience "

Capacity building & public awareness

- **Training needs assessments** on CCA, CCM , disaster preparedness and management
 - Develop survey/assessment instrument to determine the needs for training and other IEC; Conduct the TNA
- **Development of campaign materials and training modules** for CCA, CCM , disaster preparedness and management
 - Develop campaign materials and training modules for CCA, CCM , disaster preparedness and management
- **Conduct of trainings and events**
 - Organize trainings and events to increase awareness and preparedness

(IGES-UPLB Project)

Consultation meeting with LGUs: Climate Change measures



(IGES-UPLB Project)

Possible measures for climate change mitigation (CCM) and adaptation (CCA) (example)

Category	Measures	CC M	CC A
Improved land-use	Development control in high-risk areas		○
	Green space, urban greening	○	○
Flood-tolerant, environment- conscious building	Strengthened building codes in high-risk areas (e.g., embankment, high-floored housing)		○
	Roof greening, green building	○	○
Ecosystem-based, integrated watershed management	Maintenance and improvement of watershed protection function (flood alleviation, water retention ability) of ecosystem		
	Development control in upriver areas		○
	Afforestation & reforestation	○	○
	Watercourse management (e.g., riverbank reinforcement, dredging, river cleaning)		○
	Change in varieties and cultivation methods of agricultural products to prevent soil runoff		○

(IGES-UPLB Project)

Preliminary list of climate change measures by local governments

- **Zoning/building ordinance**
- **River rehabilitation**
- **Information, Education, and communication (IEC)**
- Run-off mitigation development
- Green space/building/urban agriculture
- Relocation of informal settlers
- Strict law enforcement

Inter-city cooperation

Memorandum of agreement (MOA) for cooperation

*Establishment of Council for
Integrated Watershed Management*

December 2, 2014

Catalyzed by 5-year WWF Hydrology Project



(IGES-UPLB Project)

Institutional building: Strengthen IWMC

- Review MOA / legal documents and plans
- Identify gaps/needs
- **Help establish/facilitate regular communication** among local governments and with LLDA
- **Help create workplan/action plan**
- **Provide technical assistance** or connect with experts/institutions
- **Share information, experience, and lessons learned** with other local government with similar climate change problems in and beyond the Lake Laguna watersheds

**THANK YOU VERY
MUCH!**

