Comparison of Two Land Cover Scenarios and its Effect on Runoff Inside the Mandulog River Basin, Iligan City, Philippines

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and **Blasco, Jennifer G.**

Philippines is Now The 3rd Most Disaster-Prone Country (2017 World Risk Index)

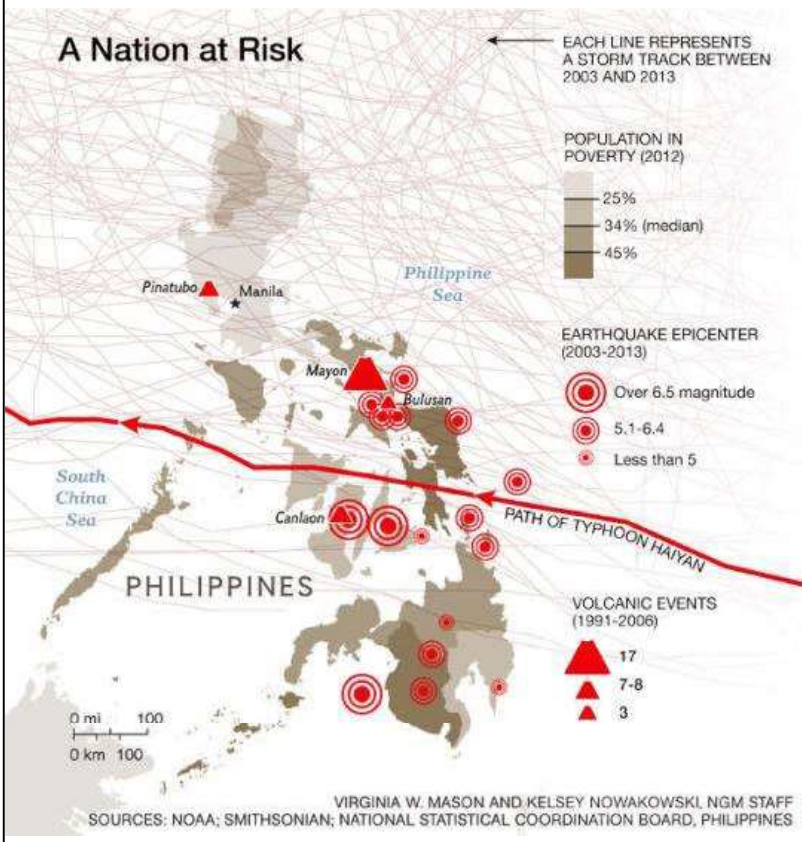
The 15 most **exposed** countries worldwide		
Country	**Exp. (%)**	**Rank**
Vanuatu	63.66	1.
Tonga	55.27	2.
Philippines	52.46	3.
Japan	45.91	4.
Costa Rica	42.61	5.
Brunei Darussalam	41.10	6.
Mauritius	37.35	7.
Guatemala	36.30	8.
El Salvador	32.60	9.
Bangladesh	31.70	10.
Chile	30.95	11.
Netherlands	30.57	12.
Solomon Islands	29.98	13.
Fiji	27.71	14.
Cambodia	27.65	15.

The 15 countries that are most at **risk** worldwide		
Country	**Risk (%)**	**Rank**
Vanuatu	36.28	1.
Tonga	29.33	2.
Philippines	26.70	3.
Guatemala	19.88	4.
Bangladesh	19.17	5.
Solomon Islands	19.14	6.
Brunei Darussalam	17.00	7.
Costa Rica	17.00	8.
Cambodia	16.58	9.
Papua New Guinea	16.43	10.
El Salvador	16.05	11.
Timor-Leste	15.69	12.
Mauritius	15.53	13.
Nicaragua	14.62	14.
Guinea-Bissau	13.56	15.

Frank Schuengel for wheninmanila.com

- **at risk from earthquakes, tsunamis , typhoons, storm surge, flooding, landslides, volcanic eruptions, drought, sea level rise and POVERTY….**

5 Reasons WHY the Philippines Is So Disaster Prone

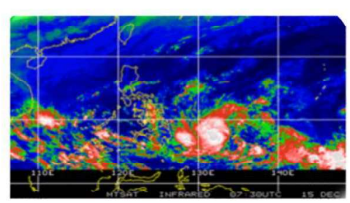


5 REASONS WHY:

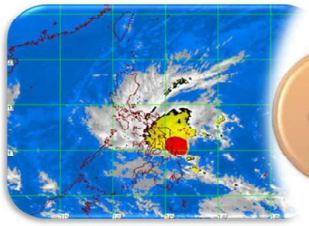
1. **Warm Ocean Waters(just above equator, facing West Pacific) – driving force of typhoons**
2. **Coastal Homes- in low-lying coastal islands**
3. **Deforestation**
4. **Ring of Fire - EQ and Volcano**
5. **Underdevelopment (high poverty rate)**

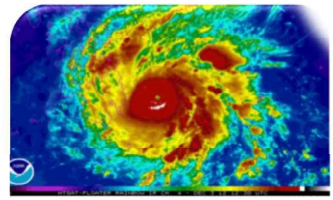
Source: By Dan Vergano, National Geographic

The Flooding Problem



Satellite image of typhoon Sendong over Cagayan de Oro. (NOAA)





Satellite image of typhoon Pablo over Compostela Valley. (NOAA)

Aerial shot of Sendong floods along Cagayan River on December 17, 2011 by Elpidio M. Paras - See more at:

http://ifg.org/v2/wp-content/uploads/2015/06/Philippi

BACKGROUND

- Massive FLOODING in Mandulog RB due to extreme RAINFALL - **180.1 mm with an equivalent return period of 75 years (RDC-10, 2012)**
- **PAGASA, Lumbia Station Data from 1977 to 2005, the daily rainfall of 125 mm was exceeded 3x only: 134mm (1985); 129mm (1998); and 142mm (1999) before T.S. Sendong**
- December 17, 2011 Tropical Storm Washi (T.S. Sendong) struck Iligan City ; a WEAK storm at 100 kph (T.S. category) but with EXTREME Rainfall
- An updated assessment shows that:
  - 1,278 died (**due to Flash Flood**) ; and more were Missing
  - 28,730 families displaced
  - 35 out of the 44 villages were affected
  - Initial damage assessment was about USD 81.4 Million

Killer Logs (source: Reuters/Erik De Castro)

LOGS. Hundreds of logs washed out from the mountains now cover the seashore in parts of Iligan City. Photo courtesy of UP National Institute of Geological Sciences.

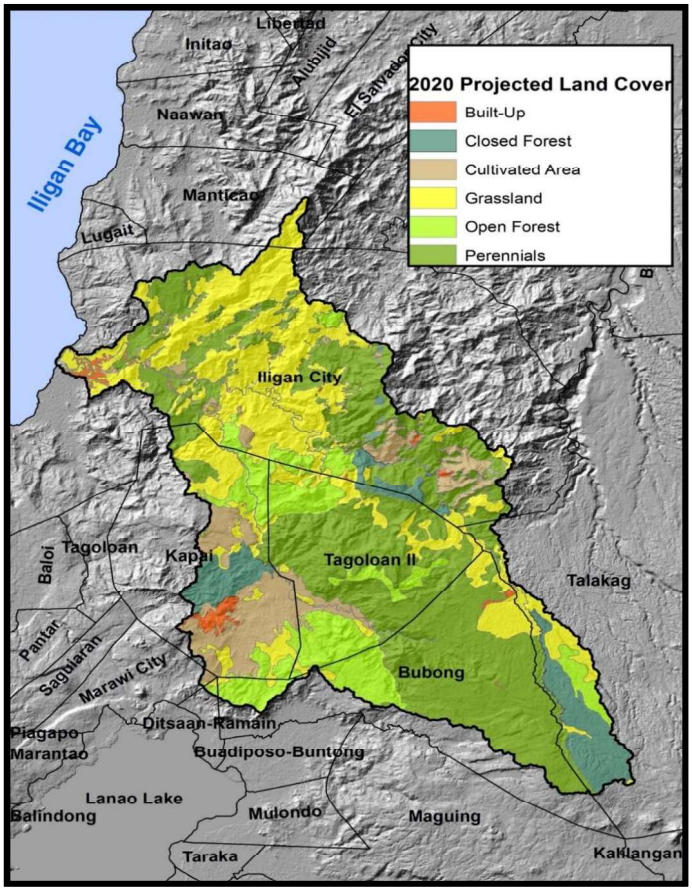

OBJECTIVE:

- This study sought to **compare/simulate** as to what happens to **runoff:**
  - When the land cover was allowed to take its natural course after ten years from TS Sendong **(projected land cover/use)**
  - When land cover is appropriately planned and managed **(proposed land cover/use)**

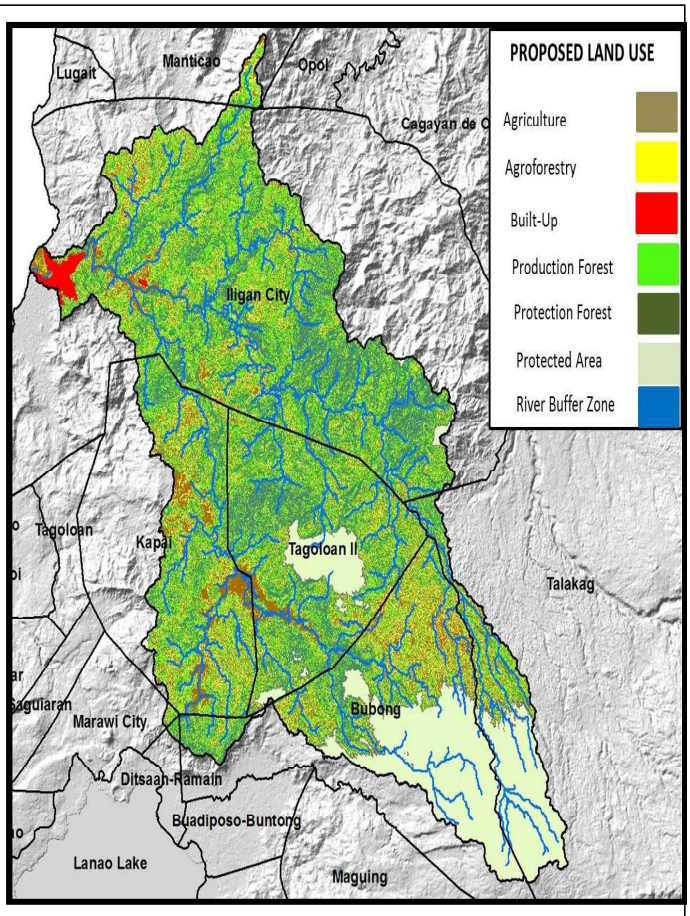
METHODOLOGY

- **Two (2) scenarios were created:**
  - **Projected Land Cover in 2020 (without intervention)**
  - **Proposed Land Cover (with intervention)**

- Projected Land Cover scenario in 2020
  - Trend Analysis function of MS Excel derived from geospatial land cover data of 1973, 1989, 1998, 2008 and 2010 (Suson, 2012)
- Proposed Land Use scenario (from LiDAR DEM using GIS)
  - A slope vector file was created from a high resolution slope raster file
  - Use **slope** as the basis in assigning the **different land uses**
- HEC-GeoHMS (using Arc GIS) and HEC-HMS to compute Runoff process
  - **Peak Discharge**
  - **Lag Time**
  - **Total Runoff Volume**
- Rainfall Intensity Duration Frequency (RIDF) for 5Y, 10Y, 25Y, 50Y and 100Year Rainfall Return Period (RRP) was used as Rainfall Data (from PAG-ASA)



PROJECTED LAND COVER/ USE



PROPOSED LAND COVER/ USE

RESULTS AND DISCUSSION

- The Lower Peak Discharge and Total Runoff Volume and Longer Lag Time of the Proposed Land Use is due to **INCREASED** Forest Cover

- Forest vegetation is known to reduce storm water runoff by improving **soil infiltration** and **canopy interception**

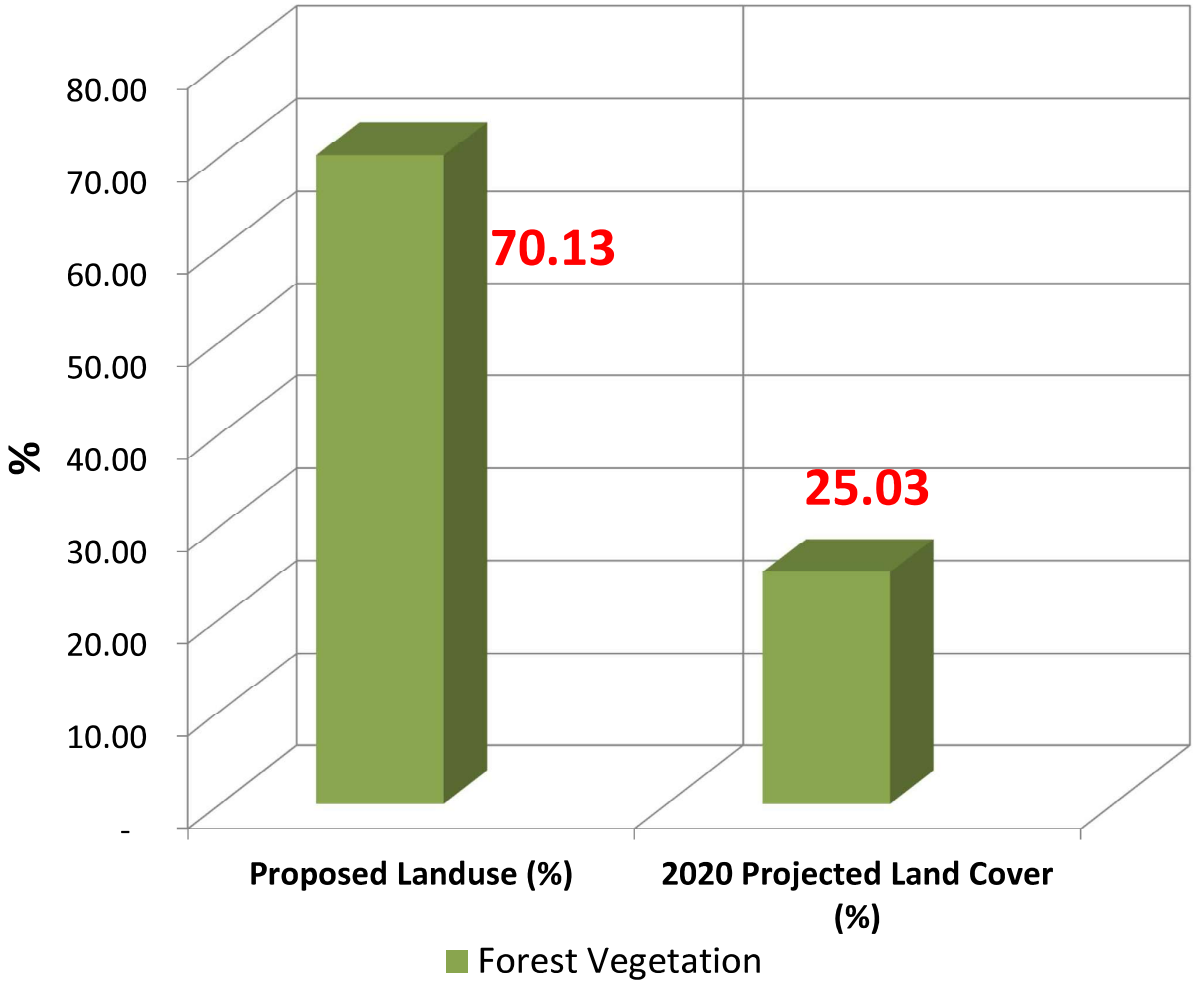
Table 3. Percentage Forest Cover of 2020 Projected Land Cover

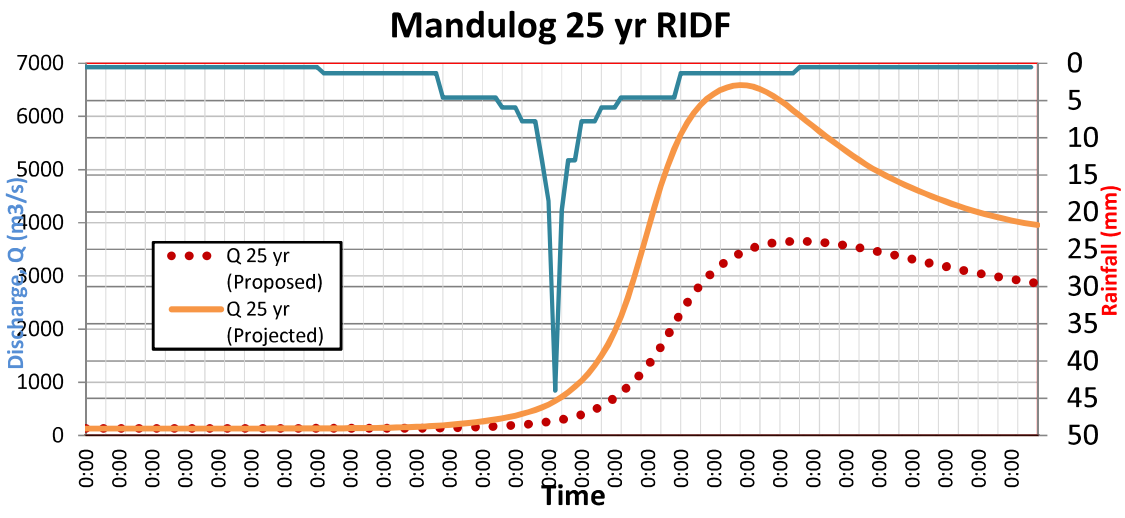
Landcover Classes	2020 Projected Land Cover	%
Closed Canopy Forest	7,796.97	10.01
Open Canopy Forest	11,695.45	15.02
TOTAL	19,492.42	25.03

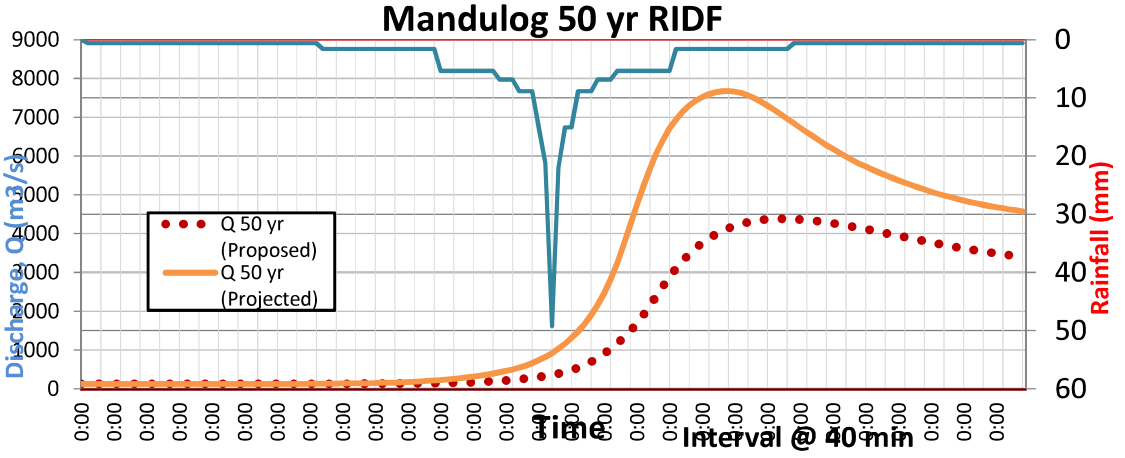
Table 5. Total Forest Cover for the Proposed Land Use

Proposed Landuse	Land Features	Area (hectares)	%
1. Production Forest	30-50% slope	17,575.90	22.57
2. Protection Forest	>50% slope	18,067.90	23.20
3. Protected Area	>1000 masl	11,096.86	14.25
4. Protection Riparian Forest	0-20 m from the river	2,622.13	3.37
5. Production Riparian Forest	20-60 m from the river	5,244.27	6.74
TOTAL		54,607.06	70.13

- **Projected LC – NO Intervention**
- **Proposed LC – WITH Intervention**


80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
%
70.13
25.03
Proposed Landuse (%)
2020 Projected Land Cover (%)
Forest Vegetation


Mandulog 25 yr RIDF
Discharge Q (m3/s)
Rainfall (mm)
Q 25 yr (Proposed)
Q 25 yr (Projected)
Time


Mandulog 50 yr RIDF
Discharge Q (m3/s)
Rainfall (mm)
Q 50 yr (Proposed)
Q 50 yr (Projected)
Time
Interval @ 40 min

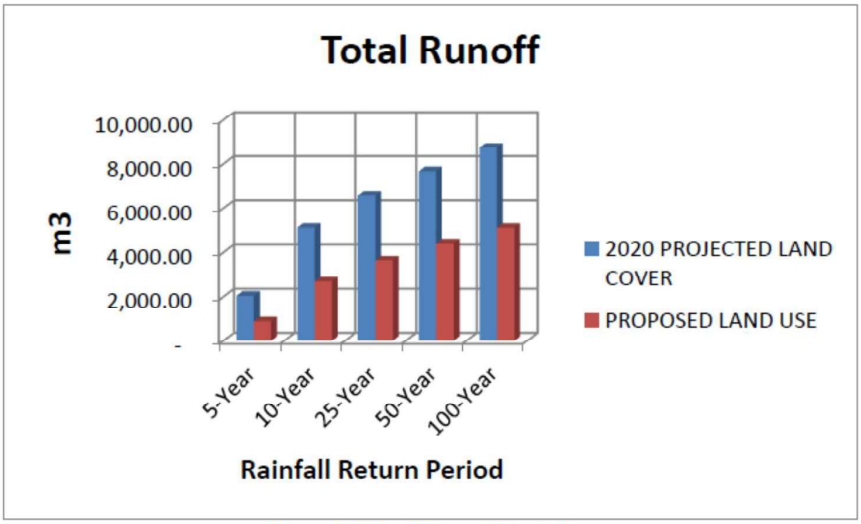


Figure 7b Total Runoff Variation

Table 4b Total Runoff for the Two Land Cover Scenarios

RIDF Period	Total Runoff (m3)	
	2020 PROJECTED LAND COVER	PROPOSED LAND USE
5-Year	2,049.50	878.70
10-Year	5,118.10	2,693.70
25-Year	6,588.80	3,652.00
50-Year	7,680.30	4,382.10
100-Year	8,760.70	5,117.10

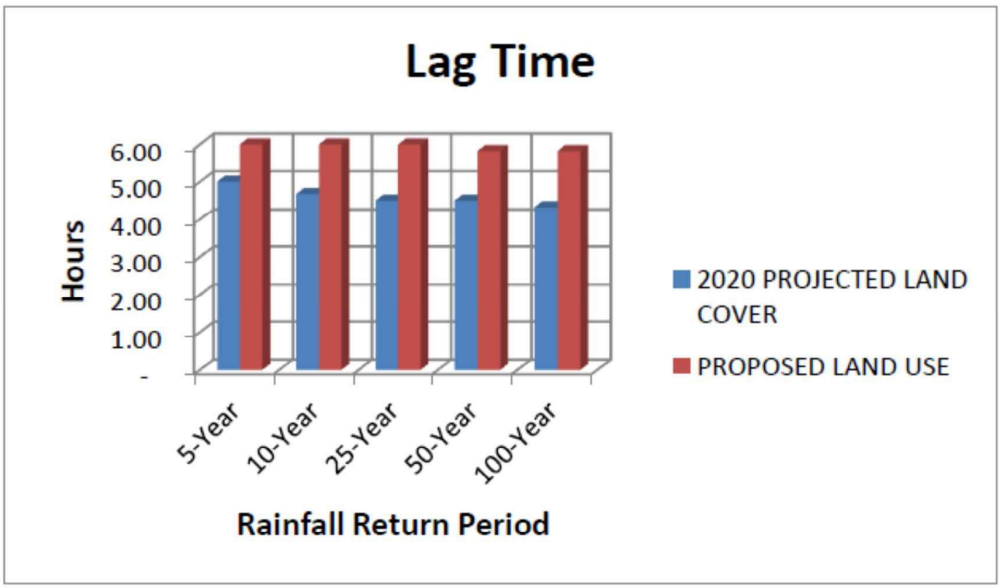


Figure 7c Lag time Variation

Table 4c

RIDF Period	Lag Time (hours)	
	2020 PROJECTED LAND COVER	PROPOSED LAND USE
5-Year	5.00	6.00
10-Year	4.67	6.00
25-Year	4.50	6.00
50-Year	4.50	5.83
100-Year	4.33	5.83

CONCLUSION

- When land cover conditions are **left by itself without any intervention** , the impact of **FLOOD DISASTER** is more likely to be magnified **due to higher peak runoff flow, higher total runoff volume and shorter lag time**

RECOMMENDATION

- Investigate Effects of Flooding at different IRRP
- **Increase Proposed Land cover area to reduce more the runoff rate**

RECOMMENDATION to LGUs

- The Local Government Units should carefully **plan**, **adopt** and seriously **enforced** appropriate land uses in their respective areas.
- If the LGUs strictly reinforced SAFEGUARDING and PROTECTING the FOREST AREA through Police Power, then REFORESTATION will flourish in time, even through its natural course…

ACKNOWLEDGEMENT

- DOST – PCIEERD
- DREAM Project
- UP-DILIMAN LiDAR
- Geo-SAFER Mindanao Program
- NAMRIA
- MSU – Iligan Institute of Technology
- DPWH Region 10
- PARTNER LGUs

Our Challenge:
WE HAVE TO PROTECT OUR ENVIRONMENT FOR THE NEXT GENERATIONS TO ENJOY… "THINK ABOUT OTHERS ; YOUR LITTLE IDEAS MAY SAVE LIVES IN THE FUTURE".

….. **Prof. ALAN MILANO**

THANK YOU