NARBO Network of Asian River Basin Organizations

Integrated Flood and Sediment Management in Cagayan River Basin towards Development of Action Framework



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> Presented at the 1st NARBO Webinar Challenges of "New Normal" river basin management: *The pandemic is not over yet, the flood control must go on* Date: 17th December, 2021 via on-line platform

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# **01** Rationale

A brief report of damages brought by typhoon Ulysses and including statement of the problem and the relevance of the study

# **02** Objectives

Present updates, on-going R&D initiatives and future works

# **03** Methods and Results

Specific data input, procedures and techniques applied and discussion of corresponding results for each method

# **04** Policy Implications

Policy Pathways in the context of Integrated Management and Development of the Cagayan River Basin and other ASEAN Basins.

## **05** Partnerships and Capacity Building

On-going partnership and capacity development support



# **Objectives** of this Paper

This paper presents an action framework for an integrated flood and sediment management in a river basin context with the following components as follows:

- 1) Phil. River Basin Management, programs issues and problems focus on flood and sedimentation;
- 2) R&D Interventions and some results;
- 3) Institutional partnership and capacity building;
- 4) Some policy pathways and action agenda.



### **Priority River Basins in the Philippines**

# The Cagayan River Basin

- Basin Area is 2.7 million hectares, 600,000 arable land;
- Consistent top corn and rice producer in the country producing more than 25% of national production;
- Largest Groundnut and Mungbean production areas;
- Has inland lakes and reservoir of about 10,000 hectares for aquaculture production;
- Other Industrial Crops: Sugar cane, cassava with biggest bio-ethanol plant;
- Largest hydropower plant in the country
- Host to largest natural park in the country
- Thematic management areas: watershed, water resources, CCA-DRRM and aquatic and coastal Resources)



# Challenges of Cagayan River basin

- Severely degraded catchment of Cagayan river basin due to high rainfall, steep slopes, land slides, human activities has produced high sediment yield in the middle and downstream reaches;
- Such high sediment inflow resulted in siltation of reservoirs, aggraded riverbed, variation of morphology and bank erosion; caused adverse impacts on local people in terms of business disruption and human safety due to flooding;
- Limited soft and hard measures that have been implemented in the catchment, reservoir sedimentation, riverbank, and coastal reaches



## Philippines and Cagayan Valley-A Disaster Prone Region due to Climate Change

- The Philippines is ranked **3rd in the 2018 World Risk Index** of most disaster-prone countries in the world;
- On the last quarter of 2020, five (5) typhoons continuously wet the Cagayan valley for over a month. And the sixth (6th) typhoon (named Ulysses) brought devastating floods all over the valley

## Flood impacts

Typhoon Ulysses in the Region (CNN, Dec. 2020)
At least 2.1 billion losses in agriculture
At least 2.3 billion infrastructure damage
27 fatalities











# Flood and sediment disasters in Cagayan River Basin due to Vamco/Ulysses lashed Luzon Island on 11-12 Nov. 2020



### Problems of Dams and Reservoirs during Extreme Weather Events https://newsinfo.inquirer.net/1361587/nia-mullsrevising-dam-protocols-to-prevent-futureflooding

SECTIONS Sunday, September 19, 2021
 INQUIRER.NET
 TODAY'S PAPER
 NATION
 NIA mulls revising dam protocols to prevent future flooding

By: Krissy Aguilar - Reporter / @KAguilarINQ INQUIRER.net / 09:57 AM November 17, 2020



MANILA, Philippines — Following the massive flooding in Cagayan, the National Irrigation Administration (NIA) said Tuesday it will revisit the protocols on releasing water in dams to prevent another massive flooding in low lying areas from happening again in the future.

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The NIA was heavily criticized by several groups and even Cagayan governor Manuel Mamba for opening Magat Dam's gates only at the height of Typhoon Ulysses. But NIA insisted that it followed proper protocols in releasing water from Magat Dam's reservoir.



NEWSINFO



EDITORS' PICK



strike killed 10 civilians including children, in 'tragic mistake' TECHNOLOGY

US says Kabul drone

MOST READ

TECHNOLOGY Welcome the next imagery master with vi X70 co-engineered with Zeiss CAGAYAN VALLEY Flood Mitigation and Rehabilitation Program



### Problems of Dams and Reservoirs during Extreme Weather Events

Cagayan Valley Flood Mitigation and Rehabilitation Program

# 6.3.4 Review/ update dam protocols in flood water management

While the Magat Dam offers opportunities for economic growth in the region, the releases from its spillway in cases of continuous heavy rains can cause flooding downstream, if this shall not be strictly regulated. There is therefore a need to revisit the protocols on releasing water in dams to prevent the repeat of widespread flooding, mitigate the possible loss of human lives and damage to crops and properties. Many of these protocols on dam operations could be reviewed and updated such as assessing the latest capacity of dams and the conditions of the facilities which may have changed over the years.

### "Integrated Flood and Water Resources Management in the ASEAN Basins for Sustainable Development Project" Land use Reforestation

There is a need for an integrated flood and water resources management approach on the river basin scale.

We aim at developing new innovative approaches and techniques for integrated flood, sediment and water resources management for sustainable development in major river basins

Our R&D Intervention



### "Integrated Flood and Water Resources Management in the ASEAN Basins for Sustainable Development": A tri-lateral collaboration



Rainfall-Runoff-Inundation(RRI) Model application for Typhoon Vamco: A Tool in Forecasting Flood Inundations in River Basin and Dam Pre-Discharge Guidelines during Extreme Rainfall Events



# **Flood Inundation Maps using RRI Model**

Maximum Simulated Flood Inundation Maps

Accuracy of the RRI model in estimating river water levels was up to 88% and estimating inflow up to 87%



# Flood Inundation and Post-Flood Survey(Ulysses)



Figure 27. Brgy. Linao East Flood Map

## **Post-Flood Survey**



### **Post Flood Survey**

Field surveys thru questionnaires and field investigations were conducted at different barangays in the Cagayan river basin randomly.

#### Sampling

84 locations and households were surveyed for highest actual flood depth and flood duration. The data was used to determine threshold value of flood extent using GEE. Those with a zero value indicate that no flooding happened in that specific location. survey.

# **Participatory Validation Survey**



Representatives from barangays identifies the extent and duration time in their area during Typhoon Ulysses



Georeferenced data of flood maps from and sampling points for validation of flood extent using GGE (right)

Validation of flood extent using participatory approach reveals 95% accuracy.

RRI Simulated River Discharge in Cagayan River Basin during Typhoon Ulysses - animation (Can be done on extent and depth of inundation)

- Forecast Rainfall Runoff Inundation(RRI) model will be use to simulate and quantify runoff per sub basin and inundation extent within Cagayan River Basin;
- RRI model result can be used for early flood warning and advisory, basis for plans, policy and decision making.



# Institutional collaboration for the development and Adoption of the Dam Operations and

# **Flood Advisory Improvements Tool**



Partnership with Japan Weather Association (JWA) for the use of ensemble technique coupled to RRI with a test run result.



started to increase, but still begun raine are not pr

Republic of the Philippines CAGAYAN VALLEY DISASTER RISK REDUCTION AND MANAGEMENT COUNCIL

Dalan na Pappabalo cor, Dalan na Pavvunulun, Regional Government Center, Carig Sur, Tuguegarao City Tel/Fax (078) 304-1630/1631 / ccdrc2@pmail.com

Resolution No. \_\_\_ (s.2021)

"APPROVING AND ENDORSING THE PROJECT PROPOSAL OF ISABELA STATE UNIVERSITY ENTITLED RAINFALL-RUNOFF FORECASTING USING MULTIPLE ENSEMBLE TECHNIQUE FOR DAM OPERATIONS AND FLOOD ADVISORY IMPROVEMENTS IN THE CAGAYAN RIVER BASIN TO THE NATIONAL DRRM COUNCIL (NDRRMC) FOR FUNDING"

WHEREAS, Cagayan Valley experiences various hydrometeorological hazards every year due to its geographical location;

WHEREAS, in 2020, six typhoons visited the region during the last two quarters which brought heavy to torrential rains for almost a month;

WHEREAS, Typhoon Ulysses which hit the region on November 10, 2020 brought massive and widespread flooding in Tuguegarao City and other municipalities in the northeastern and western part of Cagayan and northern part of Isabela;

WHEREAS, the flooding brought about a total of PHP 5,043,771,223.64 estimated cost of damages in agriculture and infrastructure;

WHEREAS, the massive flooding also brought forty-five (45) casualties (30 deaths and 15 injured);

WHEREAS, aside from the fully-saturated river basins due to continuous heavy to torrential rains, one factor being looked into as cause of massive flooding is the large volume of water from the Magat Dam;

WHEREAS, as an effect of the flooding brought about by Typhoon Ulysses, the National DRRM Council signed on February 19, 2021 NDRRMC Memorandum no. 02 s, 2021 Creating the National and Regional Committee on Dam Safety";

WHEREAS, at the regional level, Memorandum Number 29 dated May 5, 2021 was also signed creating the Regional Committee on Dam Safety (RCODS);

WHEREAS, Isabela State University, as a member of the RCODS, proposed a project that would help prevent and reduce flood damage downstream through rainfallrun-off forecasting, improvement of dam discharge operations, and subsequently enhancing flood advisory services;



# **Sedimentation in Magat Reservoir:** Longitudinal Profile of Sediment Deposition along Magat Reservoir Reservoir



### Losing storage capacity due to sedimentation in Magat dam



# 2021 Initial Bathymetric Survey Results

#### Total Volume Deposited in the Main Reservoir.

	Accumulated Sediment (MCM)							
Volume	1982-2016	1982-2021	2016-2021					
Volume of Sediments in the Live Storage ('El. 147 m to El. 193 m)	91.10	131.21	40.12					
Volume of Sediments in the Dead Storage ('El. 147 m and below)	72.19	97.41	25.23					
Total Volume of Sediments Deposited ('Up to El. 193 m)	163.28	228.63	65.34					



#### Storage Capacity of the Main Reservoir.

Storage	1982- 2016	1982- 2021	Percentage Decreased on	Percentage		
Capacity	(MCM)	(MCM)	the Storage Capacity (2016-2021)	Capacity		
Remaining Live Storage Capacity	587.28	547.17	6.83%	58.65%		
Remaining Dead Storage Capacity	49.17	30.52	37.93%	20.76%		
Total Remaining Storage Capacity	636.45	577.68	9.23%	53.49%		

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### **NIA-MARIIS** EXECOM MEETING: 26 APRIL 2021 – Approved Immediate Measures

Scheme 1: Dredging/Desilting will be conducted after procurement of dredging machine (by Management)

Particular (Activities Allocation (D)			2021								2022	2023	2024	2025	REMARKS	
		Apr	May	Jun	Jul	Aug Sep	o Oct	Nov	Dec							
<sup>1</sup> Bathymetric Survey <sup>*</sup>																conducted by MARIIS-DRD annually and/or twice a year
· · ·				In (	CO	lat	or	atior	<u>1 W</u>	<u>'Ith</u>	ISI	J-DOST-	KU Proje	ect		during flood event
2 Magat Dam Sedimentation Study		5,000,000.00											_			Undertake sediment sampling of the reservoir deposits
(Borehole Sampling)*				ln (	col	lat	or	atior	<mark>ı</mark> w	ith	ISI	J-DOST-	KU Proi	ect		to determine specific weights and size distribution.
3 Establishment of Soil Erosion and		5,000,000.00											· ·			Installation/construction of soil erosion plots, turbidity
Sediment Transport Monitoring																meter and depth integrating sediment sample collection
Surtern *				in (	COI	lar	por	atior	1 W	ητη	151	J-DOST-	KU-Proj	ect		network in the Area to be used in the calibration and
System													_			validation of sediment modelling using Soil and Water
																Assessment Tool (SWAT)
4 Procurement of Dredging Machine/ Installation and Training	300,0	00,000.00														
4.1 Operation and Maintenance																
4.1.a Spareparts and other Support equipment	60,0	00,000.00														Spare parts purchase every 2 years (including incidental cost)
4.1.b Fuel and Oil	6,5	00,000.00	/year													
4.1.c Personnel	2,50	00,000.00	/year													1 Supervising Engineer A, 1 Senior Engineer A, 2 instrument Technician A, 6 Plant Mechanic C, 6 Utility Worker
5 Dredging/Desilting of Magat Reservoir																Capacity - 540 cu.m/hour; 777,600 cu.m/year @6hrs/day, 5days per week
6 Dredging/ Desiltingof MARIS Reservoir	40,0	00,000.00														
7 Procurement of Survey Instrument (Multi Beam Echo Sounder and Accessories)	15,0	00,000.00														
8 Procurement of Survey Instrument (Acoustic Doppler Current Profiler)	3,5	00,000.00														
Total Allocation	524,500	,000.00		10,000,000.00						,000,0	00.00	384,000,000.00	12,500,000.00	109,000,000.00	<u>9,000,000.00</u>	

NOTE: \* - must be undertaken FIRST prior to Dredging/Desilting Activities

### Long Term Measures: Deployment of Technologies on Watershed Mgt.



Agroforestry and Conservation Farming



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# **Policy Implications**

In the context of the comprehensive and integrated management and development of the Cagayan River Basin the following policy pathways are imperatives:

### Policy Pathway 1 – River Basin Organization Empowerment

Strengthening of the Cagayan River Basin Management Council (CRBMC) particularly in the crafting and adoption of its own Vision, Mission, Goals, Objectives, Scope, Programs, and Projects as well as its legal basis (i.e., legislate the creation of CRBMC)

# **Policy Implications**

In the context of the comprehensive and integrated management and development of the Cagayan River Basin the following policy pathways are imperatives:

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### Policy Pathway 2 – Partnership and Collaboration

Engagement of individual Local Government Units-members and establish active partnership with the LGUs so as to coordinate, complement, and reinforce their respective thrusts and aspirations and contribute to the over-all "whole of the river basin" health and resilience.

# **Policy Implications**

In the context of the comprehensive and integrated management and development of the Cagayan River Basin the following policy pathways are imperatives:

### Policy Pathway 3 – Program Implementation

Pursue and implement recommendations from various master plans and studies that have been conducted, including, but not limited to: 2020 RDC-2 Cagayan Valley Flood Mitigation and Rehabilitation Program; 1987 JICA Study; 2002 JICA Feasibility Study; 2005 RDC-2 Riverine Zone Development Framework; 2006 Cagayan Valley Flood Mitigation; 2012 and 2017 Cagayan River Basin Management and Development Master Plans



BUND

SU-KU- DOST-NIA, June 13

GRATED WATER RESOURCE ENT (IWRM) IN RIVER BASINS STAINABLE DEVELOPMENT

<sup>th</sup> NARBO

Newsletter

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2 International Workshops Conducted, Feb. 2019, Nov. 2019

ISU-NARBO, Oct. 8, 2018 at NARBO HQ

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### Fellowship Grants to Graduate Students

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### FOR APPLICATION

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The Integrated Flood and Water Resources Management (IFWARM) is announcing the initial offering of its fellowship program to interested graduate students. The fellowship program is open to qualified graduate students in the areas of engineering, social, economic and biophysical sciences and policy development related to flood, sediment and watershed management in a river basin scale in support to the conduct of their thesis work.

The program provides an exciting opportunity for individuals and young scientists to take part in the various studies and monitoring activities in the whole of Cagayan River Basin. Fellows will have the chance to work and interact with teams of experts from a range of disciplines and will work as a part of these teams. Through their involvement and attendance in project trainings, workshops, and meetings, fellows will gain valuable knowledge and experience in diverse facets of river basin management and ecosystem conservation. Furthermore, fellows will have opportunities for hands-on training in the operation and maintenance of various field monitoring instruments and in the application of models and other decision support tools. Fellows will also have the opportunity to network with a wide range of experts from Japanese and Vietnam Universities, which could be of great value to future careers.

### **IFWARM** FELLOWSHI PROGRAM FOR CAGAYAN

# **RIVER BASI**

For inquiries conta

College of Engineer Isabela State Univer Echague, Isa c/o Dr. Lanie A. A Mobile: 0917536.2 Email: Ihan\_1023@vahoo.com

#### Key Implementing Guidelines of the IFWARM Fellowship Program

- Fellows should be enrolled in relevant graduate degree program in any of the following: engineering, social, economic and biophysical sciences:
- 2. Fellows shall participate and be involved in at least one of the studies being conducted by the project or conduct his/her own research related in one or more of the studies being conducted by the project (please refer to the list of project studies);
- 3. Fellows are required to work with the project researchers as chair and members of their thesis panel:
- The time commitment includes participation in meetings, workshops trainings, fieldwork, data collection, data analysis, and other related oject activities:
- 5 Fellows shall receive monthly stinends amounting to Php 2,000-3,000 during the approved period of fellowship. Further, all expenses incidenta to fellows with project activities will be shouldered by the program:
- 6. All outputs, including publications of journal articles, produced by any fellow in collaboration with any project researcher shall be considered outputs of the project. The credits for the outputs shall be on the fellow and collaborating researchers.
- 7. Fellows shall properly acknowledge the project and DOST-PGIEERD as follows-

"This study was made possible with the generous support of the "Integrated Flood and Water Resources Management in ASEAN Basins for Sustainable Development" and the Philippine Council for Industry. Energy and Emerging Technologies Research and Development (PCIEEBD) "

- 8 The duration and other terms of the fellowship program will be mutually agreed upon by the candidate fellow and the IFWARM project management:
- 9. All agreement provisions shall be formalized through a Memorandum of Agreement between the fellow and the IFWARM project leader: 10. A certificate of completion shall be awarded to successful fellows at the
- end of the fellowship period.

#### **Oualifications of IFWARM Fellows:**

- Must demonstrate a keen interest and willingness to do research:
- 2 Preferably have excellent, writing skills in English and Filipino: Have good research and analytical skills in dealing with complex issues
- well as the ability to meet deadlines:
- Have the ability to interact with people from other disciplines and work effectively and efficiently as a team member.

### **IFWARM** FELLOWSHIP PROGRAM FOR CAGAYAN

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#### List of Project Studies: · Effects of climate and land-use changes

- on water resource · Modeling and technology development studies for climate. hydrology sedimentation and flood · Assessment of floods, morphological changes and sustainable agriculture development · Identification of solutions addressing
- integrated river basin management for ster risk reduction and resilience · Cross-cutting studies i.e. development communication. gender and development, socio-economic studies. institutional development, capacity building and training needs assessment



Integrated Flood and Water Resources Management in ASEAN Basins for Sustainable Development (IFWARM) Fellowship Program and Isabela State University

grant this

#### NOTICE OF AWARD to CYRIL A. CABUYADAO

of the Isabela State University - Echague to receive the IFWARM Research Fellowship Grant for Graduate Students under the Integrated Flood and Water Resources Management in ASEAN Basins for Sustainable Development Project to pursue the study on the "Flood Damage Assessment: Survey and Analysis of Flooding Caused by Typhoon Ulysses in Isabela" for a duration of six (6) months commencing on March 1, 2021.

As IFWARM Research fellow, Cyril A. Cabuyadao shall be entitled to the privileges stipulated in the IFWARM Fellowship Program Contract.

#### Civen this 17th of June, 2021

Isabela State University, Central Graduate School,

Echague, Isabela

RICMAR P. AOUINO, PhD President, ISU

The 2nd Virtual International Graduate Research Colloquium on River Basin Management Meeting - May 29, 2021

Attendees: Kyoto University (Japan), Japan Water Agency (JWA), The Ministry of Land, Infrastructure, Transport and Tourism (MLIT), University of Da Nang (Vietnam), Thuy-Loi University (Vietnam), Bicol University (BU), Ifugao State University (IFSU), Department of Agriculture (DA), NIA-MARIIS, DOST-PAGASA, Office of Civil Defense (OCDRO II) and ISU



#### Agenda

1. Report updates of ISU team

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- 2. Climate and hydrologic modelling for Magat watershed
- 3. Forecasting inflow in Magat Dam and Flood inundations in Cagayan River basin under extreme rainfall events using Rainfall Runoff Inundation (RRI) Model
- 4. The Vulnerability of critical infrastructure in Tuguegarao

### WP4: Japan-ASEAN Science, Technology and Innovation Platform on Education and Research Network for Disaster and Climate Resilience

### Facilitating sustainable development in ASEAN through education, research and field practice-



### INTEGRATED FLOOD AND WATER RESOURCES MANAGEMENT IN THE ASEAN BASINS FOR SUSTAINABLE DEVELOPMENT



