Strengthening Resilience of Flood and Drought Management against Climate Change

- Pilot Project at the Solo River -

February 26, 2020

ICHARM

Goal

Make society resilient and Minimize Damage of Water Related Disasters

Objective of the Pilot Project

Establish Climate Change Adaptation Plan on the Solo River

Activities

1) Data integration
2) Climate change impact assessment
3) Climate change adaptation - Flood management
4) Climate change adaptation - Agricultural productivity improvement

IFI Platform activities in Indonesia

Core member of the Platform

• Ministry of Public Works and Housing (PUPR)	River Management
• National Disaster Management Authority (BNPB)	Disaster Information
• Meteorological, Climatological, and Geophysical Agency (BMKG)	Meteorological Observation
• Ministry of Environment and Forestry (KHLK)	River Basin Management (Forest)
• Ministry of Agriculture (MoA)	Irrigation, Food security

2018.1.15	Consultation for establishing the Platform
2018.8.3	Consultation for establishing the Platform
2018.10.24-26	11th GEOSS AP Symposium in Kyoto
2018.12.4-6	Consultation for establishing the Platform and Field Survey
2019.1.28	Consultation for establishing the Platform(Proposal of adding KLHK)
2019.3.12	Consultation for establishing the Platform
2019.4.9-13	Preparatory meeting on the Platform and Field Survey
2019.8.5	Meeting on the Platform (Proposal of adding MoA)
2019.11.2-4	12th GEOSS AP Symposium in Canberra
2019.11.19-20	Consultation of the Platform meeting
2020.1.21-24	Consultation of the Climate Change Orientation

Participants of the Platform meeting

Report to PUPR Minister Dr. Basuki about the Platform meeting

Structure of Climate Change Adaptation Planning

Central Government

Core Partners

BMKG
(Climatology)

BNPB
(Disaster Risk Reduction)

PUPR
(River Basin Management)

Core Management Group

KLHK
(Environment, Land Management)

MoA
(Water User)

Partners

- BAPPENAS
- LIPI
  Indonesian Institute of Sciences
- .....
- University

Support Local Agencies for developing Climate Change Adaptation Plan

Two-layer Multi-stakeholder Engagement

Develop Climate Change Adaptation Plan in River Basin

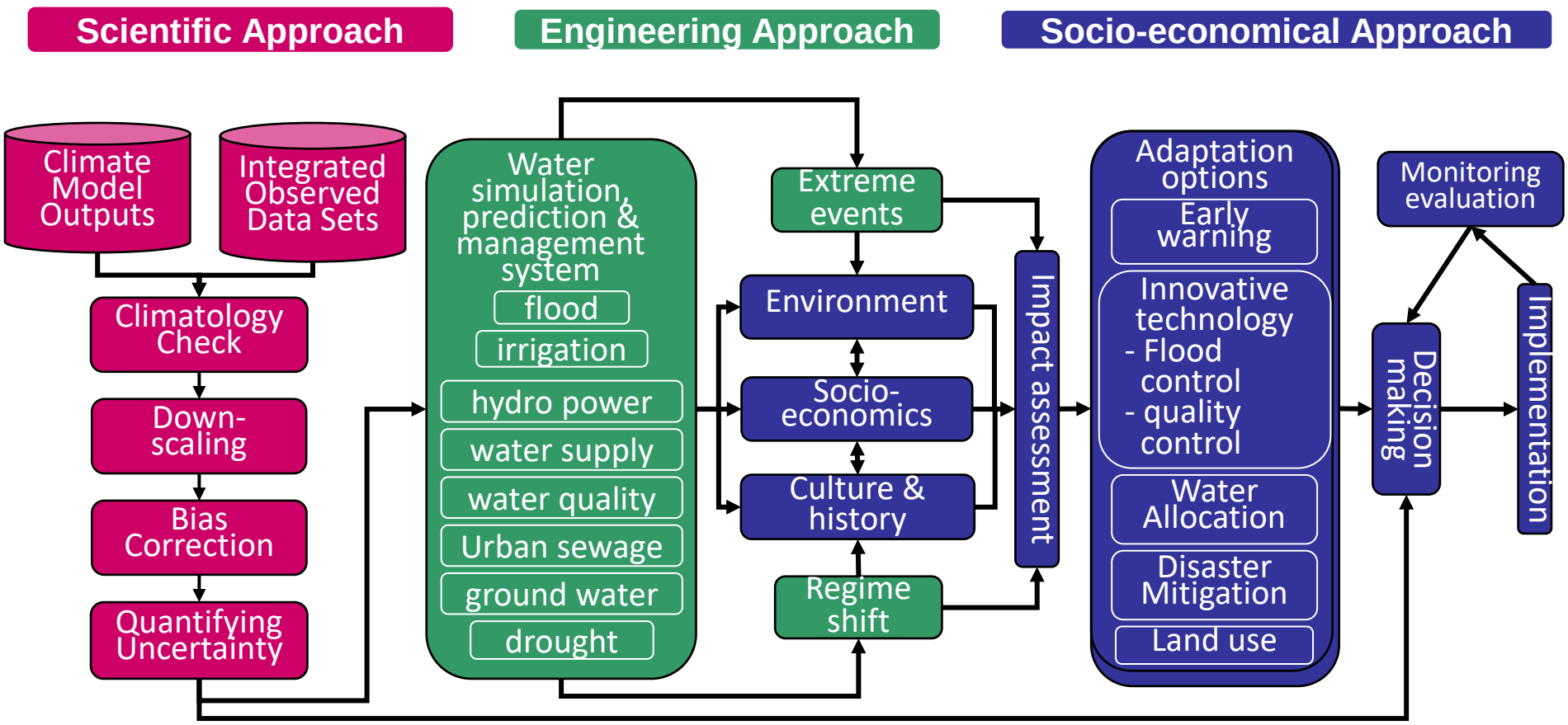
Solo River Basin

- BBWS
- BPBD
- Watershed Unit
- Balitek DAS
  Research and Development Center for Watershed Management Technology
- Local Government
- TKPSDA

Water Resources Management Coordination Team
Tim Koordinasi Pengelolaan Sumber Daya Air

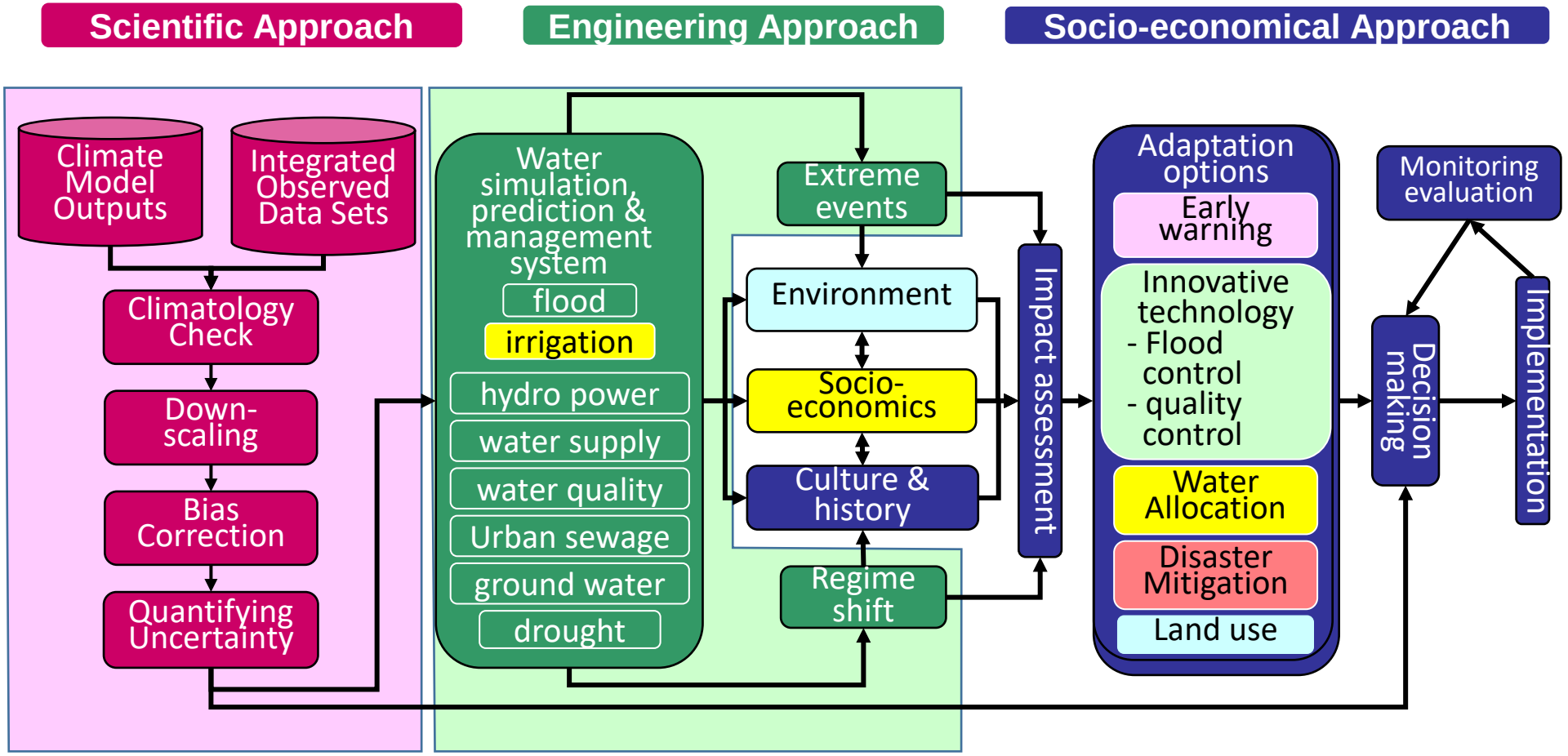
End to End Approach for Climate Change Adaptation

Expected roles of core partner organizations

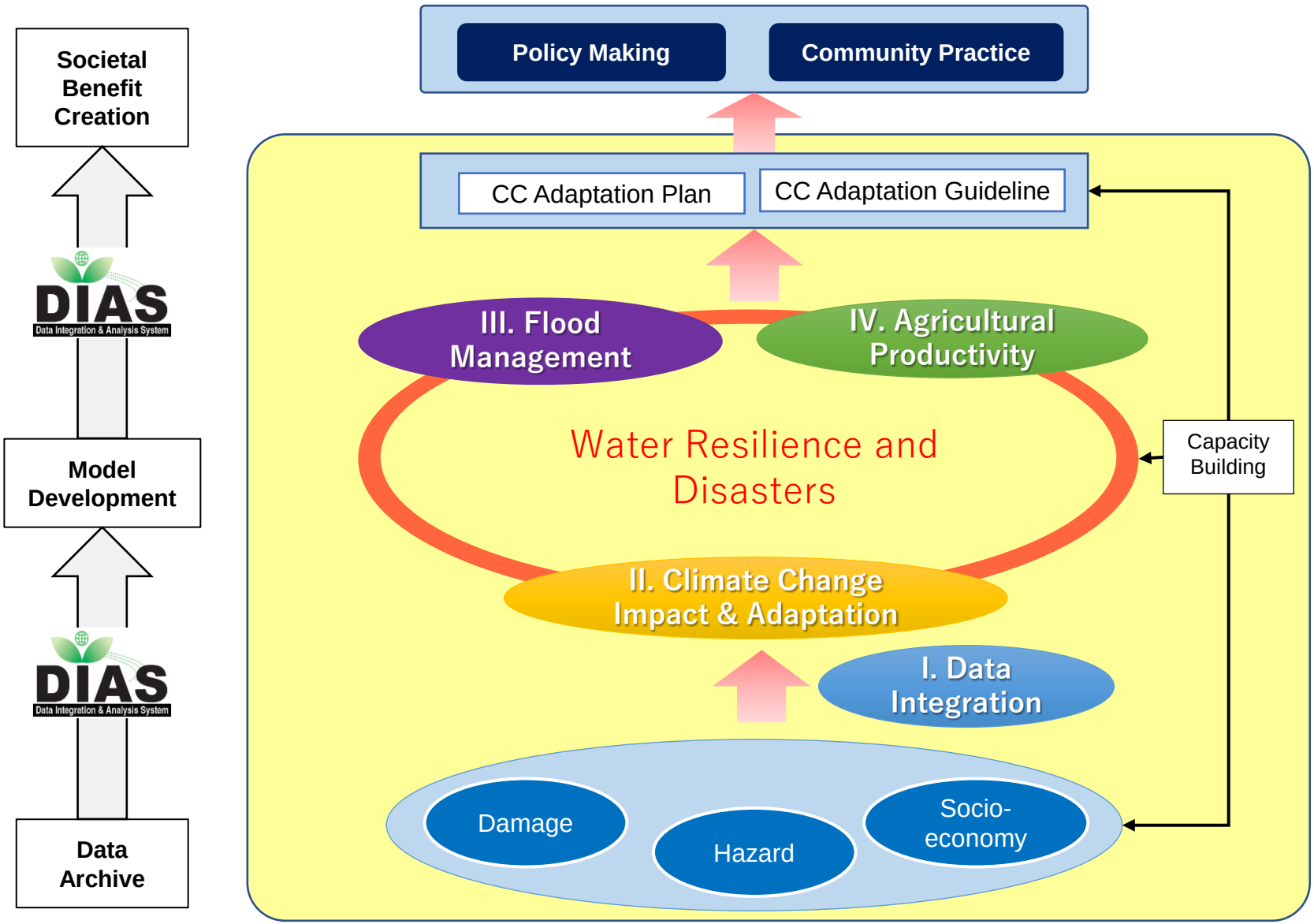


End to End Approach for Climate Change Adaptation

Expected roles of core partner organizations



Framework of IFI Platform



Necessary Data for Assessment of Climate Change Impact

- Identify responsible organizations for data sharing
- Collect and archive data sets

Damage

Data	Data Source
Casualties & missing person	DesInventar Database
Num. of affected people	
Agricultural damage	
Housing damage	
Damage to critical infrastructure	
Direct economic loss other than agricultural loss	

Hazard

Data	Data Source
DTM	Local Agencies, etc.
Runoff Vulnerability Map ✓ Topographic configuration ✓ Soil Properties ✓ Vegetation density ✓ Depression storage	
Inundation depth	
Rainfall	
Hydromet	
River flow	
River cross section	
Tidal level	

Socio-economic

Data	Data Source
Land use	Province Census Data, etc.
Agriculture	
Population	
Infrastructure	
Industry	
Commerce	
Drainage facility	
Information	
Regional GDP	
Tax revenue	
Land price	

Data Specification

	Tidal level	NAMRIA	Time series (Point) ☐ Digital ☐ Paper	Name(s) or Total number: Period: Temporal Resolution: Elements:
	Inundation depth (LiDAR)	UP Diliman	Map	Year: **2016** Area: **Davao City** Spatial Resolution: **1/500000** Elements: **Flood hazard map (100 year return period, 1.5m depth)**
	Inundation depth (interview)	PAGASA	Map/Point ☐ Digital ☐ Paper	Year: Area: Spatial Resolution: Elements:
	Dam operation	NIA	Time series (Point) ☐ Digital ☐ Paper	Name(s) or Total number: Period: Temporal Resolution: Elements:
Damage	Casualties & missing person	OCD	Statistics ☐ Digital ☐ Paper	Period: **2012, 2013, 2014, 2015, 2016, 2017 (event-base)** Area: **Region XI** Scale: ☐ Nation ☐ Region ☐ Province ☐ City ☐ Municipality ☐ Barangay Elements: **Dead, Injured, Missing**
	Affected people	OCD	Statistics ☑ Digital ☐ Paper	Period: **2012, 2013, 2014, 2015, 2016, 2017 (event-base)** Area: **Region XI** Scale: ☑ Nation ☑ Region ☑ Province ☑ City ☑ Municipality ☑ Barangay Elements: **Families, Persons**
	Agricultural damage	DA	Statistics ☑ Digital ☐ Paper	Period: **2010, 2011, 2012, 2014, 2015, 2016** Area: **Region XI** Scale: ☑ Nation ☑ Region ☑ Province ☑ City ☐ Municipality ☐ Barangay Elements: **Affected area, Production loss**
	Housing damage	OCD	Statistics ☑ Digital ☐ Paper	Period: **2012, 2013, 2014, 2015, 2016, 2017 (event-base)** Area: **Region XI** Scale: ☑ Nation ☑ Region ☑ Province ☑ City ☑ Municipality ☑ Barangay Elements: **Number of damage houses**
	Critical infrastructure damage	DPWH LGU	Statistics ☑ Digital ☐ Paper	Period: **2012, 2013, 2014, 2015, 2016, 2017 (event-base)** Area: **Region XI** Scale: ☑ Nation ☑ Region ☑ Province ☑ City ☑ Municipality ☑ Barangay Elements: **Estimated cost of infrastructure**
	Economic damage	LGU NEDA	Statistics ☑ Digital ☐ Paper	Period: **2012, 2013, 2014, 2015, 2016, 2017 (event-base)** Area: **Region XI** Scale: ☑ Nation ☑ Region ☑ Province ☑ City ☑ Municipality ☑ Barangay Elements: **Estimated cost of infrastructure and agriculture**

Data from Solo river basin (1)

Damage data

(source: DesInventar Indonesia, 1974-, open)

Example: December 2007 flood in Solo river basin

- Deaths (111), Injured (91), Missing (2)
- Directly affected people= Evacuated (52,402), Indirectly affected people (91)
- Crops (31,865 ha), Irrigation facilities etc.(48)
- Houses heavily damaged (1,705), Houses slightly damaged (11,415), Houses inundated (60,238)
- Education centers(174), Hospitals (34), Pools (1,513), Buildings (1), Worship facilities (403), Fasum (73), Road (59 m?), Forest (1,130 ha)

Example: January 2007 drought in Solo river basin

- Crops damaged (2,191 ha)

Additional Data needed

- Damage amount (Rupiah) by district or village

Data from Solo river basin (2)

Hazard data

- Annual average rainfall (mm) (BBWS, 94 stations)
- River discharge (m3/s) (BBWS, 1990-2009)
- Dam reservoir operation (BBWS)
- River water balance (BBWS)
- Digital elevation model (USGS, open)
- Soil type (FAO, open)
- Land use (USGS, open)
- Vegetation = Leaf area index (NASA, open)
- Air temperature, Humidity, Wind speed, Radiation, and Surface pressure (JMA, open)

Additional Data needed

- Recent river discharge (2010-)

Data from Solo river basin (3)

Socio-economic data by regency/municipality (or by province)

(source: Central Jawa Province Census, 2004-, open, East Jawa Province Census, 2003-, open)

- Population
- Paddy area (ha)
- Rice productivity (ton/ha)
- Clean water supply (m3)
- Regional GDP by industry by province
- Regional GDP
- Labor force
- Labor force by industry by province
- Local tax by province
- Domestic capital investment for project
- Foreign capital investment for project
- Investment by industry by province

Additional Data needed

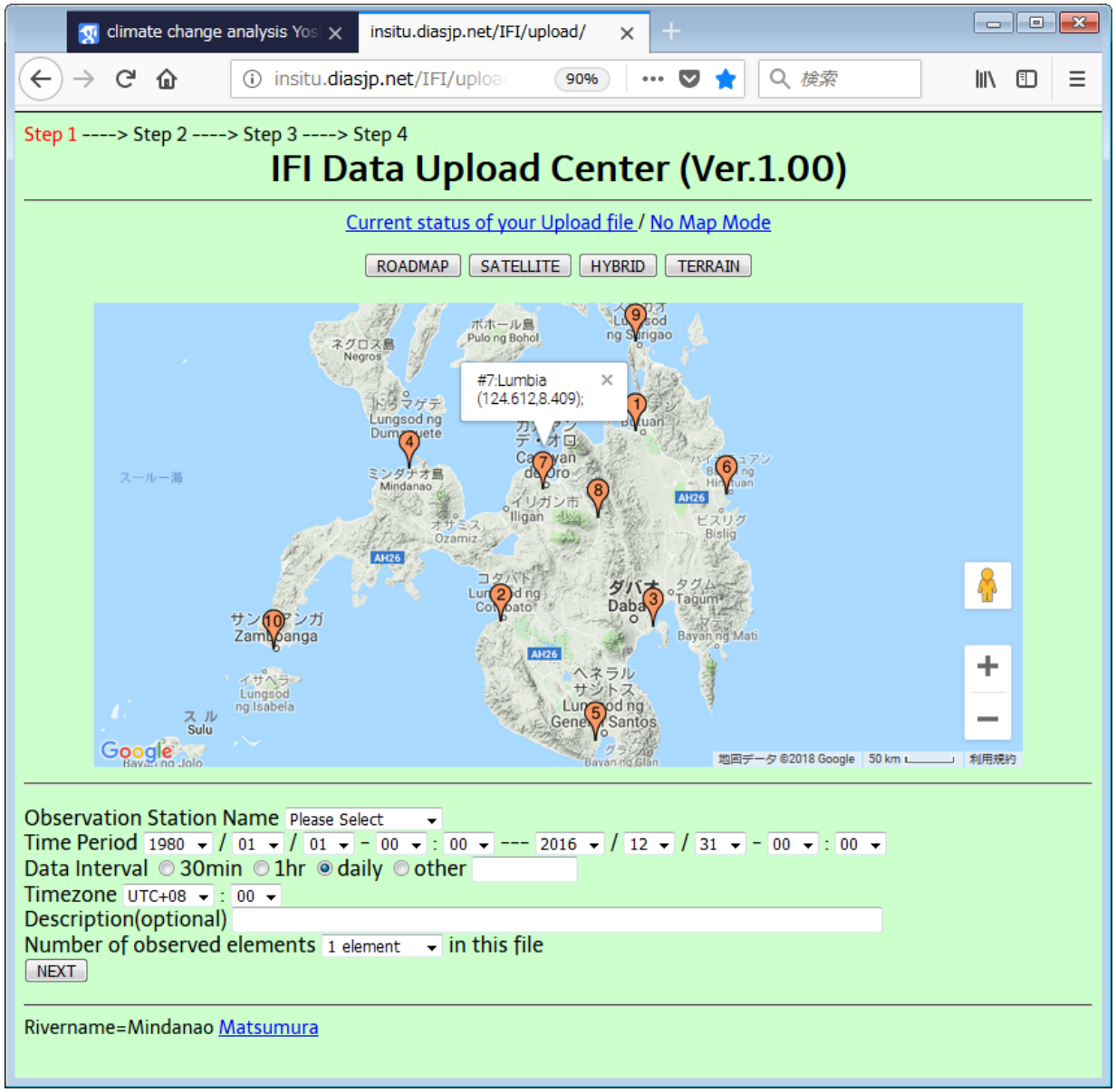
- Economic data by district or village
- Regional GDP by industry, labor force by industry, local tax, capital investment

Example: Data Archiving (Philippines)

Web-base Database Interface

Input Item

- Area, District
- Category
- Data Source
- Data Type
- Period
- Resolution



Example: Database training (Myanmar)

Date: February 4th and 5th, 2019
Venue: Yangon Technological University

Objectives

Participants learn:

1. Data management of the IFI Platform by DIAS
2. Methods and tools for data uploading, and quality control
3. Methods and tools for processing climate model (CMIP5) projections of future precipitation for assessment of climate change impacts

Participating Organizations

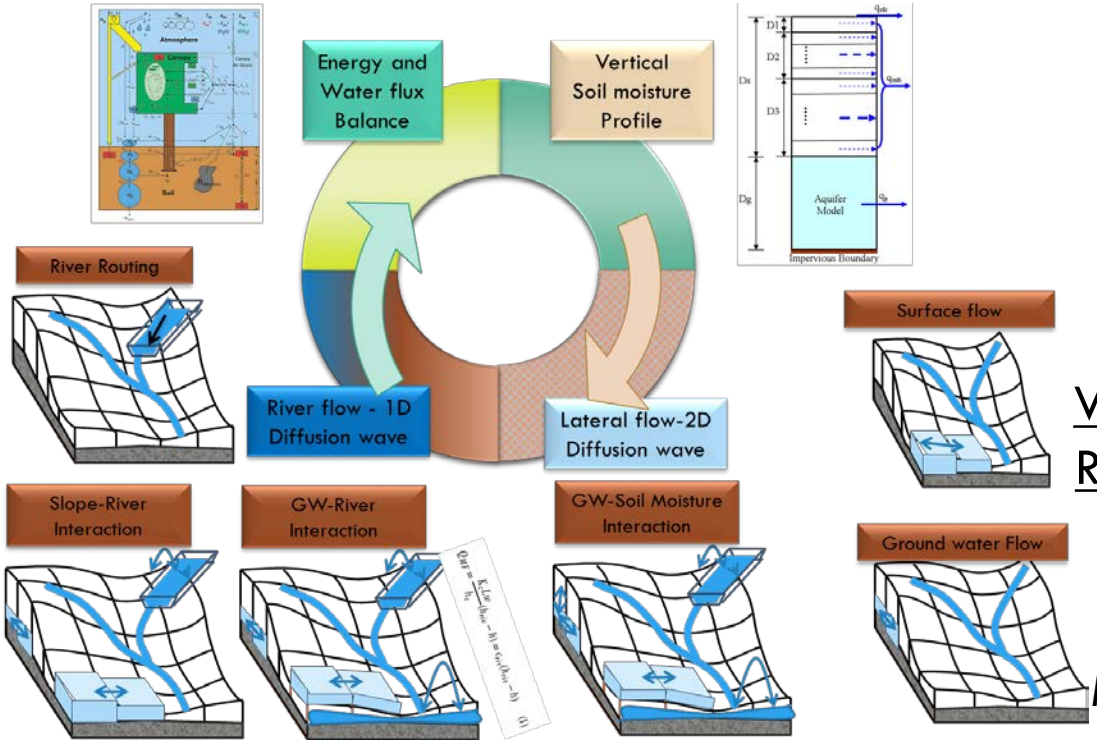
- Directorate of Water Resources and Improvement of River Systems
- Irrigation and Water Utilization Management Department
- Department of Meteorology and Hydrology
- Department of Disaster Management
- Yangon Technological University

Trainer Organizations

- University of Tokyo
- ICHARM

DIAS (Data Integration and Analysis System)

Hydrological Modeling for A Seamless Approach



Water and Energy budget Rainfall-Runoff-Inundation (WEB-RRI) Model

Rasmy et al., 2019: Journal of Hydrology

- Physical formulations for ET, and soil moisture → improve reliability of flood and drought
- Reliable responses to the water cycle variability as well as climate change scenarios → Assessment of hydrological extremes with a great confidence
- Complete consideration of hydrological cycle with restarting function → enable reliable real-time applications such as flood forecasting
- Inputs outputs are compatible with climate and agricultural models → direct coupling for impact assessments

Example: Contingency Planning (Philippines)

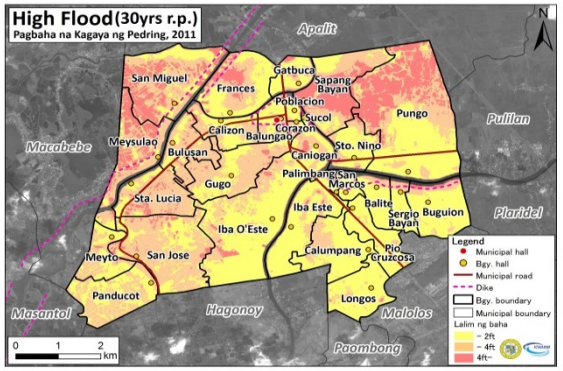
Formulation of Plan

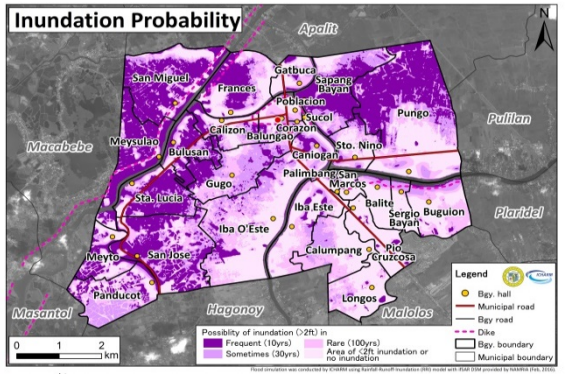
- Step 1: Understanding current conditions
- Step 2: Identifying risk
- Step 3: Analyzing impact
- Step 4: Developing response strategies

Documentation and Sharing

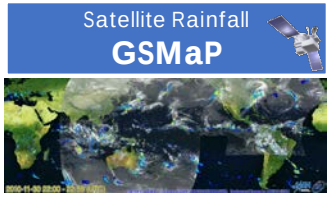
- Step 5: Developing evidence-based contingency plans
- Step 6: Sharing disaster contingency plans

Contingency Plan

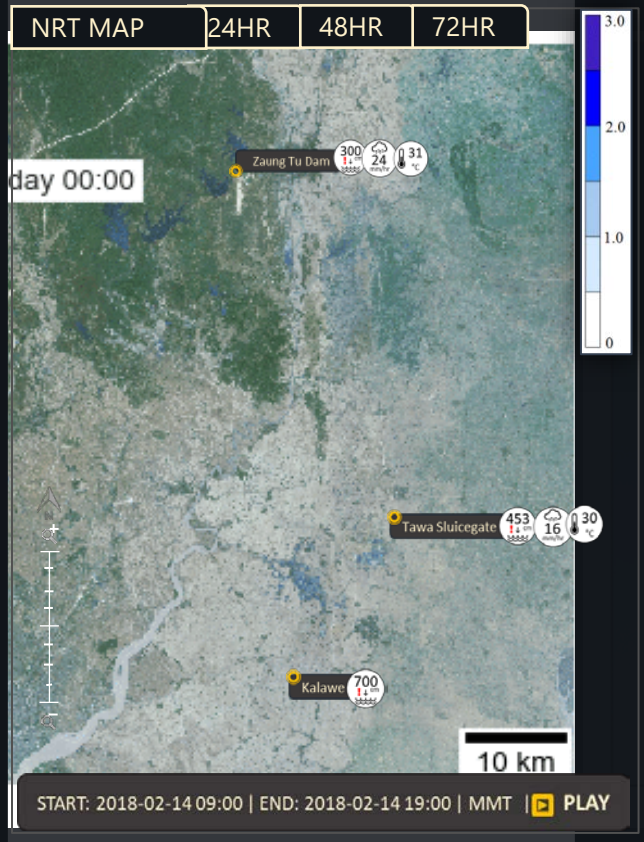


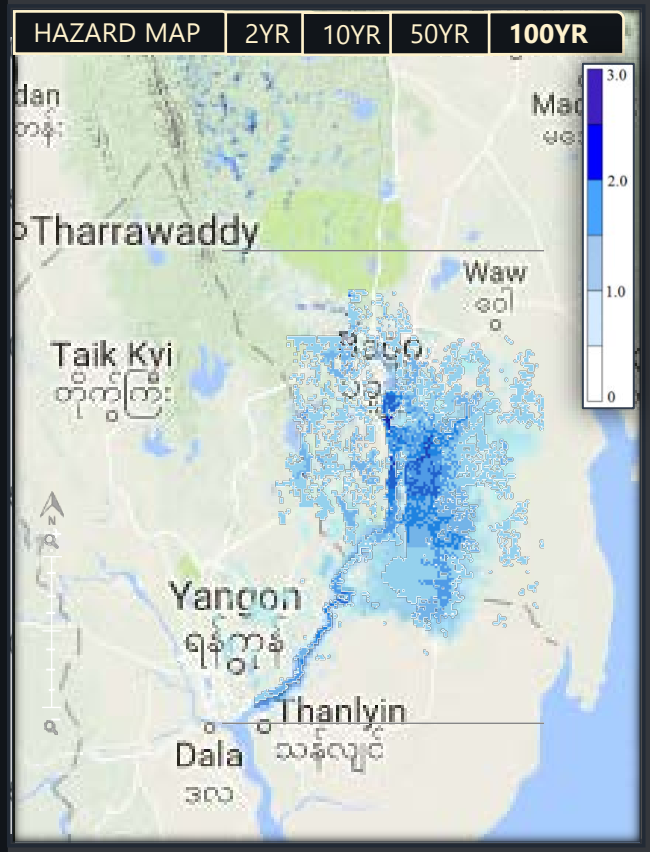


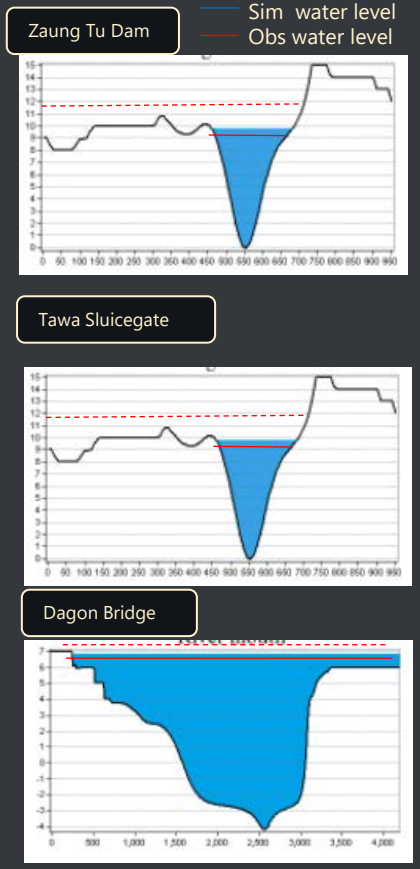
Example: Near real-time flood forecast (Bago river, Myanmar)



Flood and Inundation | Near Real-time Forecast | Flood Hazard Maps





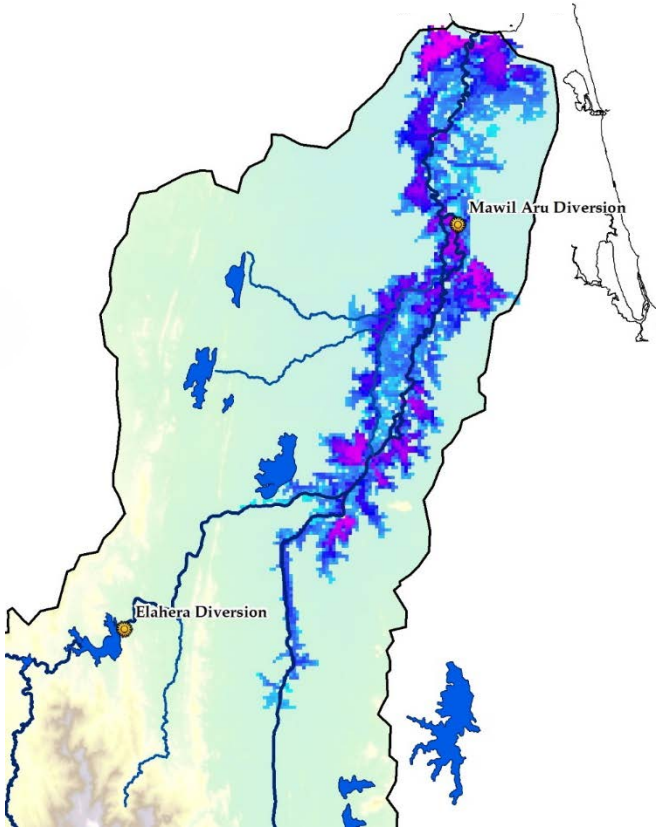


Example: Effect of Dam Operation (Sri Lanka)

Improved dam operation rules are estimated to reduce flood level by 1.5 m.

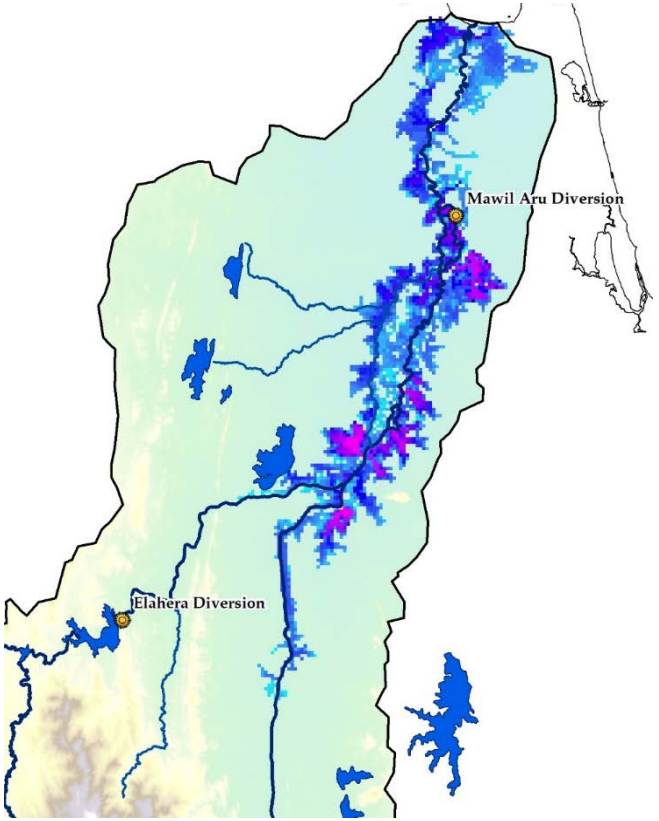
1.5 m Reduction

Max Flood Level 7.23 m



2014 Flood Actual Simulation

Max Flood Level 5.75 m



2014 Flood with Improved Dam Operation Rules

Wonogiri Reservoir Operation Guidelines

Possibility of reservoir operation using ensemble forecast

① - Maximum target water level (w.l.)

② - Normal target w. l.

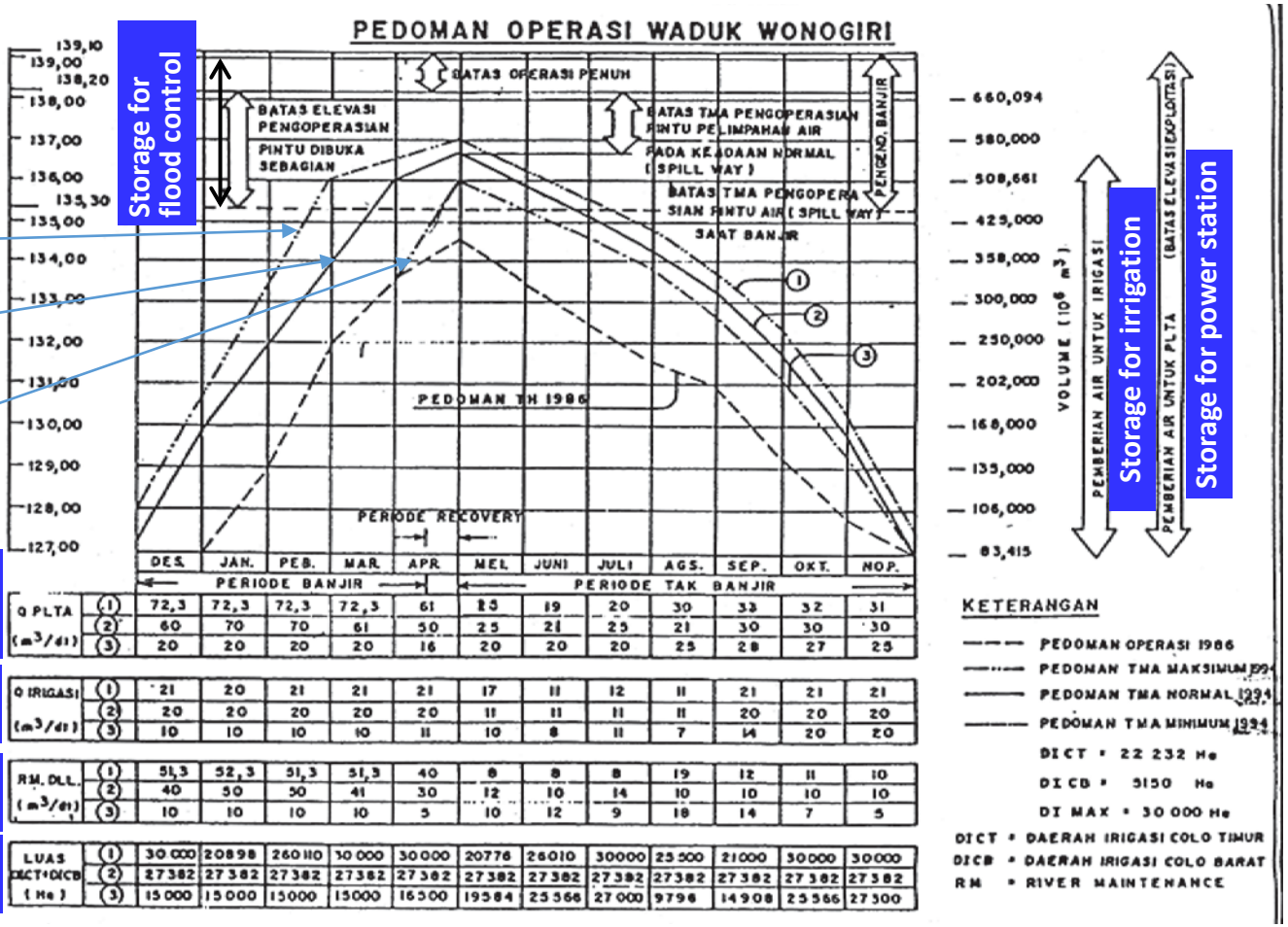
③ - Minimum target w. l.

Total discharge for power station (irrigation + flow maintenance) [m^3/s]

Discharge for irrigation [m^3/s]

Discharge for river flow maintenance [m^3/s]

Irrigated area [ha] East Colo + West Colo



		DES.	JAN.	PEB.	MAR.	APR.	MEI	JUNI	JULI	AGS.	SEP.	OKT.	NOP.
Q PLTA (m^3/dt)	(1)	72,3	72,3	72,3	72,3	61	25	19	20	30	33	32	31
	(2)	60	70	70	61	50	25	21	25	21	30	30	30
	(3)	20	20	20	20	16	20	20	20	25	28	27	25
Q IRIGASI (m^3/dt)	(1)	21	20	21	21	21	17	11	12	11	21	21	21
	(2)	20	20	20	20	20	11	11	11	11	20	20	20
	(3)	10	10	10	10	11	10	8	11	7	14	20	20
RM. DLL. (m^3/dt)	(1)	51,3	52,3	51,3	51,3	40	8	8	8	19	12	11	10
	(2)	40	50	50	41	30	12	10	14	10	10	10	10
	(3)	10	10	10	10	5	10	12	9	18	14	7	5
LUAS DICT+DICB (Ha)	(1)	30 000	20898	26011	30 000	30 000	20776	26010	30000	25 500	21000	30000	30000
	(2)	27382	27382	27382	27382	27382	27382	27382	27382	27382	27382	27382	27382
	(3)	15000	15000	15000	15000	16500	19584	25566	27000	9796	14908	25566	27300

Flood season: 1 December to 15 April / Non-flood season: 1 May to 30 November

PLTA: Pusat Listrik Tenaga Air, DICT: Daerah Irigasi Colo Timur, DICB: Daerah Irigasi Colo Barat, DLL: Dengan Lain-Lain

source: Operasi Pemantaatan Air Bendungan Serbaguna Wonogiri, Departmen Pekerjaan Umum, Directorat Jenderal Pengairan, Proyek Induk Pengembangan Wilayah Sungai Bengawan Solo, Nopember 1993

Research on Climate Change Impact (SOUSEI Program)

Schematic of flood risk assessment for agricultural economic loss (Rice production)

Philippines

Present Climate

344.8

48-hour rainfall (mm) for 100-year return period

increased by 61 %

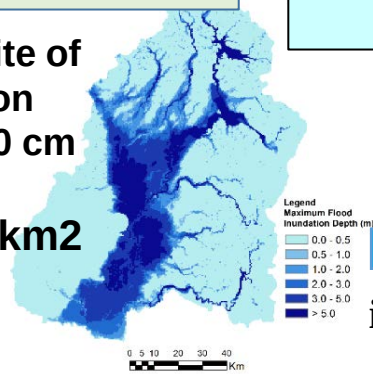
Future Climate

556.5

Maximum inundation Area (worst case)

Present Climate

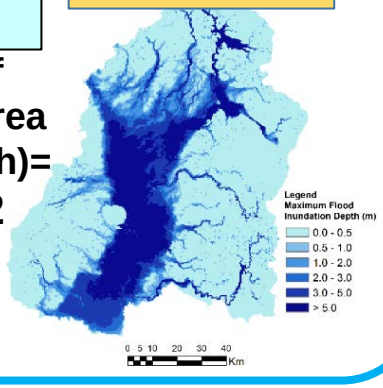
Composite of Inundation Area (>50 cm depth)= 3,661.2 km2

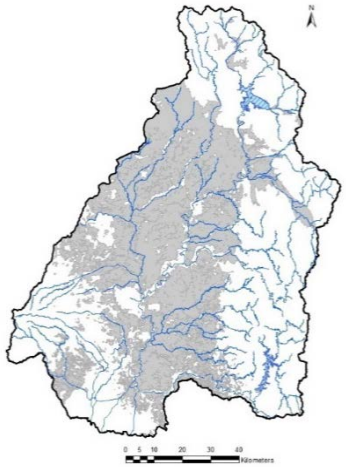


Future Climate

Composite of Inundation Area (>50 cm depth)= 4,376.6 km2

increased by 20 %





Paddy field area (Global data)

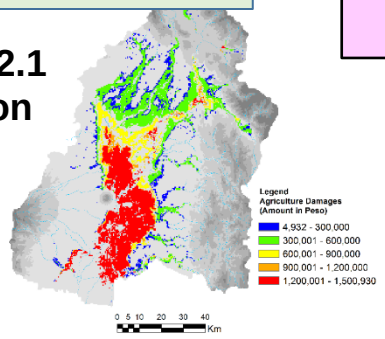
Value of farm gate price (17 Peso/kg)

Rice yield (4360 kg/ha)

Damage function for rice production (ICHARM developed)

Present Climate

8,412.1 million Peso

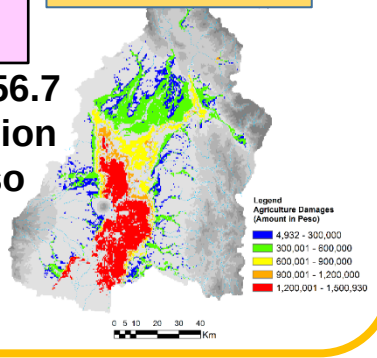


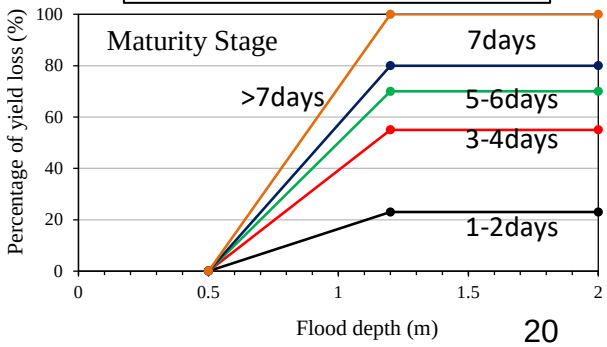
Agricultural economic loss

Future Climate

8,756.7 million Peso

increased by 4 %



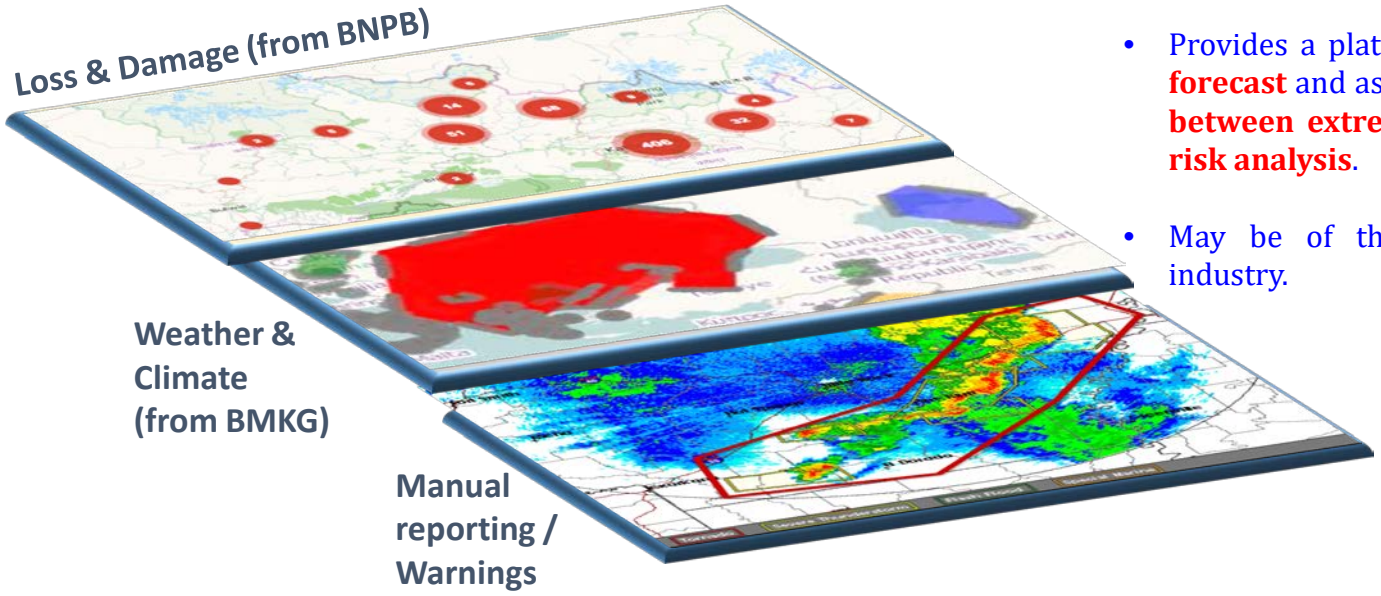


Conclusions of Indonesia Presentation

1. Extended hydrometeorological services exist to support the activities of sectors sensitive to weather and climate. Earth observation data are used quite heavily in providing the services.
2. Challenges exist to increase the information from standard hydrometeorological services into impact based information which are tailored to the sector's information.
3. Indonesia has experienced bush and forest fires these recent years, and the Government has framed some prevention measures that are involved the local communities and corporations.
4. …

World Meteorological Organisation

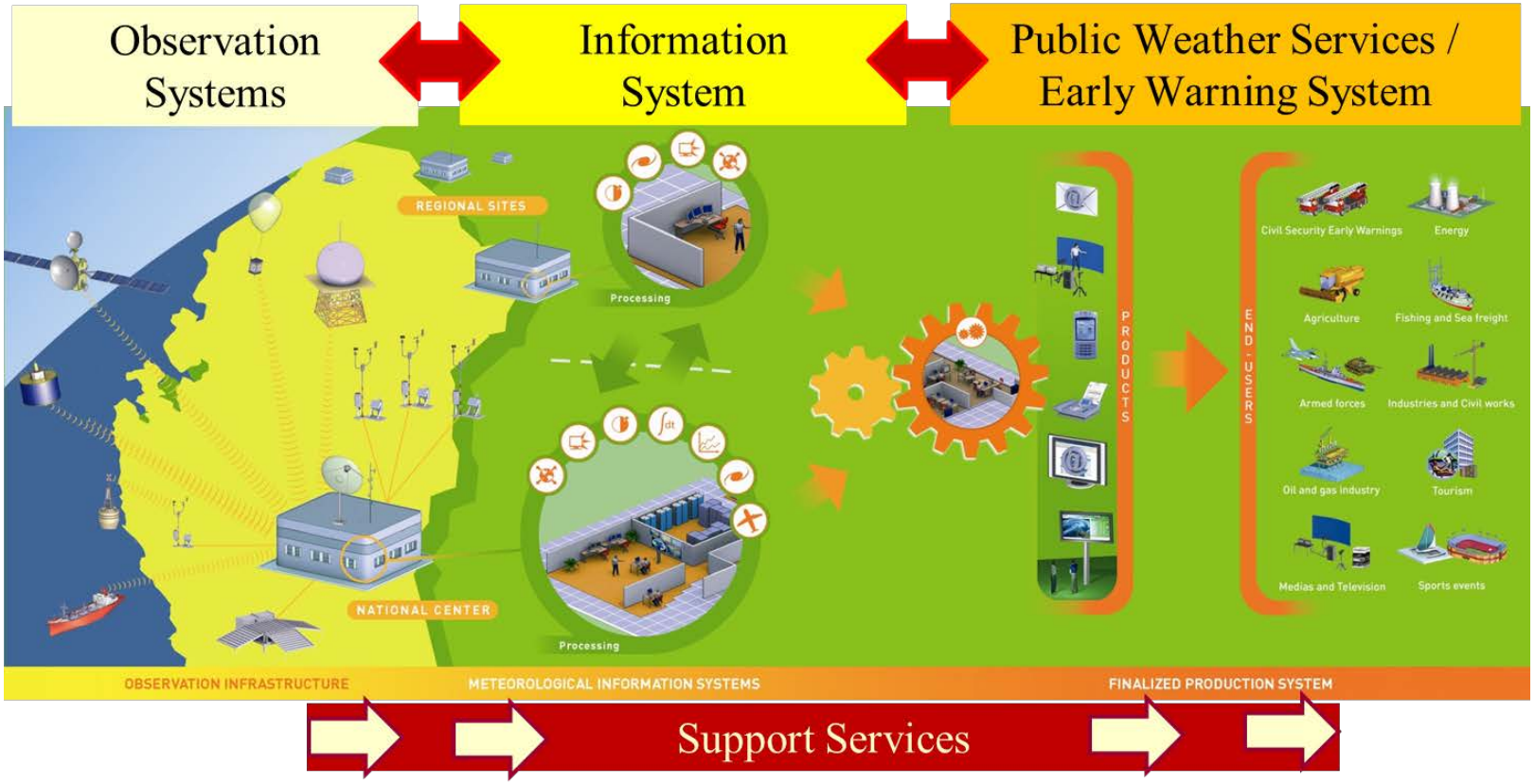
Wmo community contribution:
cataloguing hazardous event



- Layering of extreme event information and loss and damage information will enable new possibilities for analysis and application.
- Provides a platform **for building impact forecast** and as well as historical **relation between extreme events – impacts for risk analysis**.
- May be of the interest for insurance industry.

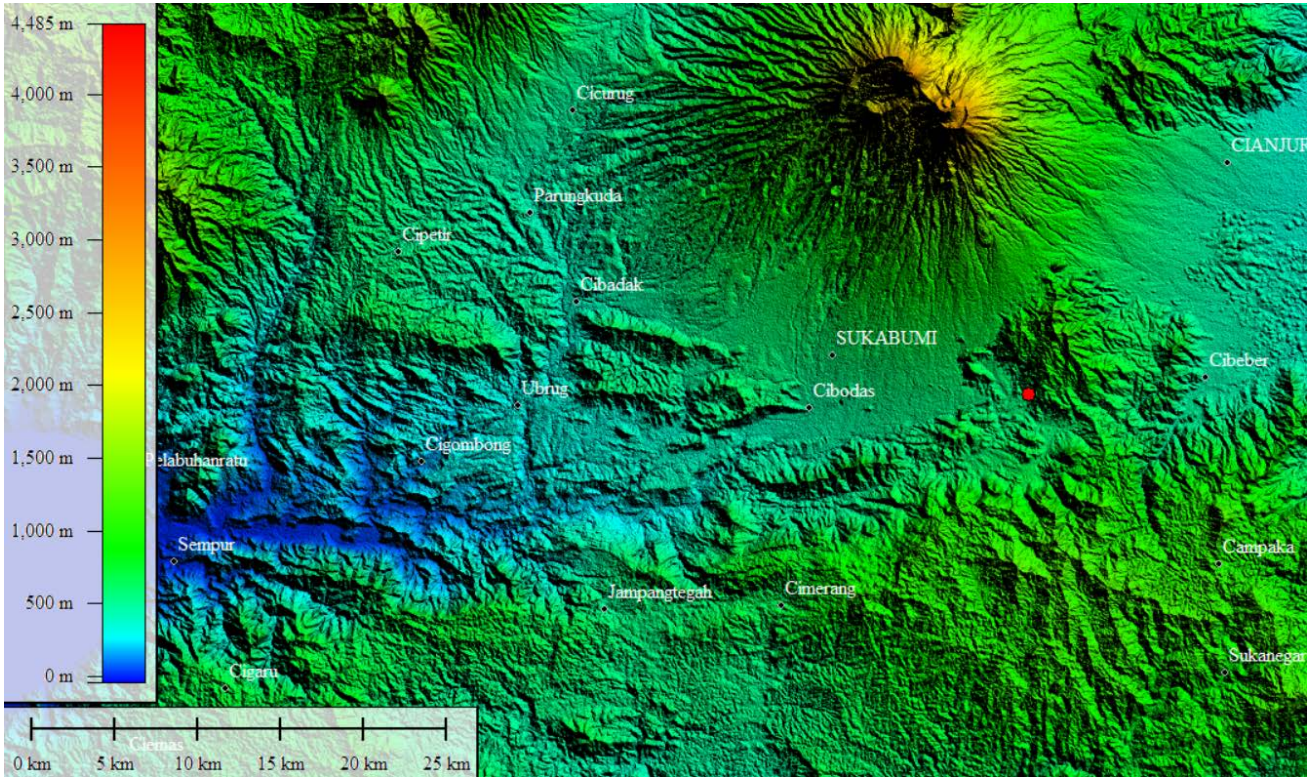
BMKG

Typical organization

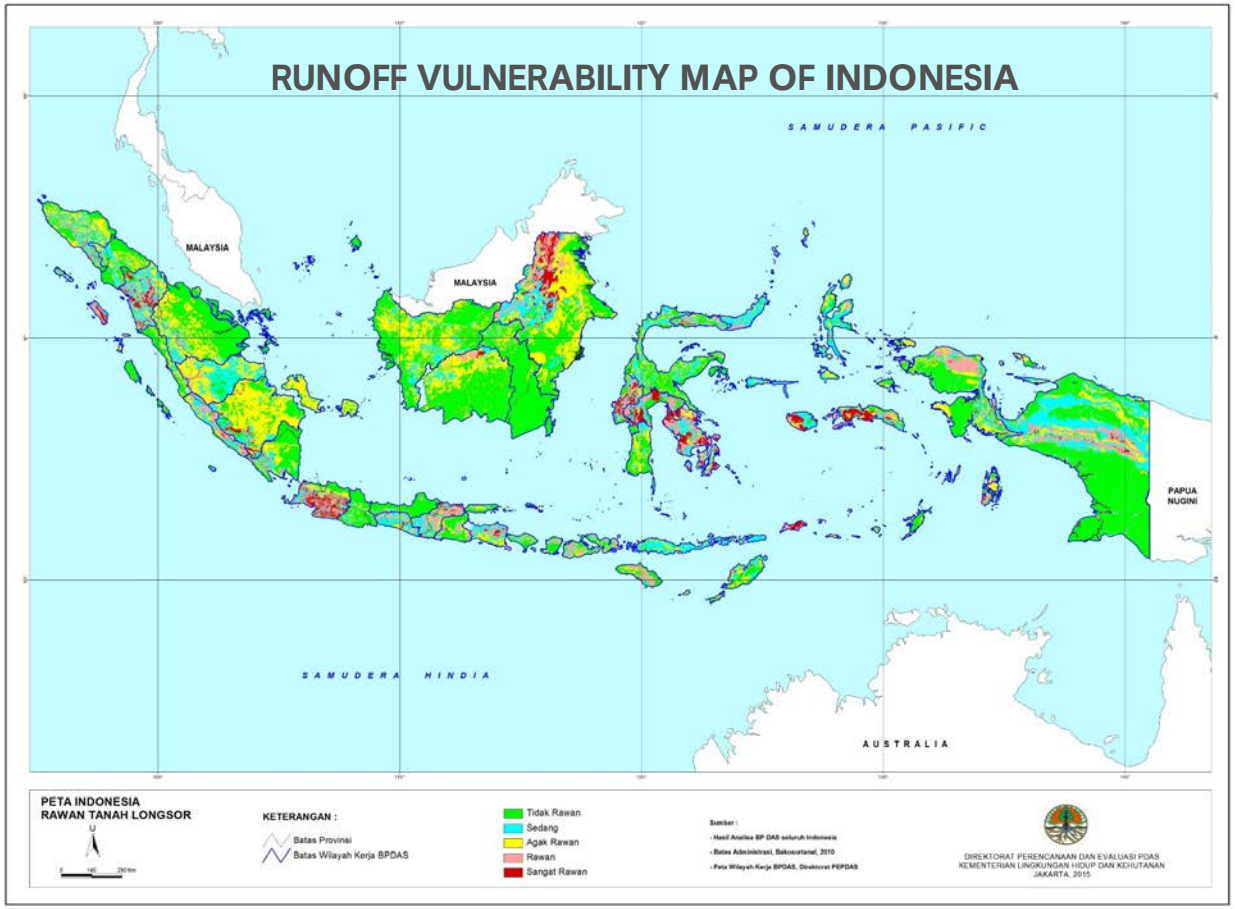


MoEF

DIGITAL TERRAIN MODEL FOR IDENTIFYING LAND CHARACTERISTIC PRODUCING RUNOFF

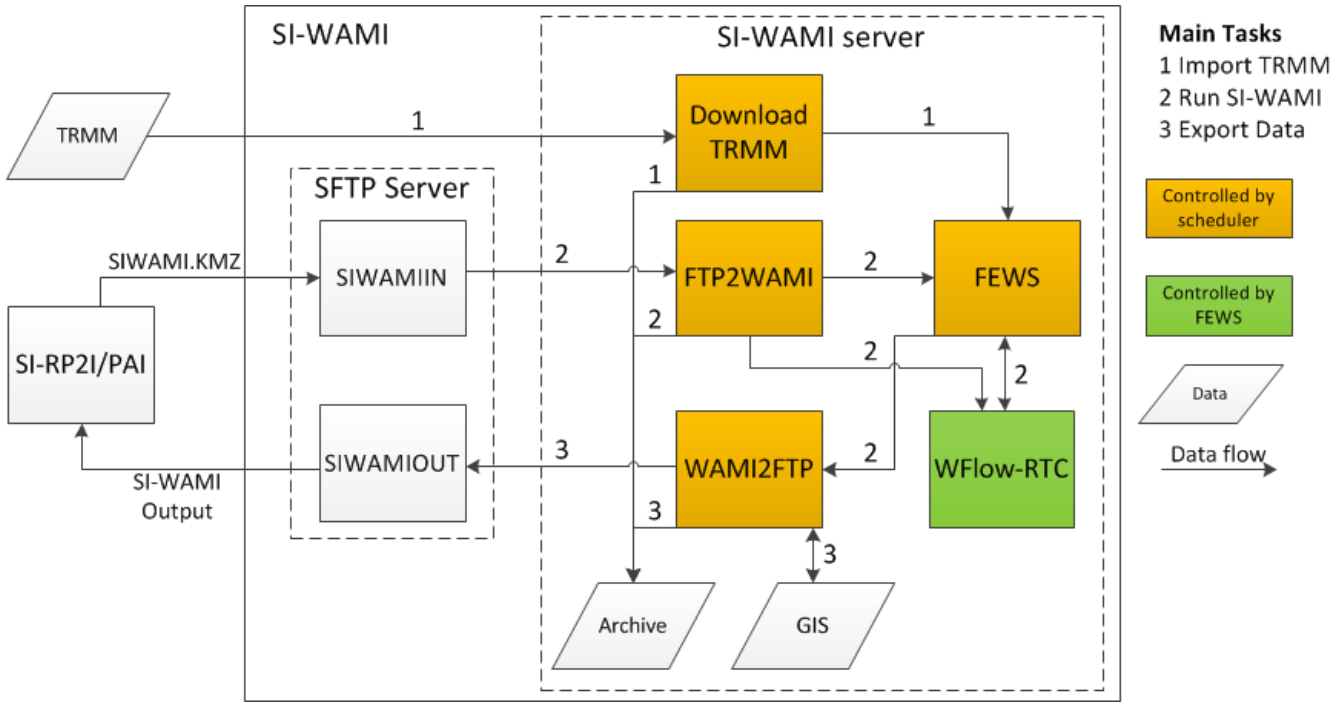


MoEF



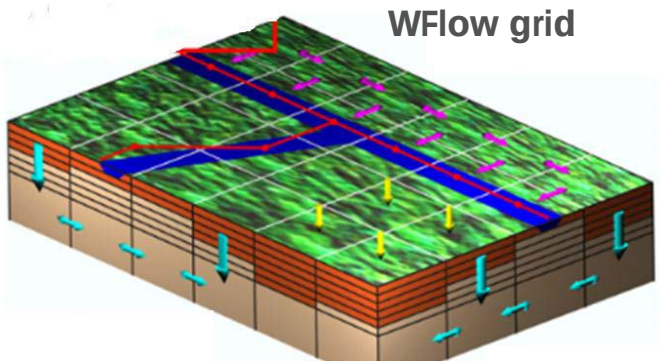
- SPATIAL DYNAMIC MODEL
- CONSIDER VARIOUS LAND ATTRIBUTES IN DRIVING RUNOFF:
  - ✓ Topographic configuration
  - ✓ Soil Properties
  - ✓ Vegetation density
  - ✓ Depression storage

Siwami setup



Wflow models

WFlow is a 3 Dimensional, topographically and physically based: model concepts are related to topographical features: elevation, slope, river networks, land-use and soil type.



Even un-calibrated models provide realistic results as long as you respect physics.

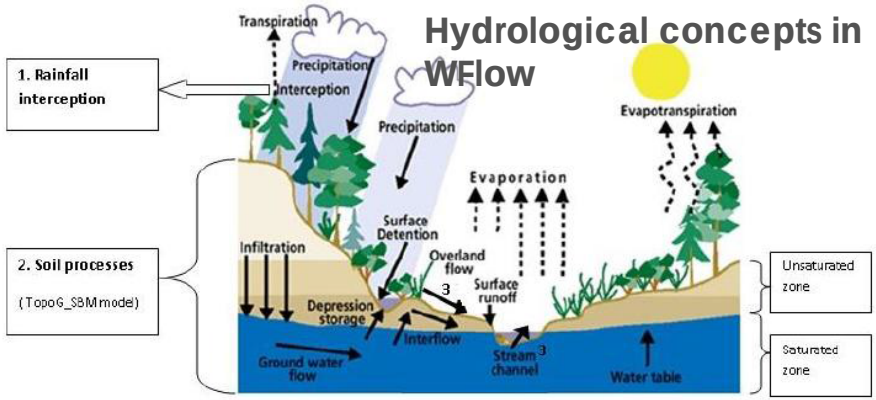


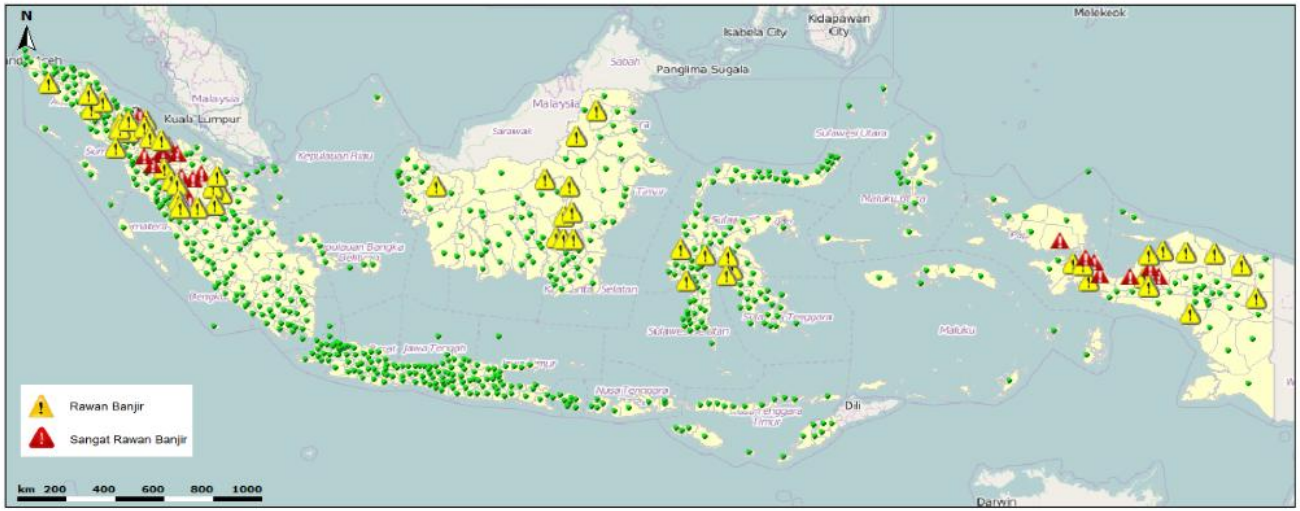
Figure 8.13 Processes in the hydrological cycle

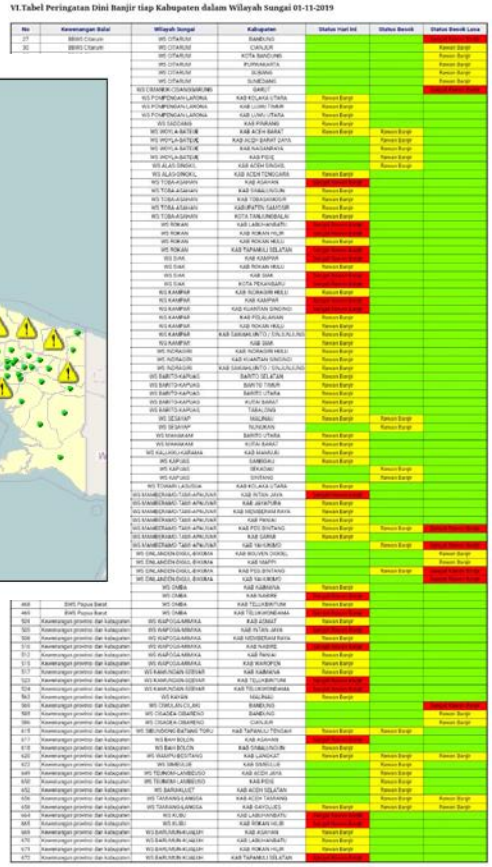
AOGEO Symposium 2019

GEOSS ASIAN WATER CYCLE INITIATIVE Session

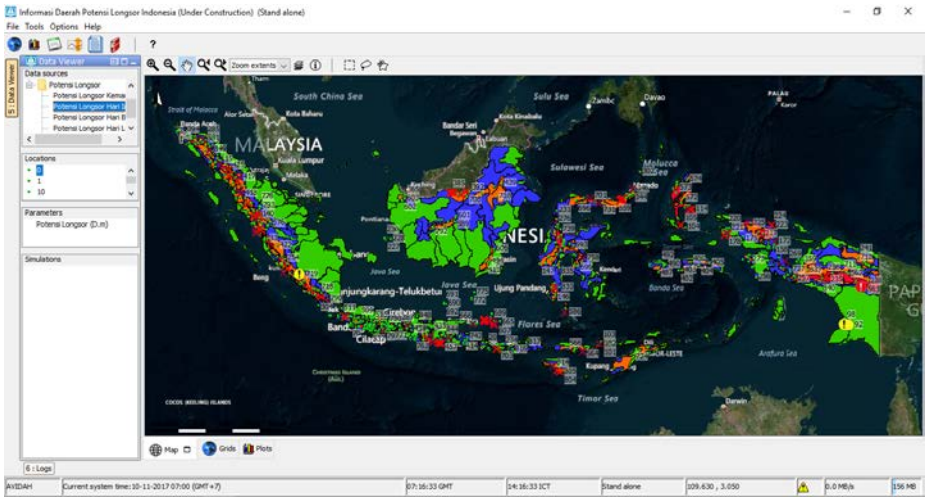
4 November 2019, Canberra Australia

Flood early warnings





Land slide ews

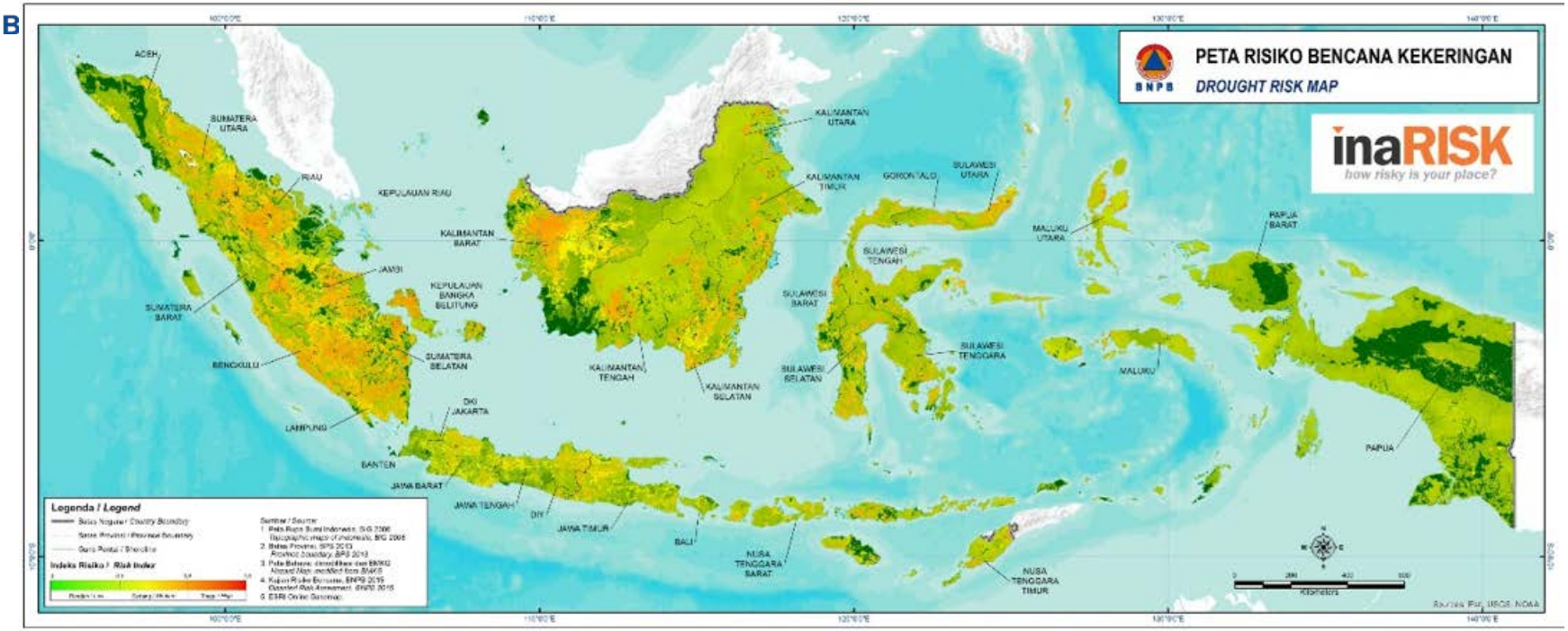


Interactive view based on FEWS Desktop

Sample of dissemination through WA group

AOGEO Symposium 2019
GEOSS ASIAN WATER CYCLE INITIATIVE Session
4 November 2019, Canberra Australia

BNPB



DROUGHT

AFFECTED LOCATION
PROVINCE 34 REGION/CITY 489

PEOPLE AFFECTED
48.491.666

ECONOMIC LOSS (RP.MILYAR)
192.737.143

AREA OF RISK (HA)
46.735.107

PHYSICAL LOSS (RP.MILYAR)
0

ENVIRONMENTAL LOSS (HA)
29.820.457

Vulnaralibility Parameter:
- Total Population (BPS)
- Total Housess, public facilities, critical facilities (GPS, BIG, Loc.Gov)
- PDRB Data (Loc.Gov)
- Land Cover Data (KLHK and BIG

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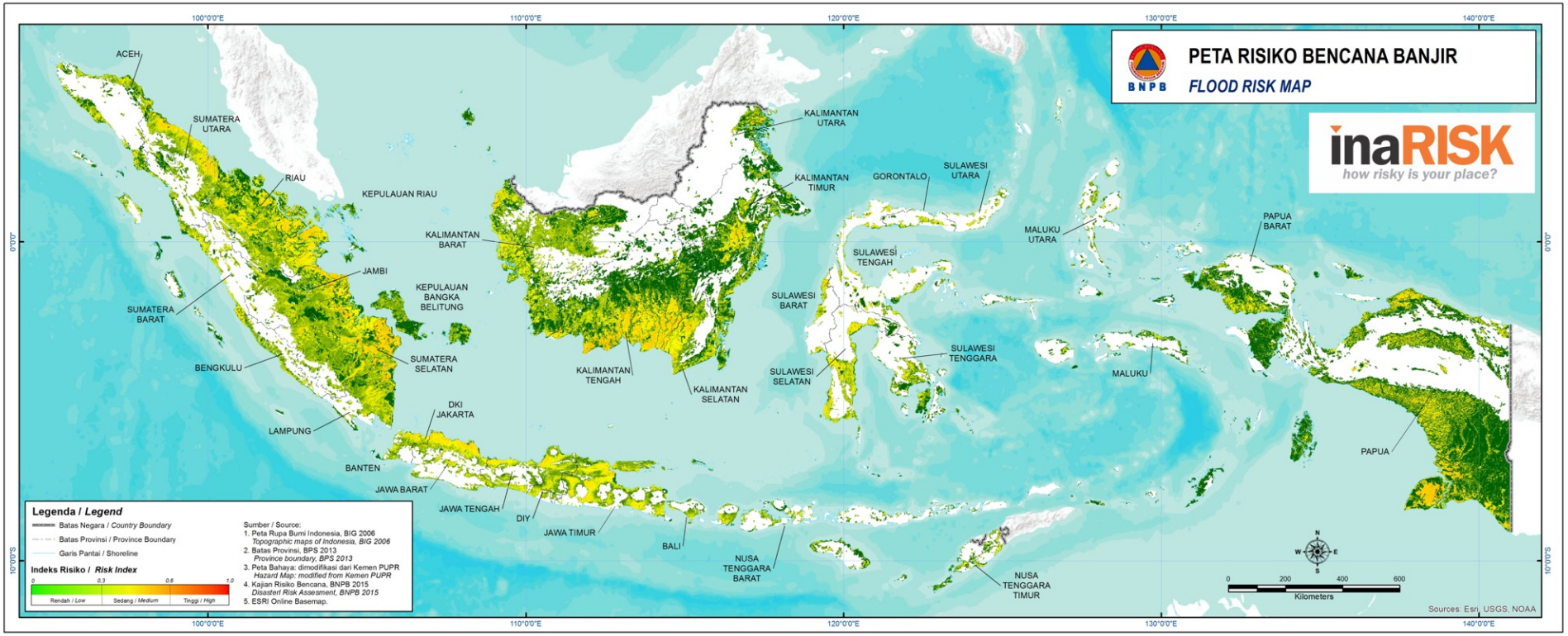


POTENTIAL RISK DATA

MEDIUM TO HIGH RISK

PROVINCE AFFECTED **34**

CITY/REGION AFFECTED **510**

AREA OF RISK (HA) **39.371.167**

PEOPLE AFFECTED **100.814.666**

PHYSICAL LOSS (RP.MILYAR) **176.329.821**

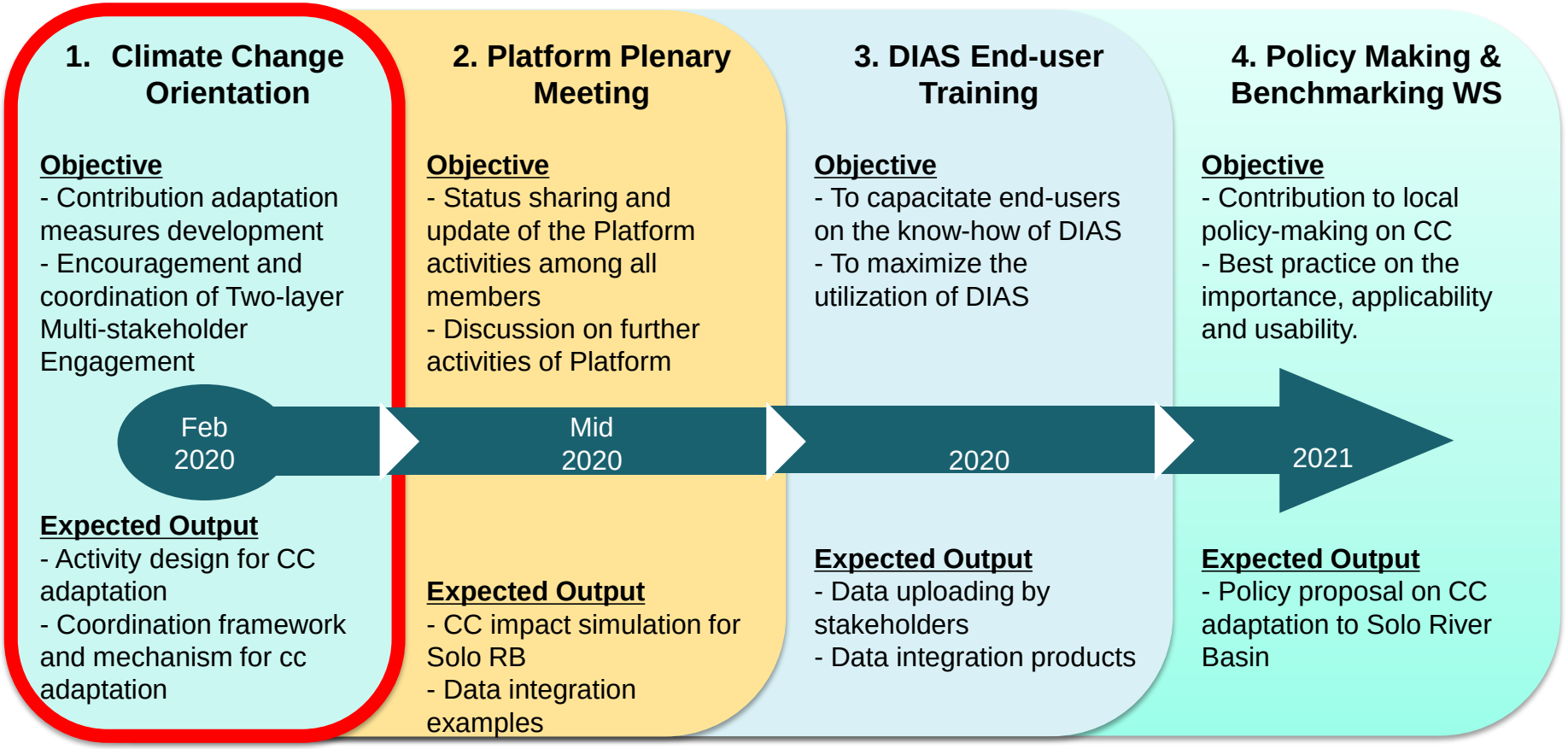
ECONOMIC LOSS (RP.MILYAR) **140.520.440**

ENVIRONMENTAL LOSS (HA) **12.135.957**

Vulnerability Parameter:

- Total Population (BPS)
- Total houses, public facilities, critical facilities (BPS, BIG, Loc.Gov)
- PDRB Data (Loc.Gov)
- Land Cover Data(KLHK andBIG)

Workplan of Platform Activities in Solo river basin



Final outputs

- Develop an Action Plan for Climate Change Adaptation in Solo River Basin
- Propose the inputs of climate change adaptation policies to the National Action Plan for Climate Change Adaptation (RAN-API), and the Water Resources Management Plan in Solo River (POLA and RENCANA)
- Develop a guideline for climate change adaptation planning
- Propose improvement of Reservoir Operation Guideline of Wonogiri Dam