Investigation Study on the Massive Flooding in the Municipalities of San Teodoro, Baco, Victoria, Naujan and City of Calapan during the Typhoon NONA on 15 December 2015

A CONSOLIDATED REPORT

TASK FORCE IWAS-BAHA
18 April 2016

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RATIONALE

On 15 December 2015, typhoon Nona, one of the most destructive calamities in recent years, hit Oriental Mindoro and left the province with enormous damages to agriculture, infrastructure, environment and power sectors amounting to more or less five (5) billion Pesos. This typhoon placed under Signal No. 3 brought torrential rains, destructive winds, landslides and massive flooding and caused distraught to Mindoreños living 108,201 displaced families comprising of490,751 individuals, 339 injured people and,worse, 13 dead persons.

Such destructive flooding was beyond the expectation of Mindoreños. A lot of speculations as to its probable cause surfaced. As surmised, the construction activities undertaken for the Lower Catuiran Mini-Hydro Power Project contributed to such eventuality. This project is perceived to have brought detrimental effects to the environment, especially resource extractive activities.

With this, the Provincial Government of Oriental Mindoro (PGOrM) immediately issued policies, particularly, SP +
Resolution No. 2885-2016 and Executive Order No.60, Series of 2016, directing the study, assessment and investigation on the direct or proximate cause of massive flooding by a task force composed of multi-sectoral representatives. These were urgent responses by the Provincial Governmentdeemed necessary to address not just an environmental issue, but also important societal issues for the general welfareof the Mindoro populace.

OBJECTIVES

1. To determine the proximate cause and extent of damages of the massive flooding which affected numerous barangays in the province of Oriental Mindoro brought about by typhoon Nona last 15 December 2015;

2. To clarify issues and speculations on what triggered the massive flooding in four municipalities and city in the province; and

3. To recommend short and long-term measures to effectively address and mitigate impacts of flooding and other related calamities.

LIMITATIONS OF THE STUDY

The Executive Order directed for the submission of a Final Report in three (3) weeks after the first meeting of the Task Force.However, it took a longer period to complete the necessary activities to carry out the methodologies identified by the created teams of the task force.

Inspection of upland areas for validation of *kaingin* sites were not successfully undertaken because IPs were apprehensive and uncooperativein guiding the personnel of National Commission on Indigenous Peoples Provincial Office. Furthermore, the plan to conduct an inspection climb at Mt. Halcon did not materialize. The Task Force decided to make use of the findings and conclusions obtained after field inspection and aerial survey.

METHODOLOGIES

The following were the methodologies undertaken to complete the investigation study:

a. Coordination with concerned agencies
b. Consultations and interview with affected barangays
c. Review of available reports and related documents
d. Conduct of meetings by teams and sub-teams of the task force
e. Ocular/field inspection and validation
f. Downloading of satellite (*Google Earth*) maps and overlaying of maps
g. Aerial survey
h. Geo-hazard study

FINDINGS

A. GEO-PHYSICAL AND HYDROLOGICAL SITUATION OF THE PROVINCE

1. The geology, geomorphology and topography of Oriental Mindoro is naturally prone and vulnerable to flooding.

As described in the MGB report, the risk of flood events in an island province like Oriental Mindoro is high due to huge river basins and vast alluvial plain.The report states that,

> "It is geomorphologically prone to flashflood and basinal flooding due to its extensive upper basins and broad flatlands which are dissected by numerous streams. The upper reaches of these rivers have steep slopes where erosion and mass wasting are active, thus serving as source of bed load and suspended sediments."[1]

The condition of the river and delta systems was explicitly explained in the MGB report. Below is the result of their recent flood assessment and analysis:

> "Regional morphology showed that the northeastern plain of Oriental Mindoro is formed under alluvial fan and deltaic conditions. Geological environments formed under these conditions are naturally prone and highly vulnerable to flooding.
>
> Topographic inspection also revealed that most of the surveyed areas are situated on a flat to very gently sloping terrain traversed by numerous braided and meandering streams. Highly susceptible areas to flooding in the form of overbank river flooding and sheet flooding are confined within the broad floodplain and on the downstream-most portions of the river systems. Inundation levels vary from 0.5 to more than 1.0 meter in depth. River bank erosion and channel migration due to heavy river siltation are highly noticeable near the mouths of rivers. Flooding in low-lying areas near the coast on the eastern part of the island is attributed to abnormal sea tidal fluctuations.

[1] Flood Hazard Assessment of Northeast Oriental Mindoro, MGB 2016

The northeastern plain of the province particularly the municipalities of Naujan, Victoria, and Baco is dissected by numerous river systems, most of which exhibit a braided pattern of drainage like the Mag-asawang Tubig River in Naujan. This type is characterized by multiple channels that branch repeatedly, with dividing and reuniting, wide, shallow channels filled with numerous islands. Due to the generally flat terrain, the rivers coursing here are slowed down by the low gradient and this decreases their capacity to effectively drain the land. The slowing down of water flow also causes rivers to deposit their sediment loads and this makes their channels progressively shallow due to siltation.

Hence, water easily fills up the channels during above normal precipitations and escapes from their banks to inundate low-lying areas. Lateral shifting of channels, bars, and islands is also frequent. However, in some parts of the plain, the drainages tend to meander particularly along the lower and midstream areas of Bucayao, Alag, Dulangan, and Mag-asawang Tubig rivers as shown by the very sinuous channels, few channel islands, and deep, narrow channels. Because perfectly laminar flow in channels is so difficult to maintain for any length of time, small perturbations in flow eventually deflect flow against the bank, reflecting flow toward the opposite bank, thus setting in motion a positive feedback system that leads to a of discharge and slope on the channel patterns.

In the upper part of the river basins of Naujan, Victoria, Baco and San Teodoro, mountain rivers are formed by erosion of the bedrock. Their courses incise progressively and the flow carries the products of the incision and of the soil erosion towards the midstream part of the basins where some equilibrium exists between sediment transport capacity of the flow and the sediment supply. In the lowest zone of a basin, the sediments are deposited by lack of transport capacity, in deltas and estuaries.

A greater portion of the plain of Baco and Calapan including the town proper of Naujan lies on a deltaic environment. Deltas are built by accumulation of sediment deposited by streams discharging into standing water. Deltaic environments are areas of very rapid sedimentation rates. As a result, a lot of geomorphologic features tend to form caused by loose sedimentation and rapid loading."[2]

[2] Ibid

2. **Recurrence of flood events in the province since 1950s to present has been more frequent.**This was explained in the Flood Review part of the Flood Hazard Assessment of Northeast Oriental Mindoro conducted by MGB Region IVB. It was mentioned that flood events after 1950 happened from mid-to-late 1990s, 2000, 2005, 2007, 2008, 2010 and 2012 and were caused by heavy rains, tropical depressions and other rain-induced events.

   Impacts of climate change include increased temperature, sea level rise and increased precipitation. Hence, the frequent floodings experienced by Oriental Mindoro is a climate change hazard.

3. **Several flood assessments and proposals to conduct river characterization and related studies have been made in the province since 2005 to recent years.**

   MGB-MIMAROPA conducted region-wideGeo-hazard Mapping Projects since 2005, and according to them,

   > "The province of Oriental Mindoro was among the priority areas due to perennial flooding that affects the region."[3]

   The detailed flood assessment was completed in year 2014. Results are presented in **Annex A.**

4. **The "freak" or "phenomenal" total rainfall depth of 268.8mm, a day before and on 15thDecember 2015 brought by typhoon Nona was tremendously voluminous to cause the devastation of numerous barangays in the municipalities of Baco, San Teodoro, Baco, Victoria and City of Calapan.**

   Flash floods at different locations due to Typhoon Nona on 15 December 2015 were caused by high intensity rainfall over an extended period.
   Rainfall was intense from 8:00am – 6:00pm (about 190.00 mm over a 10 hour-period).
   PAGASA Calapan (15 December 2016)
   Total daily rainfall = 209.2 mm
   Monthly average in December over a 30-year period = 216.2 mm

[3] Ibid

Based on the result of simulation modeling by Sta. Clara International Corporation, the rainfall of 15 December 2015 has a recurrence interval of 200 years."[4]

The rainfall values recorded before and during flood incident caused by typhoon Nona totaling to 268.6mm in the above-mentioned areas are higher than average against December 2015 daily rainfall and typical monthly rainfall from 2005 to 2015 which is equivalent to 260.4mm .

Table 1. Amount of rainfall (in millimeters) in December 2015 from PAGASA-Calapanweather Station

DECEMBER 2015 RAINFALL DATA		
DATE	**AMOUNT OF RAINFALL (mm)**	**WEATHER CAUSING PHENOMENA**
December 1, 2015	1	TECF
December 2, 2015	0	
December 3, 2015	0.4	NE Monsoon
December 4, 2015	7	NE Monsoon
December 5, 2015	0.4	NE Monsoon
December 6, 2015	3.6	NE Monsoon
December 7, 2015	3.6	NE Monsoon
December 8, 2015	4.4	NE Monsoon
December 9, 2015	0.4	TECF
December 10, 2015	0	
December 11, 2015	4.8	LPA
December 12, 2015	0.7	
December 13, 2015	1.8	TS NONA
December 14, 2015	59.4	TY NONA
December 15, 2015	209.2	TY NONA
December 16, 2015	7.3	TD ONYOK
December 17, 2015	17.6	TD ONYOK
December 18, 2015	20.8	TD ONYOK
December 19, 2015	21.5	TD ONYOK
December 20, 2015	0.4	NE Monsoon, TECF
December 21, 2015	0	
December 22, 2015	0	TECF
December 23, 2015	5	
December 24, 2015	0	NE Monsoon
December 25, 2015	2.5	NE Monsoon
December 26, 2015	17.8	
December 27, 2015	0	
December 28, 2015	0	
December 29, 2015	0	
December 30, 2015	4	NE Monsoon
December 31, 2015	10	Cold Front
TOTAL RAINFALL	**403.6**	

Note: extracted from the MGB report

[4] Annex H. Simulation of SCIC on Flood Evaluation: River Hydrolics

Table 2: Monthly Total and Annual Climatic Rainfall Data of Oriental Mindoro, 2005-2015

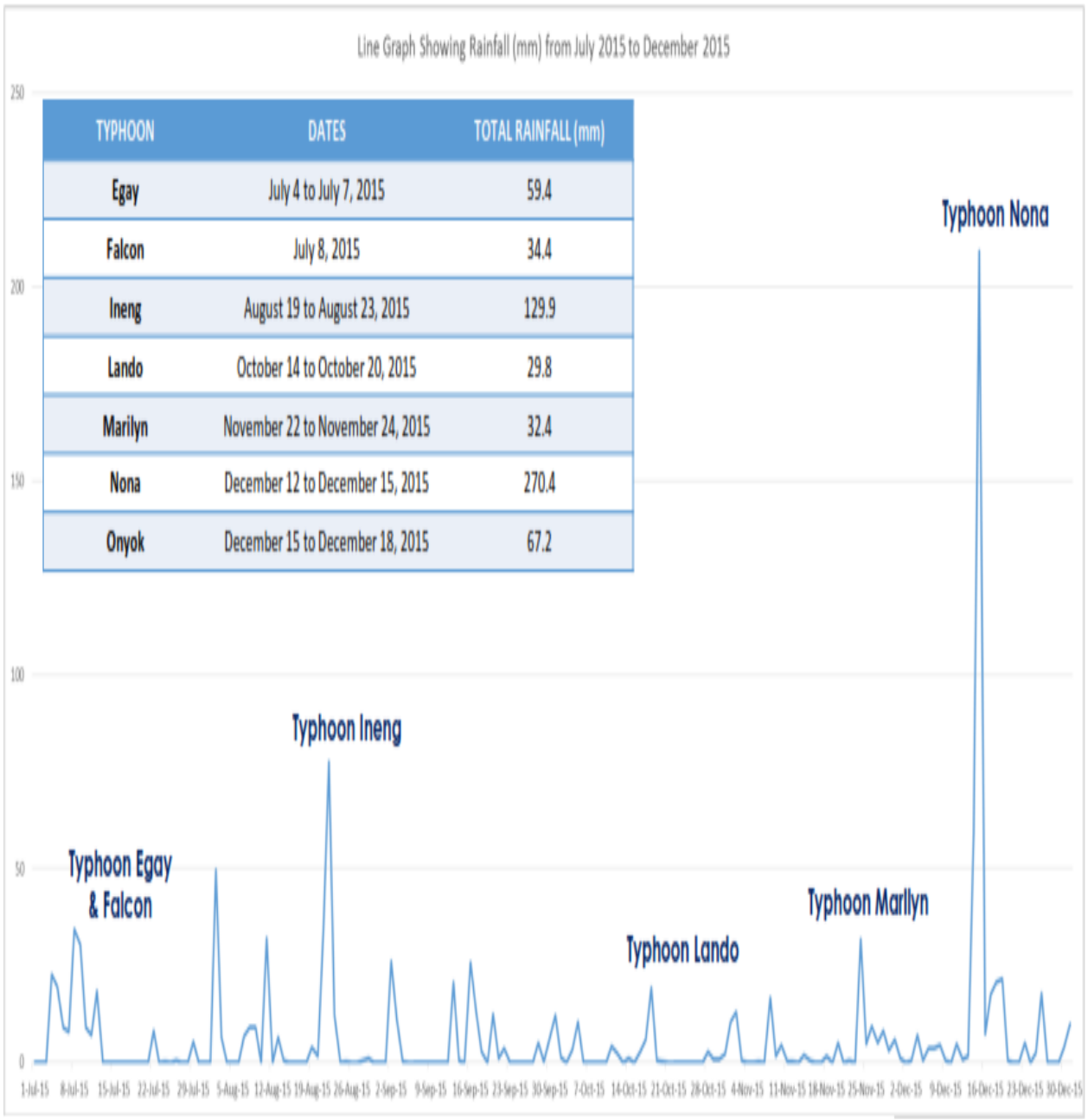
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2005	96.9	51.0	30.2	28.3	22.5	353.8	203.3	292.5	150.6	581.0	160.6	501.6	2472.3
2006	152.8	56.6	241.9	58.4	352.8	670.1	191.0	200.6	235.7	113.2	229.8	344.3	2847.2
2007	101.1	12.3	97.6	28.0	250.0	522.4	173.2	149.0	263.1	296.8	240.5	75.8	2209.8
2008	399.8	154.3	27.8	291.6	303.8	260.5	110.3	63.8	318.2	243.8	999.2	106.4	3279.5
2009	64.6	40.0	91.0	322.6	447.6	186.2	168.8	94.8	257.6	177.0	110.8	48.8	2009.8
2010	56.2	1.1	84.2	76.0	76.2	209.1	440.0	174.7	369.4	580.5	528.1	163.6	2759.1
2011	93.8	32.2	63.0	65.5	189.7	421.0	268.4	353.3	103.4	393.4	393.2	405.1	2782.0
2012	135.6	171.7	320.0	154.8	11.0	68.1	509.4	259.1	257.7	442.4	88.7	200.6	2619.1
2013	128.3	187.5	175.1	62.0	253.2	397.5	470.7	293.4	275.8	104.1	558.8	228.4	3134.8
2014	51.8	22.8	32.0	19.4	194.9	154.4	219.1	192.7	223.2	299.6	95.6	386.6	1892.1
2015	-	-	-	-	-	-	173.2	252.3	252.3	70.5	125.9	403.6	-

Source: PAGASA Station, Calapan City, Oriental Mindoro

"One of the wettest tropical cyclones on record for the province of Oriental Mindoro was Typhoon Nona, which dropped 268.6 mm of rain from December 14 to December 15, 2015. This value is very high compared to the amount of rainfall dropped by several other typhoons during the period July to December 2015 (Figure 1) and one of the highest recorded total rainfall for the month of December from 2005 to 2015 at 403.6 mm.[5] (*Table 1*)

[5] Ibid

Line Graph Data Analysis



TYPHOON	DATES	TOTAL RAINFALL (mm)
Egay	July 4 to July 7, 2015	59.4
Falcon	July 8, 2015	34.4
Ineng	August 19 to August 23, 2015	129.9
Lando	October 14 to October 20, 2015	29.8
Marilyn	November 22 to November 24, 2015	32.4
Nona	December 12 to December 15, 2015	270.4
Onyok	December 15 to December 18, 2015	67.2

Figure 1. Line graph data showing the amount of rainfall (mm) from July to December2015

5. **The island is affected by Tectonics. As excerpted from "***Master Plan and Feasibility Study of Balete River Control and Drainage Project*

Neo- Tectonic Uplift

1. The uniform shifting of the major river system at the eastern half of Mindoro Island could be a consequence of geologically recent tectonic activities which tilted depositional platform of Mindoro Island. The southern end of the Manila Trench cuts through the southern end of Mindoro Island and this geologic feature may be connected tothe presence of a thrust faulting at the southern tip of the island province. This thrust fault may have caused southern margin of the island to risethus, tipping island to the northerly direction resulting to the dipping of the northern coastline.

2. The area between Barangay Wawa, Calapan and Baco and the old town site of Baco clearly shows continues submergence. Remnants of the old Baco Town site show that the sea at this site had transgressed by as much as 200 meters. According to the study this transgression happened even prior to 1953."[6]

B. MAN-MADE ACTIVITIES

Despite the enormous rainfall volume during the onslaught of typhoon Nona last 15 December 2015 and the province's high vulnerability to flooding and landslide, other contributors which are man-made in nature cannot be set aside to whether or not it caused and/or aggravated the recent massive flooding experienced by hundreds of thousands of Mindoreños. Hence, the following man-made activities were investigated and analyzed by the Task Force' sub-groups to be able to thresh-out the real cause of the said catastrophic event.

1. HYDRO-ELECTRIC POWER PLANT

The 8-MW Lower Catuiran Hydro-Power Project (LCHPP) located at Brgy. Malvar, Naujan is a mini-hydro power project approved to operate in the province to support the need for cheap and clean source of energy in the province. Its construction which started in 2013 is facilitated by the Santa Clara International Corporation (SCIC).

[6] Task Force Iwas-Baha Team D. 2016 Assessment of Flooding event Due to typhoon Nona//DPWH Report submitted to the Task force En Banc, Provincial Capitol, Calapan City

SCIC is responsible for the construction of the hydropower plant, the tunnel, and the weir. Sta. Clara Power Corporation is in joint venture with Lucio Co, owner of Union Energy Corp., to form the Catuiran Hydropower Project.[7]

Man-made structures across Catuiran River and Mayabig River, to some extent, aggravated the effects of TyphoonNona"[8]. The causeway"[9]affected the riverflow; however, its effect is significant only at the initial stage of the rising floodwater, but effect becomes less significant as the floodwater rises."[10]

Figure 2. Causeway 2015
Source:EfrenGarcillano

The tunnel measuring a length of 3km and a width of 3.2 meters was constructed through blasting and shotcreting[11]. "This major component of the LCMHPPP might have affected the integrity of the rock structure of the site which is a critical area owing to its slope category and proximity to the central Mindoro Fault; for which reason, it is deemed necessary that

[7]Task Force Iwas-Baha Team B. 2016 Assessment of a Flooding Event Due to Typhoon Nona. Accomplishment Report Submitted to Task Force En-Banc, Provincial Capitol, Calapan City
[8] Ibid
[9]Causeway defined as a "raised road or track across low or wet ground", Merriam Webster
[10]Task Force Iwas-Baha Team B. 2016 Assessment of a Flooding Event Due toTyphoon Nona. Accomplishment Report Submitted to Task Force En-Banc, Provincial Capitol, Calapan City
[11]Shotcreting/Shotcrete is defined as the "process of placing concrete to achieve high strengths and low permeability.", http://www.everything-about-concrete.com/what-is-shotcrete.html

constant monitoring of the tunnel site must be undertaken using a deep penetrating radar."

The tunnel, where underground blasting was carried out, is located proximate the Central Mindoro Fault; hence, the inherent rock structure of the site is highly fractured. The tunnel lies below a very steep and mountainous area with critical slope. Critical slope, as defined by the above DENR Administrative Order, are areas with slope of 50% or more. This geo-physical characteristic of the site must be viewed in the light of its natural vulnerability to landslides and mass slip."[12]Despite the shotcrete to reinforce the walls of the tunnel, still "a question was raised on the effect of blasting on the geo-physical integrity and stability of the sub-surface structure in the vicinity of the tunnel."[13]

It was further revealed after lengthy discussion of Team B with the geologist of LCMHPPP that the Central Mindoro Faultis just 160 to 200 meters away from their area andthat based from the map presented by Arturo Daag of PHIVOLCS, the presence of an active Central Mindoro Fault should be treated with utmost concern (Garcellano, 2016)."[14]In addition, "the team did not find any document which describes blasting as a method in the construction of the tunnel and causeway as integral part of the project"[15].

With these findings, the question of - Why only an Initial EnvironmentalExamination Checklist was required despite the project's proximity to the Central Mindoro Fault and that the Catuiran watershed is an environmentally critical area - was thoroughly discussed with DENR-EMB.

As per Memorandum of Agreement on Streamlining of Environmental Impact System Process for Energy Projects between the Department of Environment and Natural Resources and Department of Energy, it was agreed that the project falls under "Section2.2 Energy Project to be covered by the EIS System using IEE Checklist; (d) Mini-hydro projects with rated capacity that is greater than one up to ten (10) megawatts; or with less than twenty (20) million cu.m. water impoundment."[16] (**Annex B**)

[12]Task Force Iwas-Baha Team B. 2016 Assessment of a Flooding Event Due to Typhoon Nona. Accomplishment Report Submitted to Task Force En-Banc, Provincial Capitol, Calapan City
[13] Ibid
[14] Ibid
[15] Ibid
[16] DENR-DOE MOA on Streamlining of EIS Process for Energy Projects

The assessment of the team also revealed that "it is probable that spoils from tunneling and road cuts are part of the materials which were carried along by the raging floodwater and deposited along the river bed, alluvial plain, and farm lands."[17]

With the calamitous event last 15 December 2015, LCMHPPP operated by SCIC was highly speculated by some quarters as the cause of the disaster in the province because of its alleged mining activities. While mining and tunneling operations both involve excavation and earth-moving works, mining could not be proven to exist in the area.

2. NIA DAMS

The dams and dikes of Baco-Bucayao River Irrigation System (BBRIS) were partially damaged during the onslaught of typhoon Nona on 15 December 2015. BBRIS has a total discharge of 8.040 cm and provides water irrigation to a total of 4,020 hectares. As reported by the National Irrigation Authority Calapan Office, a total of P250M is required for the complete upgrading and rehabilitation of BBRIS areas.

The adverse effect of the NIA dam is similar to the causeway which is significant at the initial and lower flood levels. Nonetheless, structures across the river should be properly managed specially during flooding events.

3. FLOOD CONTROL PROJECTS

There are seven (7) river control projects implemented by Mindoro Oriental District Engineering Office (DPWH-Calapan) that were damaged by Typhoon Nona. All structures collapsed and two (2) were found to have been totally damaged. Table 3shows the Calamity Damage Assessment Report of DPWH Calapan District.

[17]Task Force Iwas-Baha Team B.2016 Assessment of a Flooding Event Due to Typhoon Nona. Accomplishment Report Submitted to Task Force En-Banc, Provincial Capitol, Calapan City

Table 3.Calamity Damage Assessment Report of DPWH Calapan District

ACTIVITIES/ INSPEC-TION	AGENCY OFFICE	EXISTING STRUC-TURE	CONTRI-BUTING AREA	DISCHARGE	FLOW	EXTENT OF DAMAGE	LOCA-TION	COST OF DAMAGE	REQUIRED FUNDING			REMARKS
									REHAB	ADDL LENGTH	NEW STRUC-TURE	
Infra	DPWH	Burbuli River Control	170.50 km ^{2}	1,098.00|m^3/s	2.97m/s	Totally collapsed structure		10.00M	5.00M	5.00M		
Infra	DPWH	Camansihan River Control	638.00 km ^{2}	2,293.00|m^3/s	3.63m/s	Totally collapsed structure		20.00M	10.00M	5.00M		
Infra	DPWH	Mag-asawangTubig RC	420.66 km ^{2}	1,969.00|m^3/s	3.01m/s	Collapsed, tilted, settled and damaged structure		50.00M	50.0M			
Infra	DPWH	Alag River Control	282.89 km ^{2}	1,226.00|m^3/s	3.78m/s	Collapsed/ damaged structure	Abutment A & B	20.00M	10.0M	10.00M		
Infra	DPWH	Tagumpay River Control (Gabion)	280.27 km ^{2}	2,494.00|m^3/s	3.01m/s	Collapsed/ damaged structure		10.00M	10.0M			
Infra	DPWH	San Andres River Control	276.53 km ^{2}	2,351.00|m^3/s	4.03m/s	Collapsed/ damaged structure		20.00M	20.0M			
Infra	DPWH	Del Pilar River Control	268.25 km^2	2,351.00|m^3/s	4.03m/s	Collapsed/ damaged structure		10.0M	7.00M	3.00M		

These projects accommodated the volume of water coming from a total of 2,337.1 square kilometers or 233,710 hectares contributing areas. While said projects are intended to control river flow at varying discharges and flow rates, "the main waterways lack physical depth or the riverway capacity to accommodate the "phenomenal discharge" largely due to prolonged net sediment accumulation in the main river basins".

The "local flood control management" is limited only to several existing flood control structures purposely constructed to protect banks from scouring and to prevent overflow at selective river sections."[18] Furthermore, "the massive soil erosion from the upper basin caused sudden dumping of sediments down the river channel, which aggravated avulsion or sudden abandonment of a part or the whole of a river flow to a new course within the floodplain,"[19] hence making the floods completely unavoidable.

To understand flood control and management better, below are various concepts excerpted from the Master Plan and Feasibility Study of Balete River Flood Control and Drainage Project:

1) "Flood Control" is an abused expression since no one can control flood for the following reasons:

- Flood control measures are designed for a specific flood level or flood return period thus will not be effective if the design parameters used are exceeded
- Flood control designs and features are compromised to accommodate political, social and physical constraints
- Cost is always a dictating consideration and there is always no sufficient fund that can be allocated
- Flood control structures need to be properly maintained and constantly repaired to keep their level of effectiveness

2) Flood defenses were built as individual local schemes with little consideration of their impacts across the wider river catchment and their impacts on the aquatic and coastal environments.

[18] Task Force Iwas-Baha Team D. Assessment of a Flooding Event Due to Typhoon Nona//DPWH Report submitted to Task Force En Banc. Provincial Capitol Calapan City., p.1
[19] Ibid, p.1

3) Forests play a role in delaying and reducing peak flood water flows at local levels but forests cannot stop catastrophic large scale floods commonly caused by severe meteorological events. This diminishes the need for proper management and conservation of upland forests. But it does point toward the critical need for *integrated approaches in river basin management* that should look beyond simplistic forest-based solution.

4) Watershed management projects can be beneficial on a local scale given the resources poured in but they are not likely to contribute significantly to flood mitigation as a whole. They may, however, contribute to reducing sedimentation, which has adverse effects on aquatic life, reservoir life and water quality (Hamilton and Pierce 1986"[20]).

4. QUARRYING ACTIVITIES

"In the province, river systems are significant sources of quarry resources. It originated from steep sloping mountain terrain transported rapidly by the action of flowing water during torrential rain or flashfloods cascading downward to the river network. These quarry resources remain suspended beneath the river channels (bed load) and abundant in the riverbanks/floodplains, which are being mined-out either manually or mechanically by holders of commercial sand and gravel permit."[21]

The impact of sand and gravel quarrying activities was assessed and analyzed to determine if such activities contributed to the recent flooding caused by typhoon Nona in some areas of Naujan, Baco and San Teodoro. Inspection activities covered 13 barangays of Arangin, Mulawin, DelPilar and Gen. Esco, San Luis, Tigakan, San Nicolas, Apitong, Bagong-Buhay, Dulangan II, MangganganI, MangganganII and Calangatan.

The following observations and findings are summarized as follows:

1. Catuiran River's floodplain is widened, covered with silt, sand, gravel and boulders on both sides where the community areas and cultivated lands of Brgy. Arangin is located.

2. Changesinthe pattern of flow of Catuiran River.

[20] Ibid, p.2
[21] Task Force Iwas-Baha Team D. Assessment of a Flooding Event Due to Typhoon Nona//ENRO Report submitted to Task Force En Banc. Provincial Capitol Calapan City., p.3

3. “Brgy. Arangin is geographically situated adjoining the foot of Bagto watershed’s river channel (*Catuiran River*) where she can easily catch all the debris that came from its narrowriver and steep headwater of Catuiran River.”[22]

4. Remarkable change in riverflow phenomena:
    a. Dulangan River (Brgy. Paitan)
    b. Masagana-Arangin (Bangaya) River (Brgy. Masagana)
    c. Baco-Bucayao River (Brgy. San Nicolas)
    d. Panggalaan River (Brgy. San Nicolas)
    e. Carayrayan River (Brgy. Dulangan)
    f. Alag River (So. Ariguy, Brgy. Caagutayan)

5. Formation of an active bend due to sediment deposit build-up forming sand bar inside the bend. This active bend eroded the bank opposite the bar as it continuously pushes the river flow against the outside bank of the bends.
    a. Alag River (Brgy. Mangangan)
    b. Catuiran River (Brgy. Arangin)
    c. Panggalaan River (Brgy. San Nicolas) and other river networks
    d. Meandering River due to sand accumulation in the floodplain. Ex. Catuiran River (Brgy. Arangin)

6. Formation of a river delta due to settling down of the sediment out of the water in the lowest section of the flow. This river deltasplits into two or more channels (distributaries). Ex. Panggalaan River.

7. Boulders and huge rocks are the prevalent aggregates in the floodplain areas of Brgys. Paitan (adjoining Dulangan River), DulanganII (near Carayrayan River), Lantuyan and at So. Ariguy, Brgy. Calangatan, San Teodoro (near Alag River), but these cannot be found in Brgys. Del Pilar (Baco-Bucayao River), San Nicolas (Panggalaan River) and So. Tiboy, Sta. Rosa (Alag River).

8. Presence of huge rocks and boulders that settled in the community areas of barangays Arangin and Paitan (Naujan) and barangays Lantuyan and Dulangan (Baco) is because the watershed areas have a lot of sediment deposits (rocks, boulders, sand, gravel) and proximity of the community to the river channel.

[22] Ibid, p.3

9. Sand and gravel extraction projects in Naujan and Baco are located along the riverbed (riverine quarrying) of a major channel or confluence with tributary streams (Mag-asawangTubig, Baco-Bucayao, Alag, Catuiran, Dulangan, Panggalaan and Carayrayan - all draining from Baco-Bucayao and Mag-asawangTubig Watershed)

A total of 36 quarry projects were evaluated, however, "only seven (7) are found "in operation", three (3) at Brgy. San Luis covered by CP-ORM Nos. 092, 121 & 168 named to proponents LynsiellMarasigan, Bernardino Maramot and Maryann Miraples, and one (1) each at Brgys.Del Pilar, Bagong-Buhay, Apitong and San Nicolas covered by CP-ORM Nos. 181,076,071 & 118 named proponents Carlos Roman,Perla Ortega, Ramonita Santiago and EfrenLegaspi."[23]

It is worthy to note that "there had been observed significant effects in the river system by the long-term "riverine"[24] quarrying, which includes but not limited to riverbed and bank erosion/bank collapse (*Figure 2 and Figure 3* resulting to channel widening specifically in Alag River (Brgy. Mangangan II) and Panggalaan River (*Brgy.Tigkan*); significant bed lowering resulting to channel enlargement (*Alag River, Mangangan II, Baco*). The irregular occurrence of diggings/hole left behind in the river bed (*Baco-Bucayao River, San Luis*) that increase in slope thereby increase the capacity of the river to scour its bed that aggravated bank collapse (*Figure 4*)."[25]

Figure 3. Riverbed and bank erosion resulting to channel widening along Panggalaan River, Brgy.Tigkan, Naujan, Or. Mindoro.

[23] Ibid, p.5
[24]Riverine defined as "Relating to, formed by, or resembling a river including tributaries, streams, brooks, etc."- EcologyDictionary.ord
[25] Ibid, p. 5

Figure 4. River bank that collapsed resulting from river channel widening along Alag River, Mangangan II, Baco

Figure 5.The irregular occurrence of diggings/hole left behind in the river bed (Baco-Bucayao River, San Luis) increase the capacity of the river to scour its bed that aggravated bank collapse.

With the PAGASA data on rainfall volume of 209.2 mm last December 15, 2016, it is a fact that the "the torrential rains coming from the mountainous area where massive volume of rainwater was discharged all throughout the day during the might of Typhoon Nona had heightened the massive flooding. Exacerbated by rain-induced geologic hazard brought by the storm, the accumulation of sediment build-up in the river channel substantially decreases the carrying capacity of the river system resulting to overflow."[26]

5. UPSTREAM ACTIVITIES

Vegetative Condition of the Watersheds of Catuiran(Bagto) River.

"Another source of serious concern involves the forest condition of the watersheds of Catuiran (Bagto) River. As emphasized by Cacha (2016), in her report which mentioned that "the Project Manager of Sta. Clara International Construction Corporation stated that rains in the upper part of the mountains used to take 4 to 6 hours before the waters reached them when they were starting the project, but in the case of Typhoon Nona, the waters reached the site in only 2 hours". In view of the unusually shorter period of time within which the rainwaters, specifically runoff, would reach a given point, Cacha (*2016*) further stated that this could only mean that the rains are no longer permeating into the ground because the mountains are no longer capable of absorbing much of the rains."[27]

"This inability of the mountains to absorb much of the rainfall may have been caused by the wanton forest destruction inside the watershed areas of Catuiran River as shown in the aerial survey where *kaingin*, river quarrying, legal or illegal logging and charcoal making are happening."[28]

"Or it may also mean that these are manifestations of an extreme weather event caused by climate change", she added, or maybe a combination of these causal factors. Melgar (*2016*) made a corollary observation when she said that the carrying capacity of the forest areas of the Catuiran (*Bagto*) River watershed had already reached its maximum and that these areas are now very vulnerable."[29]

[26] Ibid, p. 6
[27]Task Force Iwas-Baha Team B. 2016 Assessment of a Flooding Event Due to Typhoon Nona. Accomplishment Report submitted to the Task Force en Banc, Provincial Capitol, Calapan City
[28] Ibid
[29]Ibid, p.

There may be insufficient records to calculate the number of actual incidences, reckon the factuality of events but "indications of deforestation in the upland of Baco and (*Naujan*) were corroborated by massive log transport downstream during "Typhoon Nona".[30] Moreover, mining of any scale small or big and infrastructure development are causative factors to massive soil erosion due to major land disturbance."[31]

And as concluded, "upstream activities, to some extent, aggravated the effects of Typhoon Nona"[32]. However, these activities of the upland dwellers like *kaingin*-making, excessive gathering of forest resources especially those with unique characteristics, timber poaching and gold panning which are destructive activities that compromise the balance of the ecosystem are necessary evil for the poor upland dwellers to survive. These activities are also the means of subsistence and sources of income for the upland dwellers that warrant provisions of alternative livelihood opportunities not destructive to the environment.

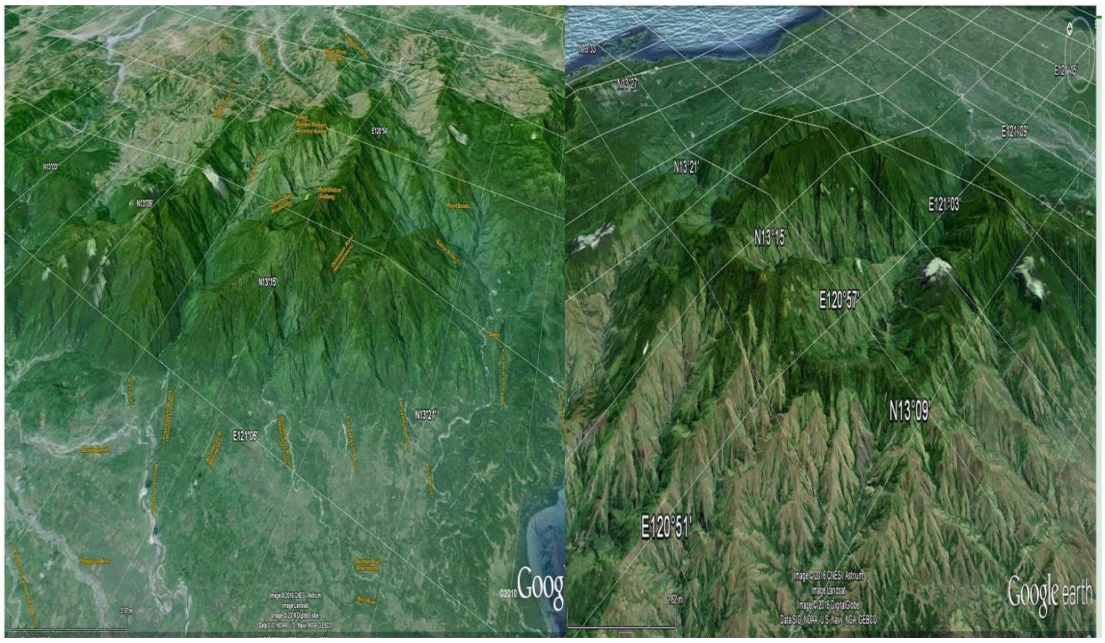


Figure 6.The Mt.Halcon watershed as viewed from the northeast looking towards the southwest. (Bottom) The Mount Halcon watershed as viewed from the southwest looking towards the northeast(*Garcellano, 2016*).
Source: Figure 8 in Team B Report

[30] Task Force Iwas-Baha Team D. 2016 Assessment of a Flooding Event Due to Typhoon Nona.//DPWH Report submitted to Task Force En Banc, Provincial Capitol, Calapan City
[31] Ibid, p. 2
[32] Ibid, slide 66

Figure 7.A portion of the Catuiran River watershed sadly dubbed by the team as "The Crying Mountain" owing to the numerous landslides resembling cascading teardrops. ***Source: Figure 9 in Team B Report***

Figure 8. Thinly vegetated watersheds, of Catuiran River, that needs immediate rehabilitation. Issues such as these can be addressed by the honest implementation of the Integrated Watershed Management Plan.

Figure 9: Aerial Survey after Typhoon Nona. Multiple landslides occurred at the upper section of the river
Source: SCIC

CONCLUSION

With the total amount of combined rainfalldepth of 268.6mm on 14-15 December 2015, not to mention the topography, geology and geomorphology of the province, numerous low-lying barangays are undeniably doomed to experience the devastating flash flooding in the municipalities of Baco, Naujan, Victoria, San Teodoro and City of Calapan.

Typhoon Nona is a meteorological event that poured an abnormal and phenomenally large amount of rainfall received by our huge river basins down to the vast floodplains in the northern part of the province. This rainfall volume flowed rapidly along the steep mountain slopeswith fragmented rock structure being near the central Mindoro Fault. Further, the tilting of Mindoro Island in the general Northeast direction because of recent tectonic activities resulted to the dipping of the northern coastline which results to the continuous submergence of certain areas.

The flashflood transported the rich fertile topsoil,trees, rocks, boulders, silt and other materials that passed through the meandering rivers and streams making them more silted with sediments. The floodwater found their way to adjacent communities where settlements, economic activities, institutional and infrastructure facilities, hence could be found causing this calamitous event during the onset of typhoon Nona.

Further, upstream activities, like *kaingin*-making, tree cutting, small-scale mining/gold-panning, whether big or small in scale,similarly posed negative effects. The unusual amount and intensity of rainfall brought by Typhoon Nona was the “final straw” that unleashed the pressures created by years and years of upstream abuses perpetrated by man.

With all the foregoing, the devastating socio-economic damages inflicted by Typhoon Nona could not be attributed to a single event but rather to a confluence of events and activities.

The abnormal large volume of precipitation brought by Nona may be attributed to climate change. The excessive run-off water from the highlands could not be totally held back by the current vegetative stand of highlands as well as in the lowlands.

Hence, the cascading waters carried with them, rocks, soild and uprooted trees that filled up natural waterways. Aside from the siltation, the illegal structures along rivers and the absence of synchronize drainage system, impeded the faster flow of water, and hence, caused massive flooding.

It is therefore incumbent upon the government to find solutions/proper interventions on how to minimize or mitigate the effects of calamitous events especially those related to climate change.

RECOMMENDATIONS

Given the submitted Team Reports, below are the general recommendations identified by the Task Force Iwas-Baha, to wit;

1. Conduct of studies related to hydrology, rainfall, geometry and morphology of major river basins of Northeast Oriental Mindoro. Flood analysis and assessment should likewise be conducted with rational and scientific approaches to come up with a comprehensive flood management program.

2. Implementation of engineering interventions like rechanneling, dredging, construction of flood protection dikes and other infrastructure for a long-term flooding solution.

3. Strengthening of LGU mechanisms in the processing and approval of projects and programs. Capacities of LGUs should be continuously enhanced relative to EIA process and other environmental laws. Multi-partite monitoring team activities should be actively participated by concerned public and private agencies/organizations.

4. Development of integrated approaches in watershed management practices and river basin management to maximize the results of upland/forests and lowland/floodplains protection and management.

5. Formulation of local policies that promote a sustained effort to monitor flood hazards considering land use planning measures, building code and natural waterways restoration, maintenance and protection.A legislative arrangement/agreement with Occidental Mindoro on conservation, protection, and management of watershed, wildlife and water resources towards a one-island planning for water, food and power sufficiency.

6. Establishment of a strengthened and long-term monitoring program for quarrying activities in strict consideration of efficientand effective enforcement of the moratorium on small-scale mining law. Identifying quarrying as an imperative component of an integrated flood control management plan may be explored.

7. Flood preparedness and flood emergency measures should be carefully planned and efficiently and effectively implemented with the goal of improving the coping mechanisms of the affected stakeholders.

8. Provision of alternative livelihood opportunities should be completely provided to those areas where there is aggressive enforcement of ENR laws.

9. Partnership with educational institutions like the MINSCAT in developing programs and curricula on water science/engineering, forestry and ecosystem managementto address the need for graduates and experts along the fields mentioned above.

   List of specific recommendations by each team or concerned agency is attached as **Annex C**.

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