



# Hydro and Agro Informatics Institute

Ministry of Science and Technology

Thailand



# APPLYING RADAR-BASED RAINFALL ESTIMATION FOR REAL TIME FLOOD FORECAST AND EARLY WARNING SYSTEM



hydro & meteo GmbH & Co. KG  
Wetter + Wasser

- Introduction
- Radar-based Rainfall Estimation system
  - Rainfall estimation (QPE)
  - Nowcasting (QPF)
- Application of radar-based rainfall for early warning system



- **Introduction**
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# Research Focuses of HAI

**Real time  
monitoring,  
Forecasting  
& Operating  
system**

- Telemetering system
- Surveying technology
- Weather forecasting system (WRF, WRF-ROMs)
- Modeling system (Flood , Water resource, Coastal)
- Decision Support System (DSS)
- Optimization

**System  
Integration**

- Open architecture / Open source
- HPC, GPU, MIC
- Big Data
- Cloud
- New Technology

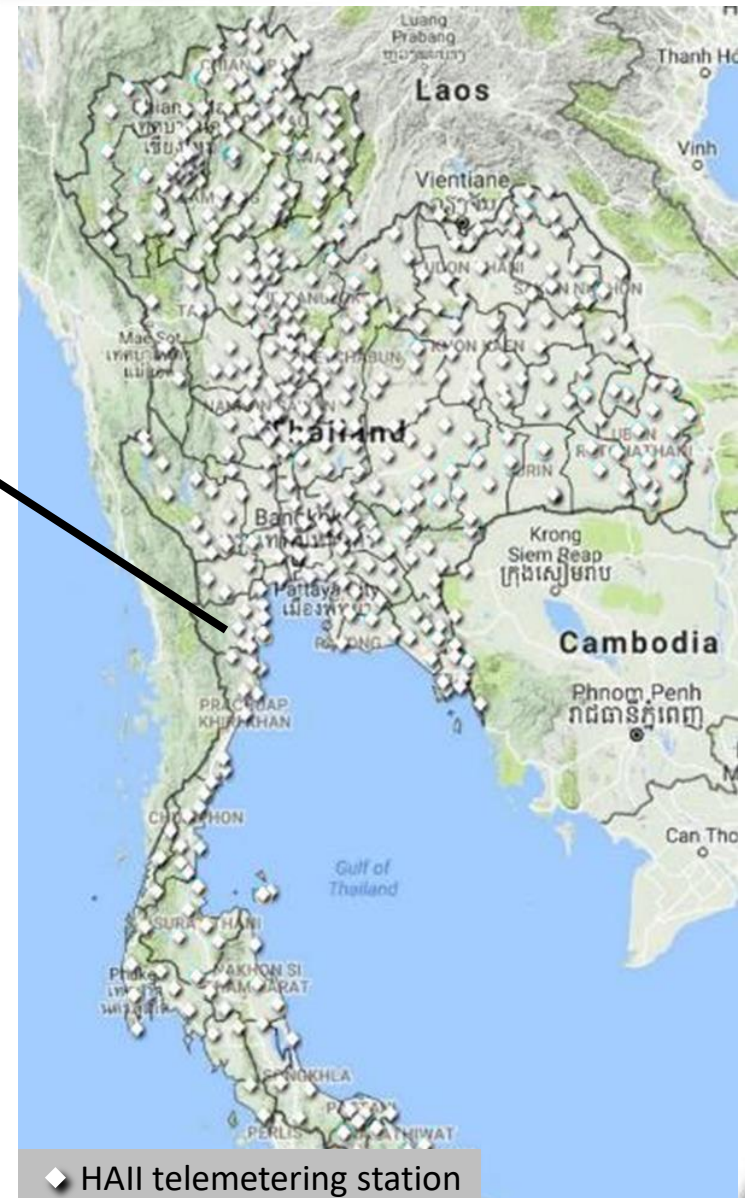
**Climate  
change,  
Adaptation  
and Good  
practices**

- Climate change scenarios and related effects
- Seasonal prediction
- Small scale water resource management
- Adaptation using S&T
- Good practice : Community Water Resource Management

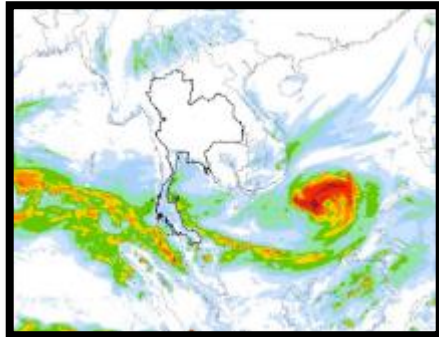
# Introduction - rainfall monitoring



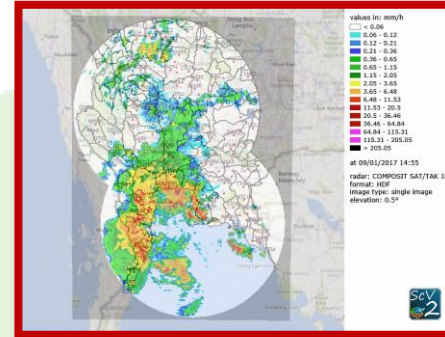
**Lack of rainfall observation in mountainous area**



# Introduction - flood forecasting



WRF-ROMS (7 day forecast)



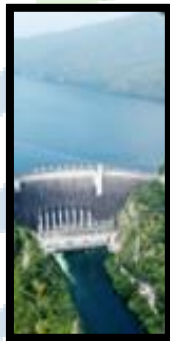
NOWCASTING - RADAR (1-3 hr forecast)

BASIN SCALE

LOCAL SCALE

Higher data resolution are needed for smaller scale flood modeling

RESERVOIR OPERATION



RIVERINE FLOOD



FLASH FLOOD



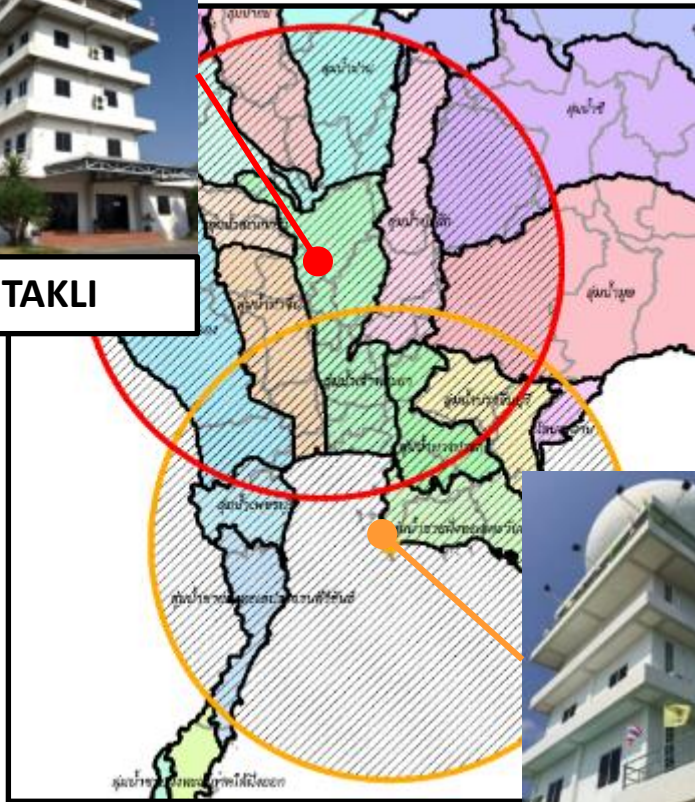
URBAN FLOOD



# Weather Radar - กรมฝนหลวงและการบินเกษตร Department of Royal Rainmaking and Agriculture Aviation



**TAKLI**



**SATTHAHIP**



Radar Type: Doppler radar (S-Band)  
Radius: 240 km  
Time Interval: every 6 min  
Rada Range Resolution: 250 m  
Area Coverage: 198,665 sq. km of 18 main basins  
in Thailand (41 provinces)



Department of Royal Rainmaking  
and Agriculture Aviation

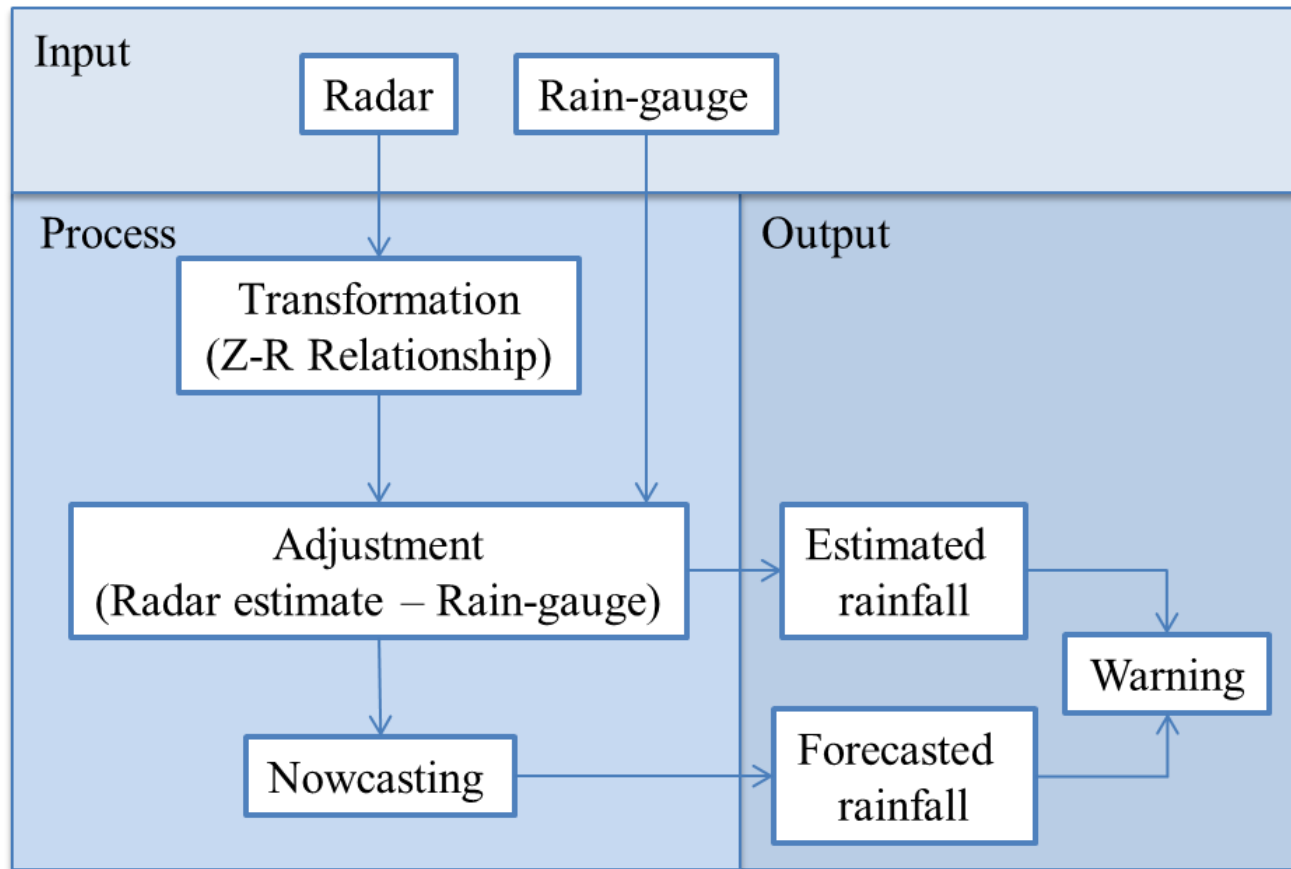


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- **Radar-based Rainfall Estimation system**
  - Rainfall estimation (QPE)
  - Nowcasting (QPF)
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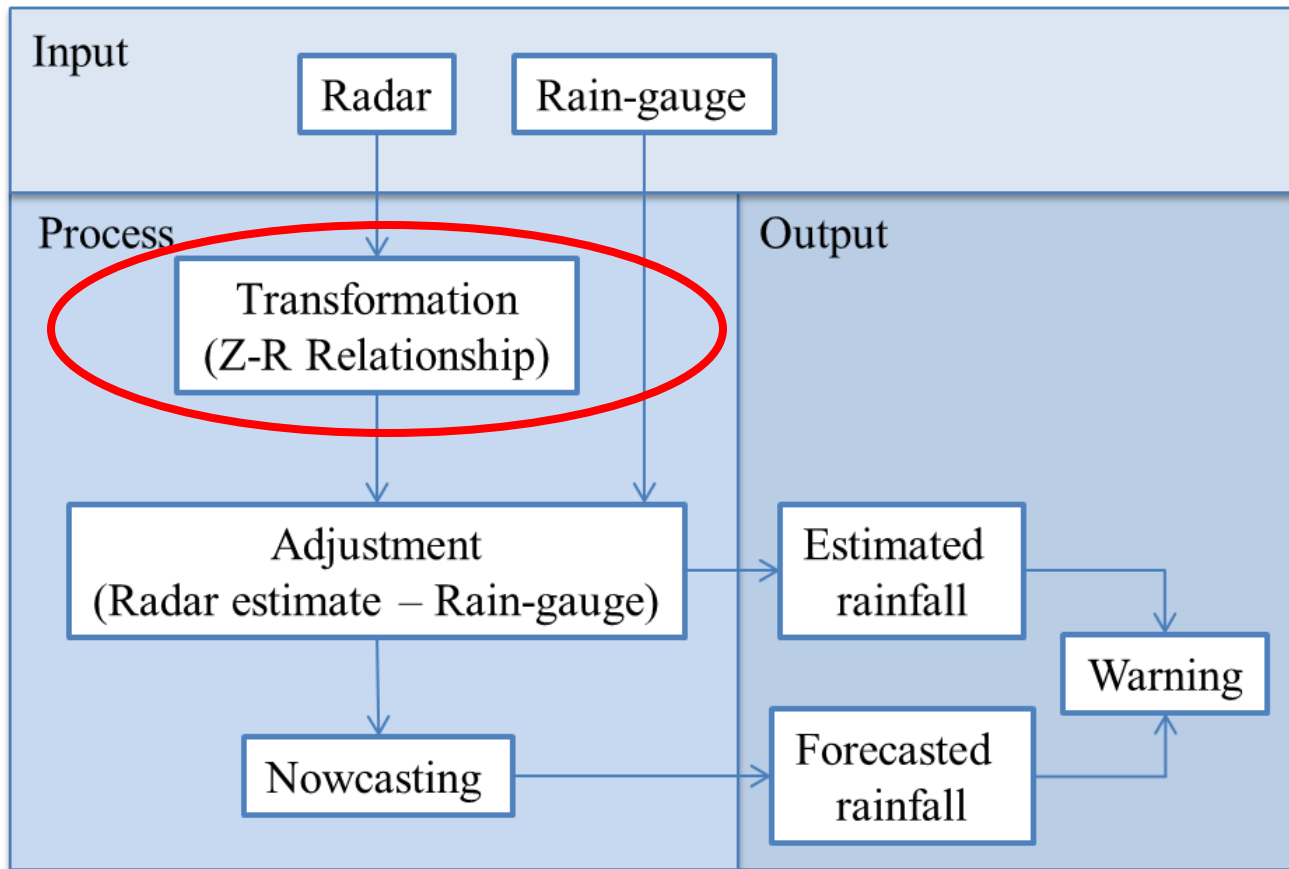


# Radar-based Rainfall system - Overview



Schematic Diagram of Radar-based rainfall system

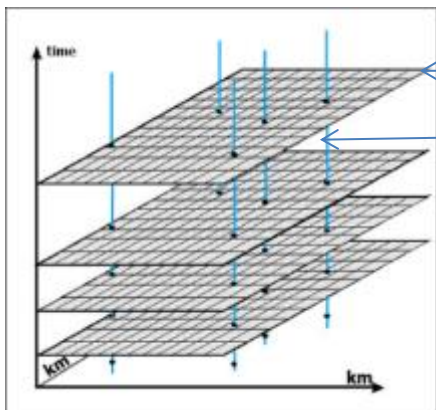
# Radar-based Rainfall system - Overview



Schematic Diagram of Radar-based rainfall system

# Radar-based Rainfall system - Rainfall Estimation

## Quantitative Precipitation Estimation (QPE)

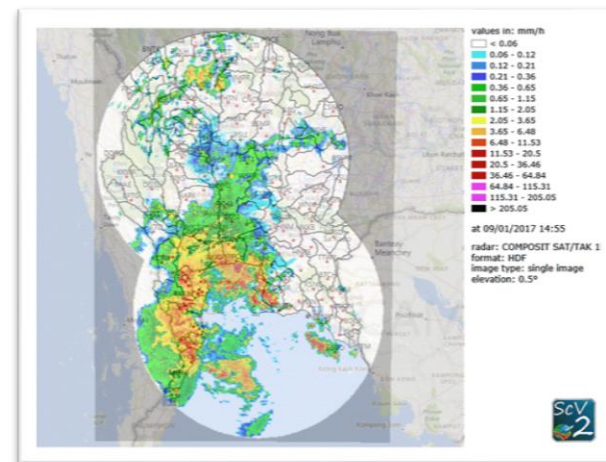


Radar Data (1x1 sq km)

Rain gauge Data

- Use 180 HAII telemetry stations in radar coverage area to develop the **Z-R relationship**

( $Z=aR^b$ , R: rainfall, Z: reflectivity)



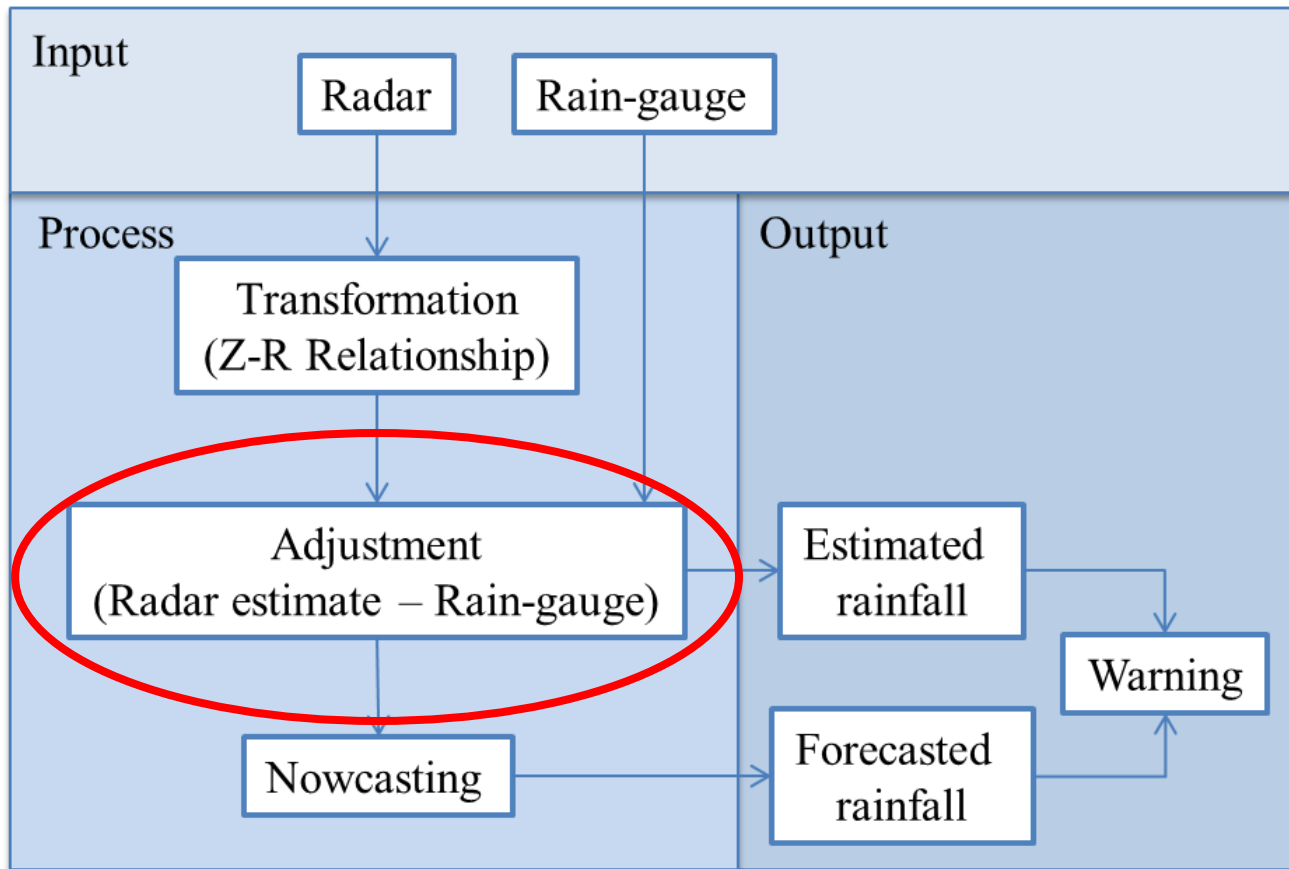
Thakli Radar	RMSE (mm/hr)		
	$Z = 116R^{1.6}$	$Z = 200R^{1.6}$	$Z = 300R^{1.4}$
90 events for calibration (5 JUN 2013 – 3 SEP 2015)	4.229	4.484	4.501
22 events for verification (4 SEP – 2 DEC 2015)	4.743	5.188	5.221
Sathahip Radar	RMSE (mm/hr)		
	$Z = 161R^{1.6}$	$Z = 200R^{1.6}$	$Z = 300R^{1.4}$
66 events for calibration (30 MAY 2013 - 2 AUG 2015)	4.805	4.844	4.948
17 events for verification (9 AUG - 27 OCT 2015)	4.612	4.719	4.768

Marshall and Palmer (1948)

other default equations from instrument

The developed equations produces the better performance

# Radar-based Rainfall system - Overview

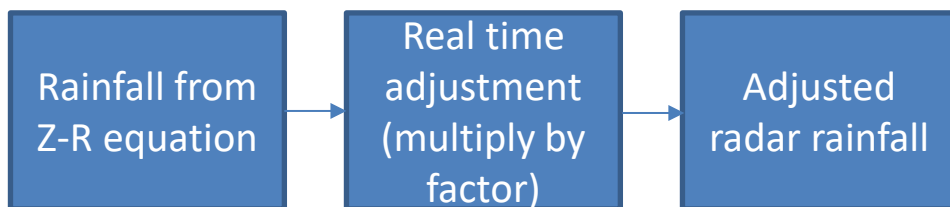


Schematic Diagram of Radar-based rainfall system

# Rainfall Estimation - Real-time adjustment with raingauge

The radar estimates are affected by systematic and uncertainty errors. These errors are reduced by the bias adjustment.

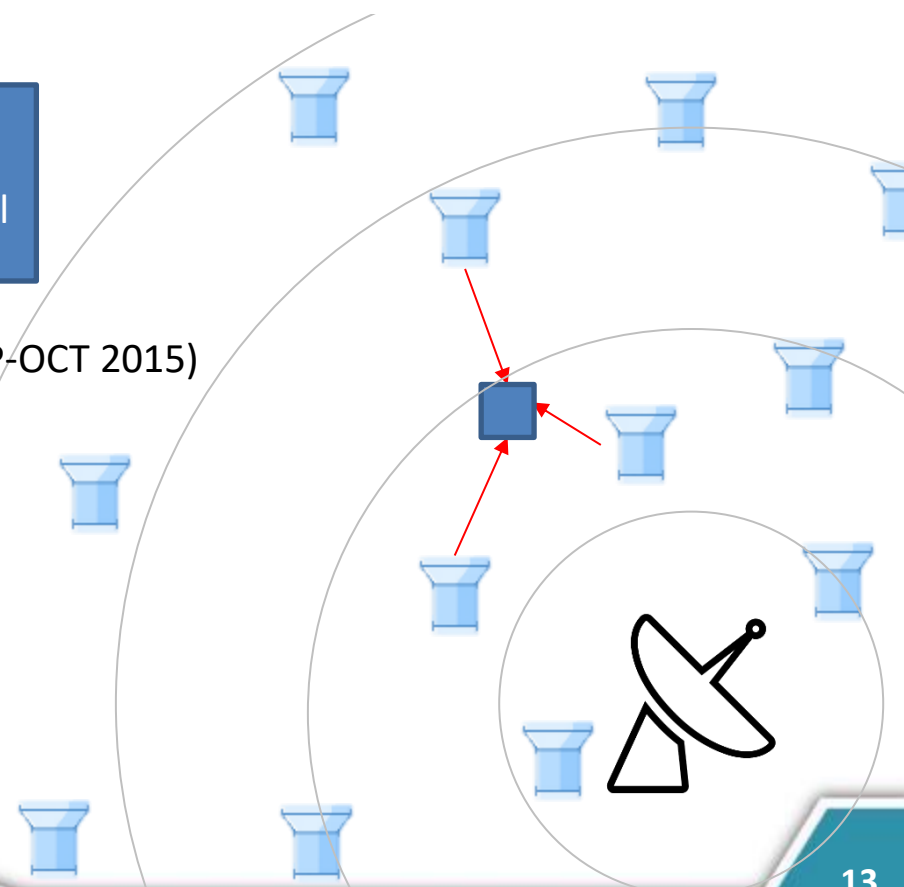
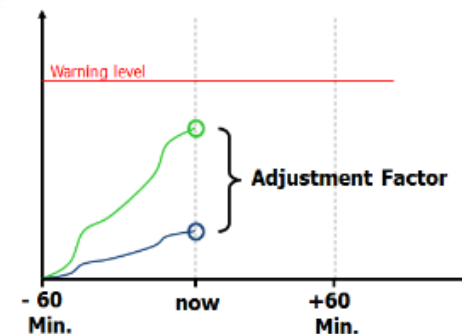
Ratio between Gauge and Radar (G/R) is calculated for each rain station. The adjustment factor for each radar pixel are interpolated based on **inverse distance weighted method (IDW)**.



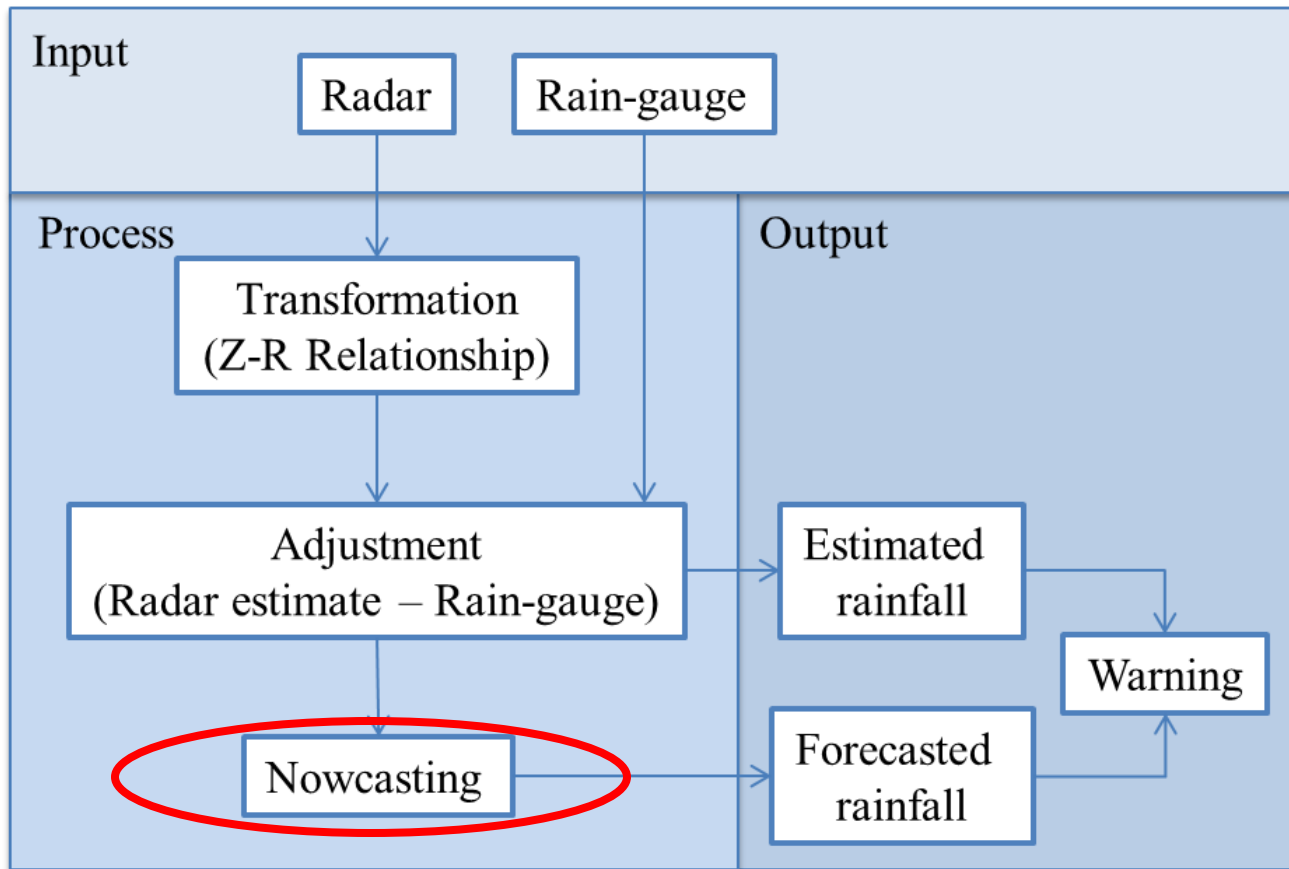
The statistical evaluation from 12 rainfall events (SEP-OCT 2015)

Radar Estimates	Z-R	Z-R with Adjustment factor
RMSE	3.209	3.028

This bias adjustment can reduced RMSE of radar estimates around **5.6%**



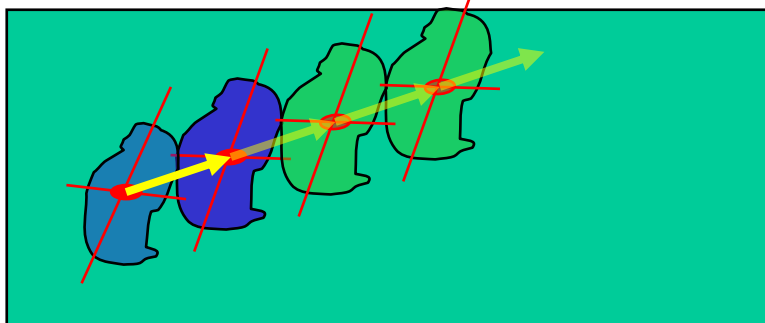
# Radar-based Rainfall system - Overview



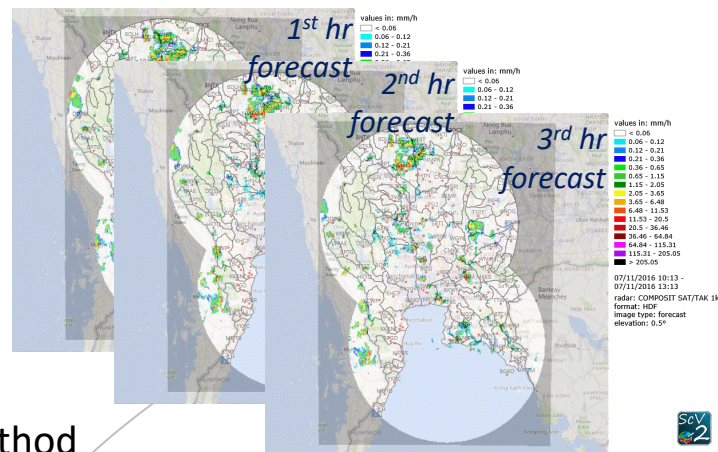
Schematic Diagram of Radar-based rainfall system

# Nowcasting

## Quantitative Precipitation Forecast (QPF)

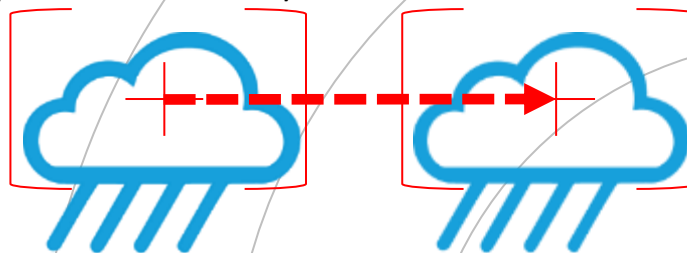


Rain cloud prediction based on **CENTROID TRACKING** method (Rosenfeld, 1987)



The spatial evaluation from 61 rainfall events (APR – OCT 2015)

	1hr	2hr	3hr
Performance	70%	64%	61%



1-3 hr Prediction >

Performance = average(Accuracy, POD, FAR, POFD, CSI)

The spatial evaluation of Accuracy, POD, FAR, POFD, CSI index can be seen in ([www.cawcr.gov.au/projects/verification](http://www.cawcr.gov.au/projects/verification), The Centre for Australian Weather and Climate Research)

- Detect
- Recognize moving pattern



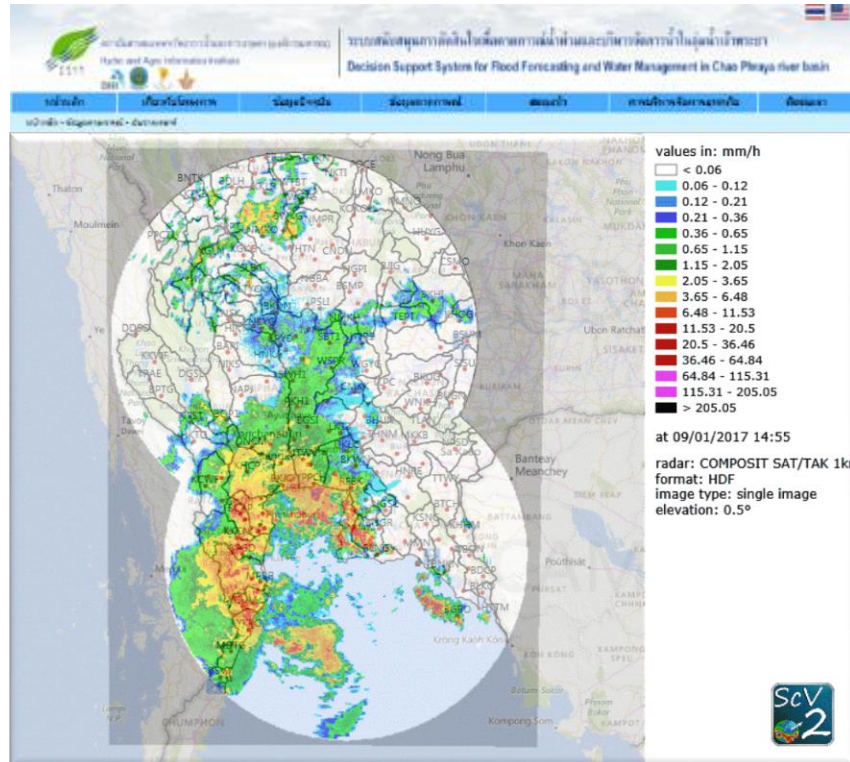
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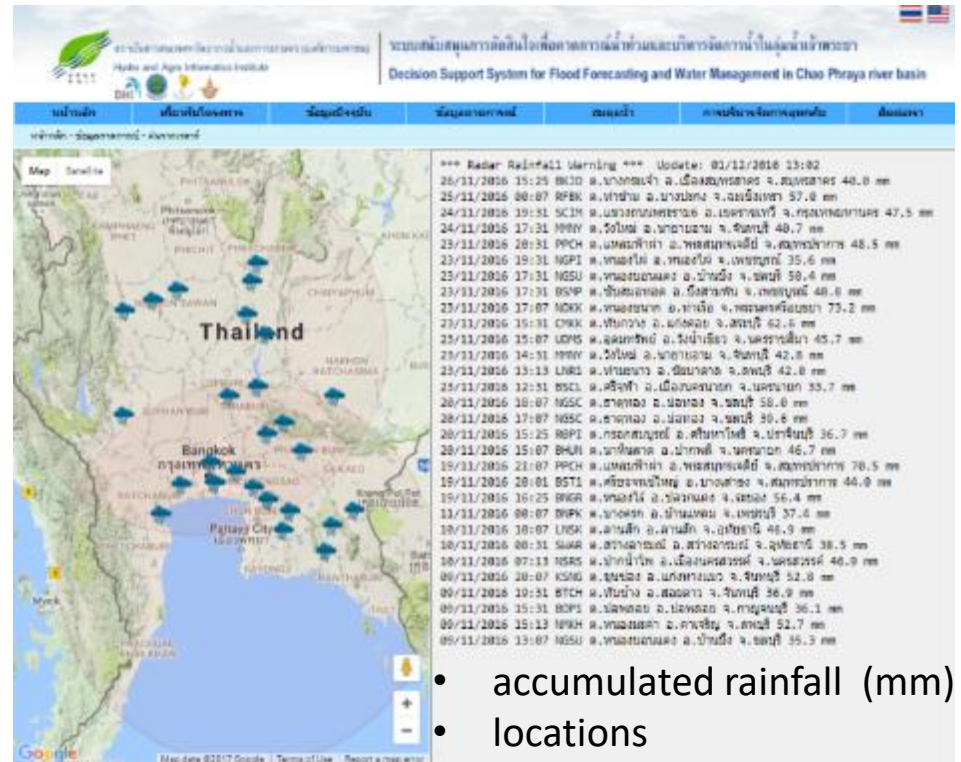


# Radar-based Rainfall on Decision Support System

## Radar Rainfall Map



## Heavy Rainfall Warning



[http://cpy2-forecast.haii.or.th/DSS/DashboardEngine.aspx?DashboardID=Chaophraya/TH/radar\\_image](http://cpy2-forecast.haii.or.th/DSS/DashboardEngine.aspx?DashboardID=Chaophraya/TH/radar_image)

# Flood Forecasting System for Local Scale

- **Flash flood potential index (FFPI)**

How prone is the catchment to flash floods based on its characteristics?

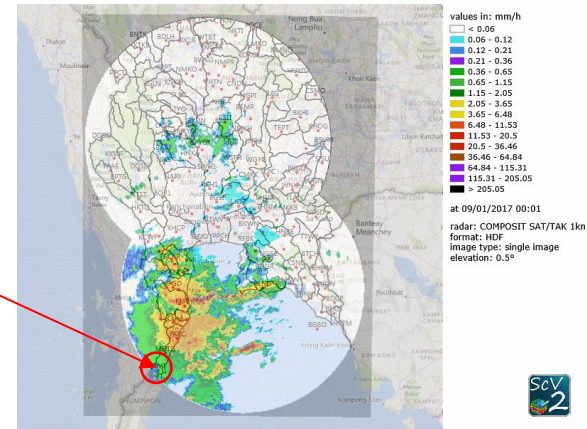
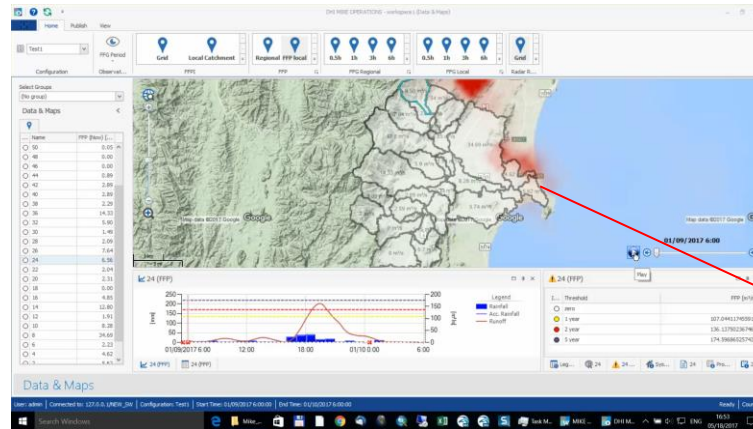
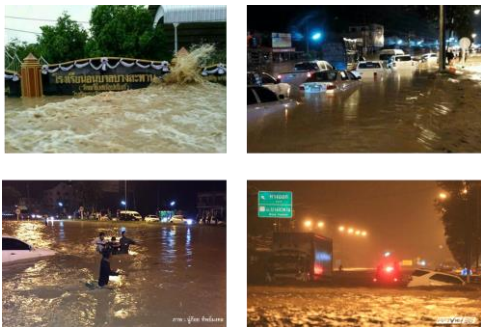
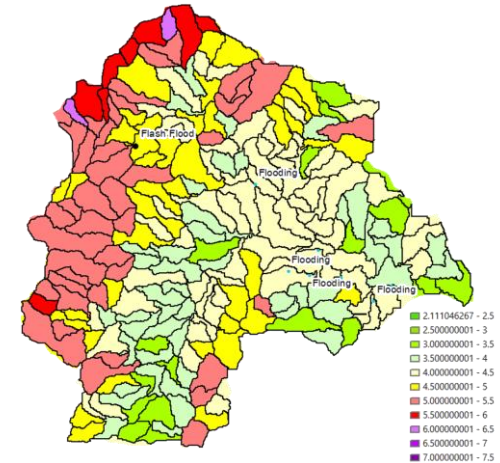
What areas are most dangerous?

- **Flash flood guidance (FFG)**

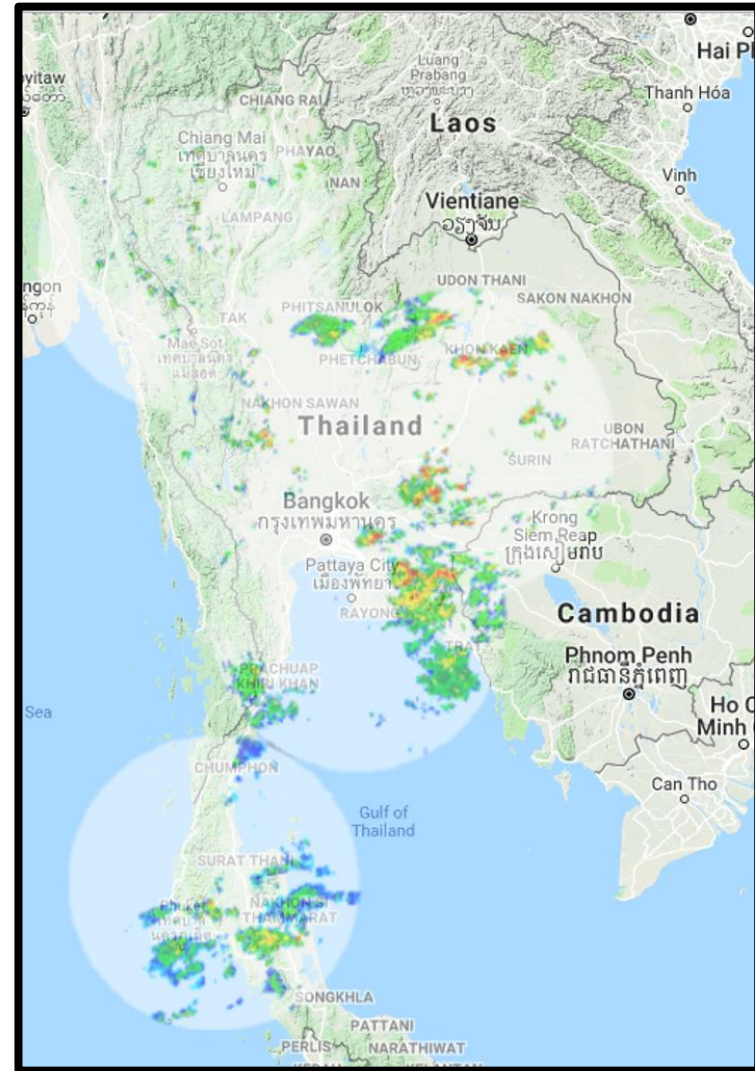
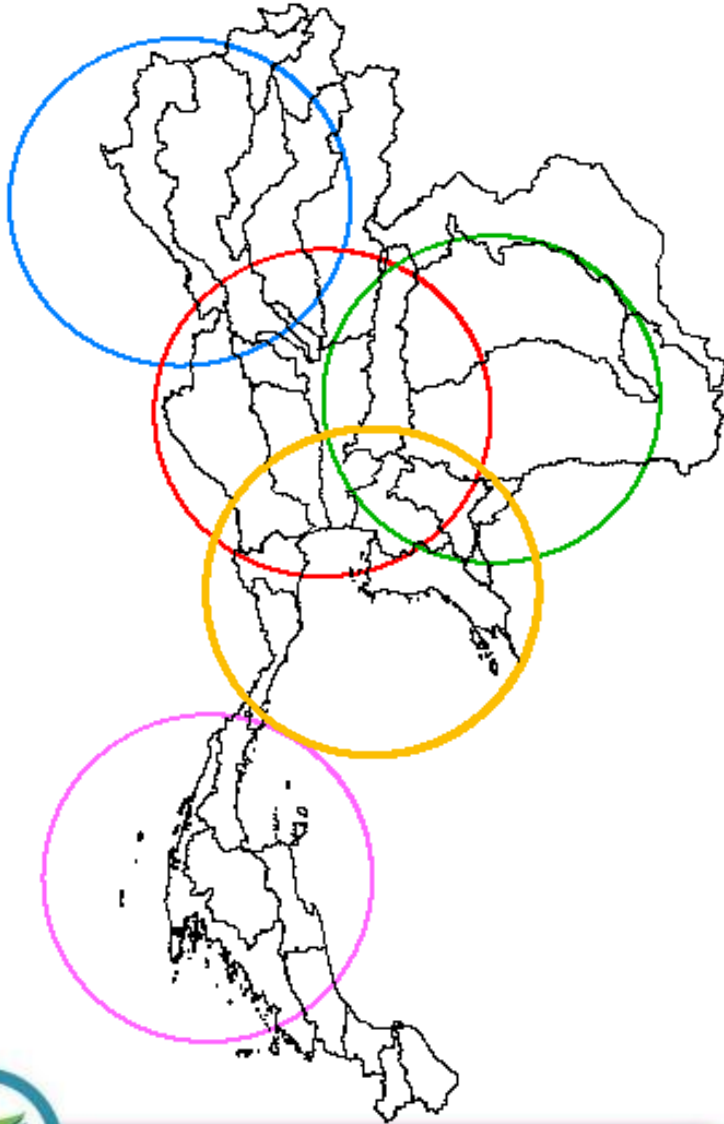
Based on the current state of the catchment how much precipitation is needed to cause flooding?

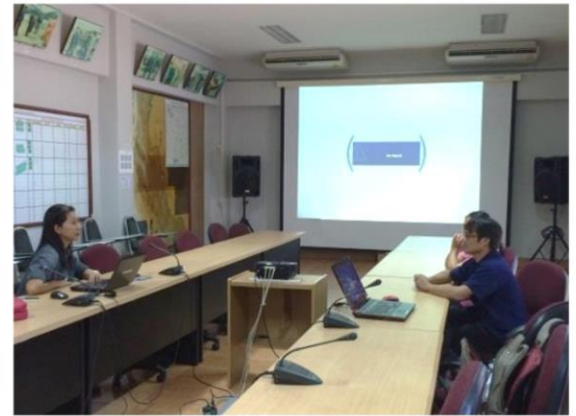
- **Flash flood prediction (FFP)**

Based on the current state of the catchment and predicted rainfall can we expect flooding?



# Future Plan









H A I I

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