Spatial Re-arrangement of local Trees and Crops: an example of Eco-DRR in practice at the erosion-landslide-drought prone area

"toward sustainable land resources utilization"

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(**TRA**nsition of **N**atural proce**S**ses in the **BU**i**L**t-up environm**ENT**)

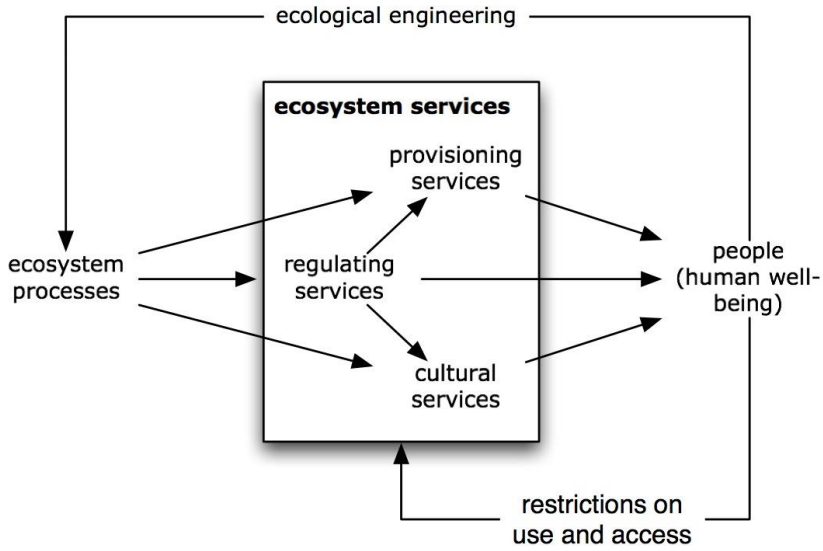
What are ecosystems?

- An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit.
- As elements of the ecosystem are degraded, those functions can be lost.

What are ecosystems services?

- Ecosystem services are the benefits that people receive from nature.
- These may be categorized as *provisioning services* (such as food and fiber), *cultural services* (such as a sense of place or tourism), and *regulating services* (such as climate moderation or flood reduction).

Ecosystem services



Risk Reduction and Resilience Services

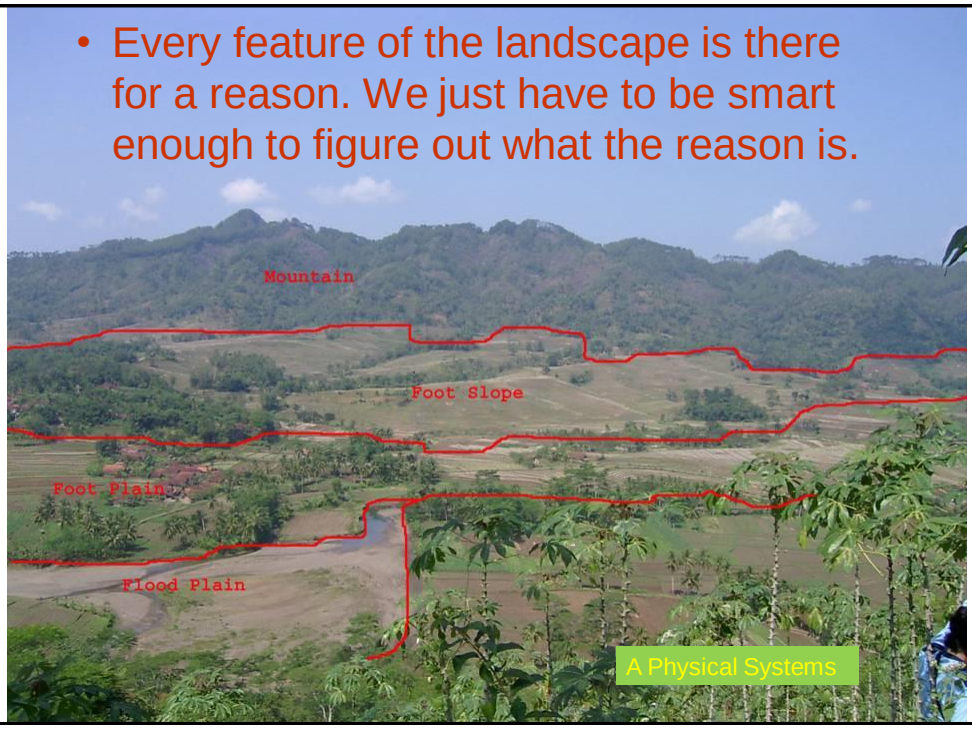
- Globally-regulating ecosystem services are declining.
- Human modification and simplification of ecosystems to produce food, fiber and fuel, has lead to a decline in regulating ecosystem services.
- This decline is expected to result in both more variable ecological dynamics and more human exposure to hazard.

Ecosystem Resilience

- Ecosystems themselves are resilient when processes and components are kept in balance,
- It is important to understand the limits of ecosystem resilience to optimize their benefits to humans.
- Understanding the resilience of ecosystems explains why they are so effective for natural hazard mitigation.

Biodiversity and Resilience

- In bio-diverse ecosystems, species within the same functional groups will respond differently to environmental change, and this “response diversity” may be critical to ecosystem resilience.
- High levels of biodiversity in an ecosystem can be viewed as an insurance against major disturbance.



Rationales

- Our community who live in the certain location have understood the physical system well:
  - They have made adaptation strategy to survive

  But ……
- Our community does not capable to explain systematically, therefore, other community may take lesson learnt

Rationales

- Any natural processes happened in the earth surface shall have created unique signature on the relief
- All natural processes that happened in the past is also happening nowadays and it will be continuous in the future under different intensity; however, in the most cases those natural processes tend to be less intensity in the future
- All kind of natural disasters are belong to natural processes
  - All kind of natural disasters shall have created unique relief

Problematic background

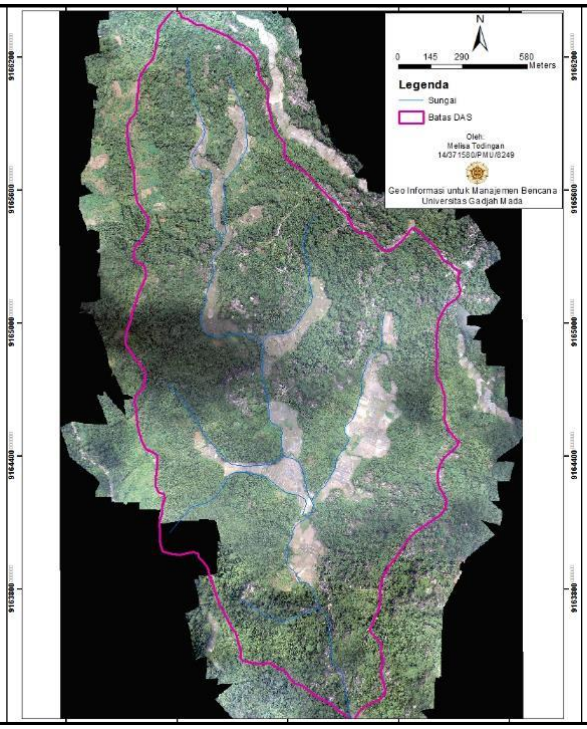
- Several soil-water conservation techniques have been extensively proofed to be not fully accepted by community
- The community more concern on economical income, while the soil-water conservation techniques is more emphasized at soil protections
- The general ideas of soil-water conservations are to control overland flow by increasing infiltration water into the soils and water storage on the land surface
  - Those situation creates the increasing landslide hazard

Scientific Problems statement

- It is important to formulate a conservation strategy having:
  - Accepted by local community:
    - Easy in application
    - Local based materials
    - Local based culture
    - Local based knowledge
    - Provide sufficiently **economic income**
  - Effectively control soil erosion
  - Do not trigger landslides

How do the people manage such erosion-landslide prone areas??, an economic income based on traditionally sound agro-forest systems.

- Through three steps:
- Thorough understanding of geomorphological processes occur at Bompon Sub-watershed → erosion-landslide
- Depth observation on community behavior in cultivating the land → agricultural crops, wood and fruit trees plantation, all of thing that might provide economic income (daily, monthly, seasonally, and yearly incomes)
- Strengthening the finding by providing scientific explanations: biomass weight, trees and crop cover density, root systems, water demand of crops and trees → those all crops and trees shall provide economic income



It looks so green – densely covered by vegetation, isn't it?

Do you aware of this are has been heavily populated?
We need to enhance the local resources based productivity without increasing natural hazard !!

Bompon Sub-watershed

It is a part of Bogowonto Watershed, one permanent river in the Central Java Provice flowing to the Indian Ocean

Bompon Sub-watershed has a range of elevation between 600 – 700 msl

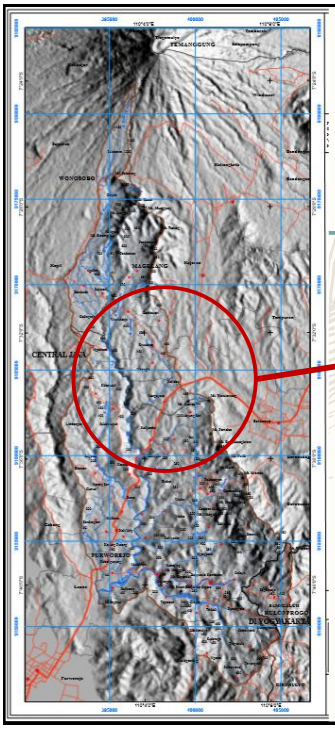
The whole are is covered by clayey to heavy clay soils

The area of watershed has been cultivated intensively for traditional agriculture in a broad sense

It is an area with high erosion-landslide and drought hazards

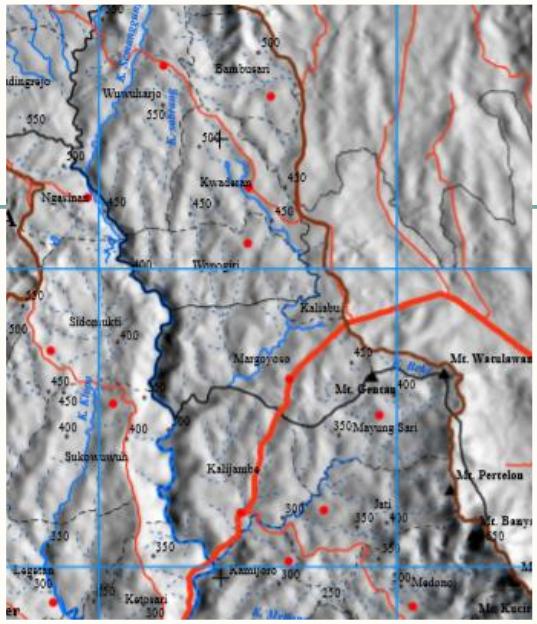
Geographical setting of Bompon Sub-watershed landscape

- It is geographically located at the foot slope area of Sumbing Volcano but it not truly part of it
- It has total area of ±300 hectars
- Administratively belong to Magelang District at the boarder with Purworejo District
- It has ± 2500 inhabitants, most of them are farmers



Geographic Setting

- Administrative boundaries
- Geomorphic setting
- Geologic setting
- Hydro-climatic situation
- Pedogeomorphic condition
  - Genesis of soil parent materials
  - Thicknes of soil parent materials
  - Soils Characteristics
  - Soils Distribution
- Socio-economic and cultural



Geographical setting of Bompon Sub-watershed landscape

- It is a transition zone between the Quaternary Sumbing Volcano and Tertiary Kulonprogo Volcanic landscapes
- The basement rock consist of Tertiary Volcanic Materials but the surficial materials consist of Quaternary Volcanic ash
- The super deep soils embodied by hydrothermal clay layer at the bottom overlayed by thick layers of heavily weathered volcanic ash with high content of clay
- High rainfall areas (> 100 mm/hour and >3000 mm/year)

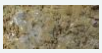
Landslide and Drought

Super-deep volcanic ash soils; Altered parent rock; Para-rock contact

The Bompon sub-watershed embodied by sensitive clay

Sample Codes	Liquid Limit	Liquidity Indices	Max. natural water content	Sensitivity	Sensitivity
				BC < KA	IL > 0,5-4
L1L1	63,21	0,99	62,98	Moderate sensitivity	Sensitive Clay
L1L2	69,15	1,05	69,65	**High sensitivity**	Sensitive Clay
L1L3	76,04	0,98	75,62	Moderate sensitivity	Sensitive Clay
L1L4	85,37	0,97	85,09	Moderate sensitivity	Sensitive Clay
L1L5	79,12	1,18	82,05	**High sensitivity**	Sensitive Clay
L1L6	71,95	1,01	72,15	**High sensitivity**	Sensitive Clay
L1L7	79,51	1,02	80,05	**High sensitivity**	Sensitive Clay
L1L8	79,46	1	79,44	Moderate sensitivity	Sensitive Clay
L2L1	67,57	1,09	68,86	**High sensitivity**	Sensitive Clay
L2L2	98,07	0,99	97,58	Moderate sensitivity	Sensitive Clay
L2L3	67,70	1,14	69,61	**High sensitivity**	Sensitive Clay
L2L4	74,52	0,91	73,08	Moderate sensitivity	Sensitive Clay
L2L5a	75,47	0,95	74,29	Moderate sensitivity	Sensitive Clay
L2L5b	83,81	1,03	84,62	**High sensitivity**	Sensitive Clay
L3L1	64,21	1,07	65,19	**High sensitivity**	Sensitive Clay
L3L2	89,29	0,97	88,45	Moderate sensitivity	Sensitive Clay
L3L3	78,63	1,49	81,24	**High sensitivity**	Sensitive Clay
L3L4	94,23	1,15	95,48	**High sensitivity**	Sensitive Clay

The depth of clay assessment at the slide location 1 DAS Bompon

Sample Code	Photos of soil	Depth (m)	Thickness (m)	Elevation from sea level (m)
L2L1		Surface layer	14,62	437,50
L2L2		14,62	3,11	422,88
L2L3		17,73	0,93	419,77
L2L4		18,66	0,60	418,84
L2L5a		19,26	0,41	418,24
L2L5b		19,67	0,53	417,83

The sensitive clay occurs at the first, the third, and the sixth layers, with average thickness 14,62 m; 0,93 m; 0,53 m consecutively

The depth of clay assessment at the slide location 2 DAS Bompon

Sample Code	Photos of soil	Depth (m)	Thickness (m)	Elevation from sea level (m)
L3L1		0	3,32	432
L3L2		3,32	3,55	428,68
L3L3		6,87	2,45	425,13
L3L4		9,32	2,63	422,68

The sensitive clay occurs at the first, the third, and the fourth layers, with average thickness 3,32 m; 2,45 m; 2,63 m consecutively

Some characteristics of super-deep clayey volcanic soils

Performing pseudo sand at the near surface layer due to high content of oxidized irons

No trees rooting systems effectively protect the soils from landslide

- The more dense trees vegetation cover the more heavier

Limited water storage capacity due to

- Slow infiltration
- High capacity to hold moisture

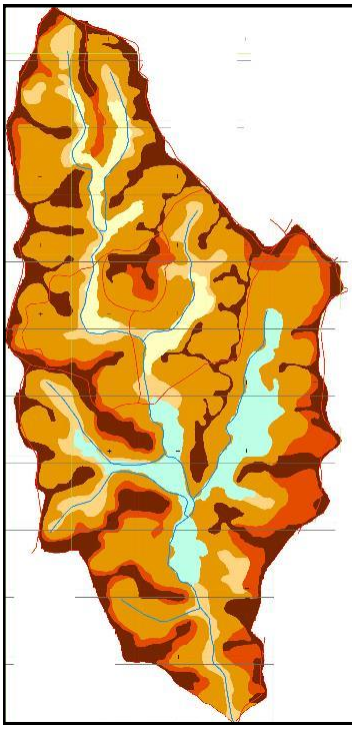
Geographical setting of Bompon Sub-watershed landscape

- The landcover characteristics:
  - The valley bottom is utilized for paddy field
  - The other parts are utilized for varies species of wood trees and inter-space crops:
    - *Bamboo, Albazia, Mahagoni, dadap (Erithrina Crista gali), duku (Lansing Domestic correct), kokosan (Domestic bar aquarium), Coconut, Mangosteen, Durian, Rambutan, kepel (Steelchocarpus burahol)*
    - *Varies of inter-space crops: banana, varies of herbal crops (lemon grass, cardamom, turmeric, ginger, galangal, Kaempferia galanga, Curcuma xanthorhiza, Phaleria macrocarpa)*

Some Local Product from Bompon Sub-Watershed

There are many others than the presented pictures



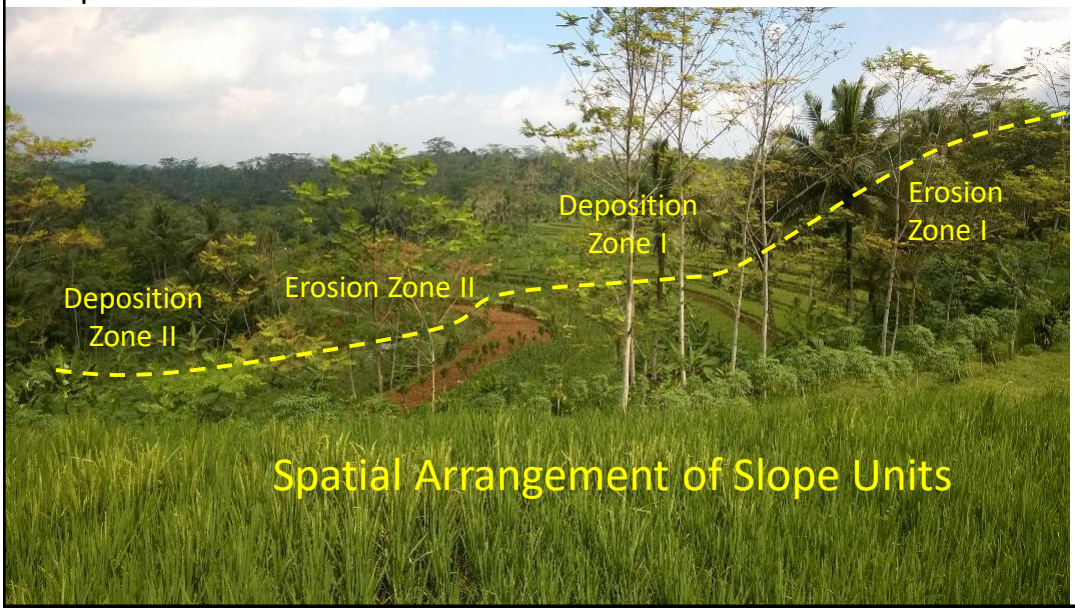



> 70% of the region had been sliding and continues sliding with different intensity

- River
- Fluvio-Coluvial Foot Slope
- Coluvial Foot Slope
- Foot Slope
- Middle Slope
- Upper Slope
- Ridge of hills

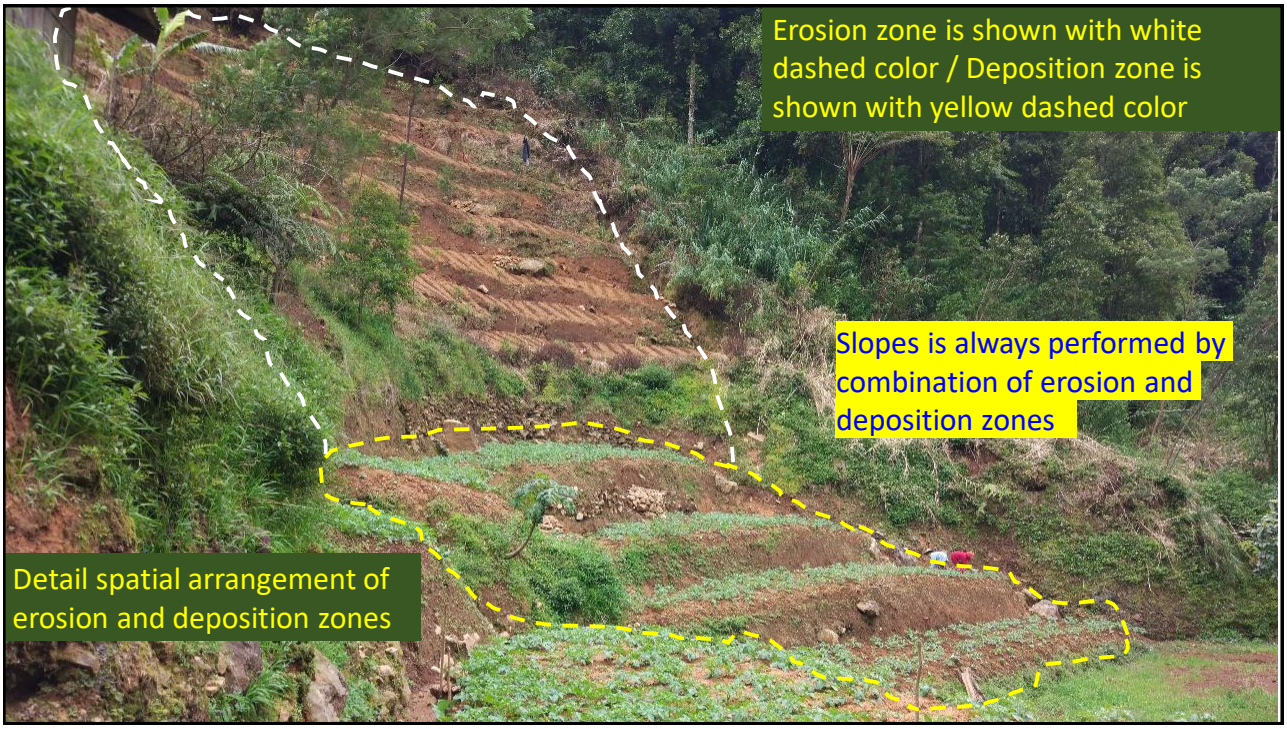
Most of the ridges is the areas of landslide remnants. The foot slope is an area of landslide deposition. The middle and upper slope are the area of former landslides

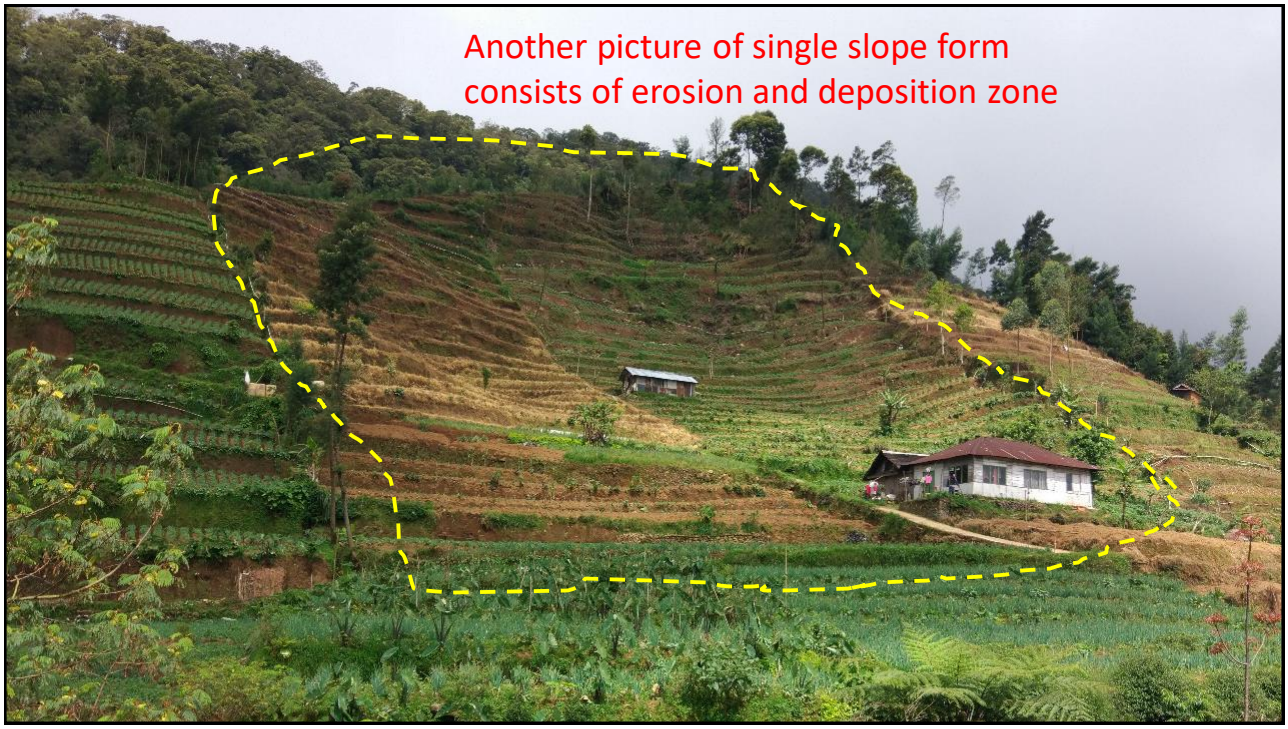
Morphological Characteristics of Slopes at the erosion-landslide prone areas



The gully formation by erosion found at **deposition zone I**

We shall not apply the same soil utilization type for all slope unit





Fact Findings → Rotational Slides (Slump)

There were two types of landslides in the study area:

The active landslide

- Consist of small-small landslides associated with gully erosion
- Albazia trees plantation with poor management
- Slope cut by both natural and/or artificial process
- Excessive addition construction weight

The in-active landslide

- Slope inclination +10% at the toe and +30% at the crown areas
- Relative proper management by local people

Fact Findings → the detail natural processes following the major landslide

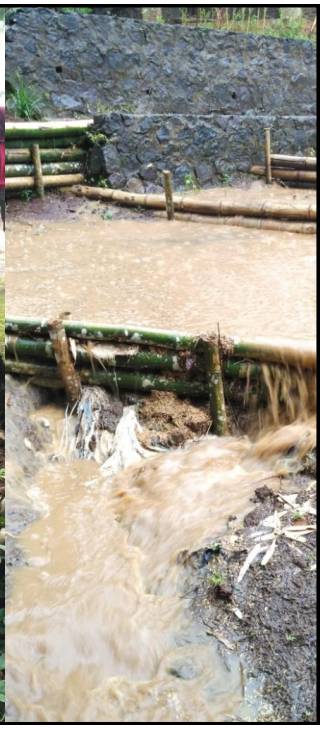
Crown part:
- Splash and sheet erosion
- Topless due to standing wall slope

Main body part:
- Rill erosion
- Small rotational slide followed by gully formation

Toe part:
- Gully widening and creep-flow mass movement

Re-activation of landslides is mostly initiated by un-controlled gullying processes

Gully protections by controlling the water flow (speed and direction)



Gully protections
(velocity and river side protection)

Fact Findings → Spatial arrangement of landuse at the area of landslide; managed by local people

The crown of landslide:

They were planted by permanent trees such as bamboo and *Lansium parasiticum* and *Lansium domesticum*, durian → landslide still occurs

The main body – toe of landslide:

The gully sides were planted by permanent trees → coconut, ***Lansium parasiticum*** and ***Lansium*** *domesticum*, bamboo, *Arenga pinata*

The inter-gully were planted by coffee or other crops in the form of light weight seasonal and/or annual crops and trees

Improved land management → based on lesson learned

The crown of landslide:

Relative permanent trees with minimum land disturbance; less heavy biomass → coffee

The main body – toe of landslide:

The gully sides were planted by permanent trees → coconut, *Lansium parasiticum* and *Lansium domesticum*, bamboo, *Arenga pinnata*

The inter-gully were planted by coffee or other crops in the form of light weight seasonal and/or annual crops and trees (albazia, coconut, *Lansium p.* and *L. p.*, durian, rambutan, bamboo)

Important note: income continuity is more important than discontinue high income

Fact Findings → Economical value of local crops and trees; managed by local people

Coconut and *Arenga pinata* provide daily income; they produce palm sugar

Banana, paddy, chilli, tomato and other agricultural crops provide seasonal income

Rambutan, durian, jackfruit, mangosteen, *Lansium parasiticum, Lansium domesticum,* and another kind of fruit trees provide annual income

Herbal *(Kaempferia galangal, Alpinia galangal, Curcuma zanthorrhiza, Curcuma aeruginosa)* crops provide three-annual income

Wood trees *(Albazia sp, Swietenia mahagoni)* provide mostly ten-annual income

Other crop and wood trees are not dominant

Important note: income continuity is more important than discontinue high income

Concluding remarks

Vegetative based conservation but it has to provide sufficient economic productivities:

- In the case at Bompon Sub-watershed, the high density of vegetation cover has another ecological function, i.e., as cloud forest since the elevation range is between 600-700 msl
- Multi stratum of vegetation provide optimum protection for soil surface from erosive rainfall and runoff

The community has been considering the "spatial arrangement" of trees and crops plantation following the erosion-landslide sequences. Those spatial arrangement become a win-win solution between economic productivity and soil conservation