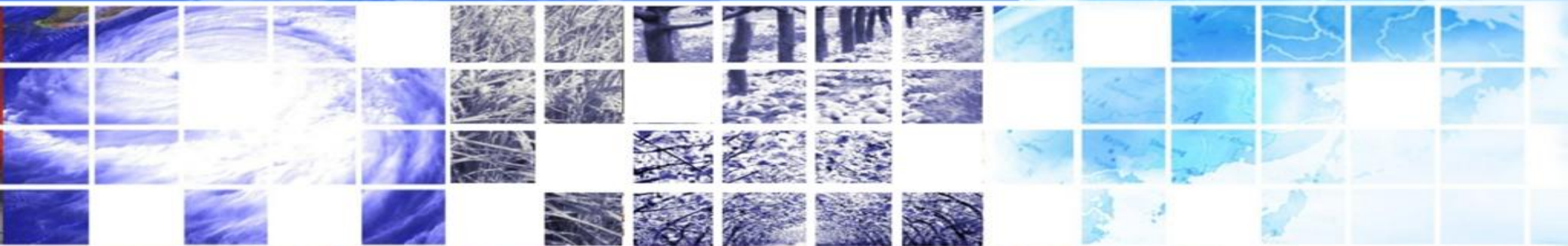


# KIDI CAT Model

- Korean Typhoon-Flood Model for Property

3 December 2021



Joonghee Yu

# Outlines



Framework of Korean Typhoon-Flood Model for Property

Methodology of Korean Typhoon-Flood Model for Property

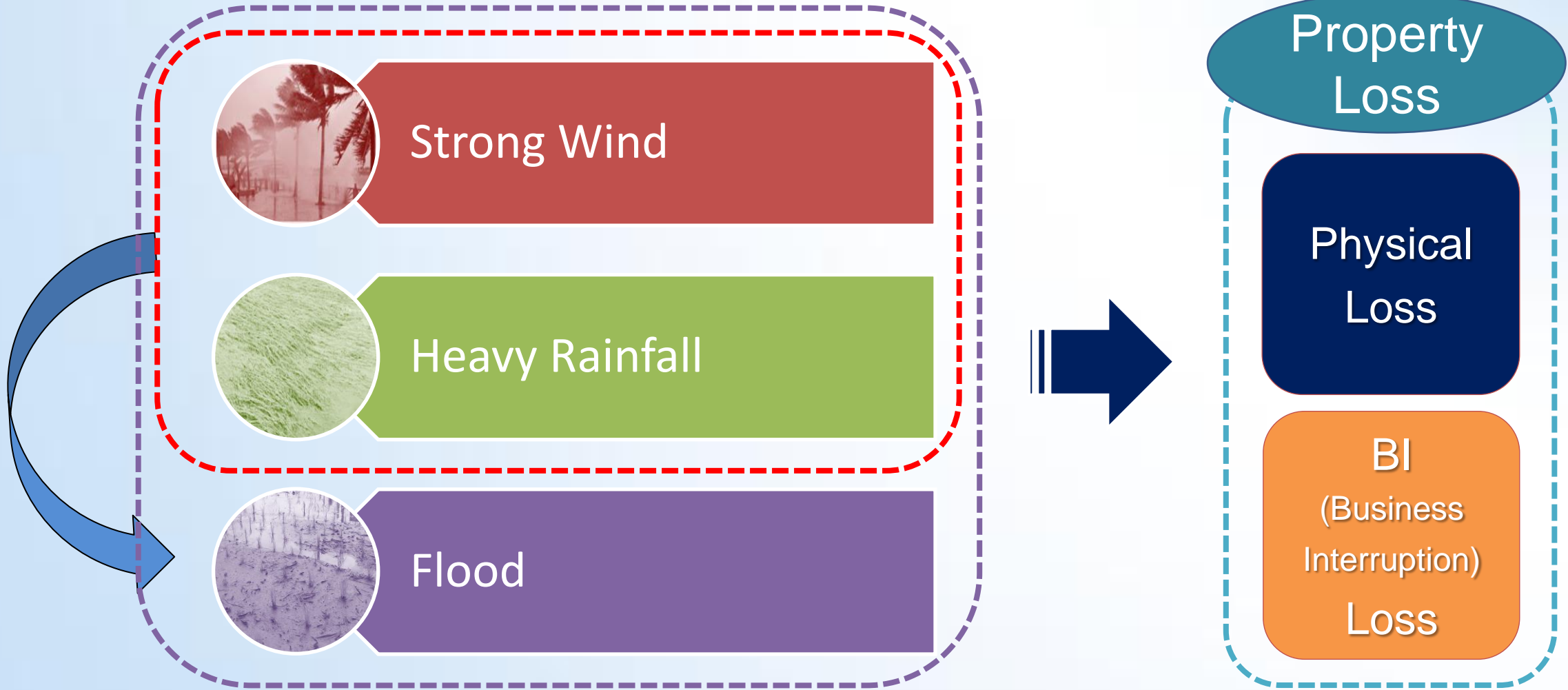
Brief introduction of KIDI Pandemic Model



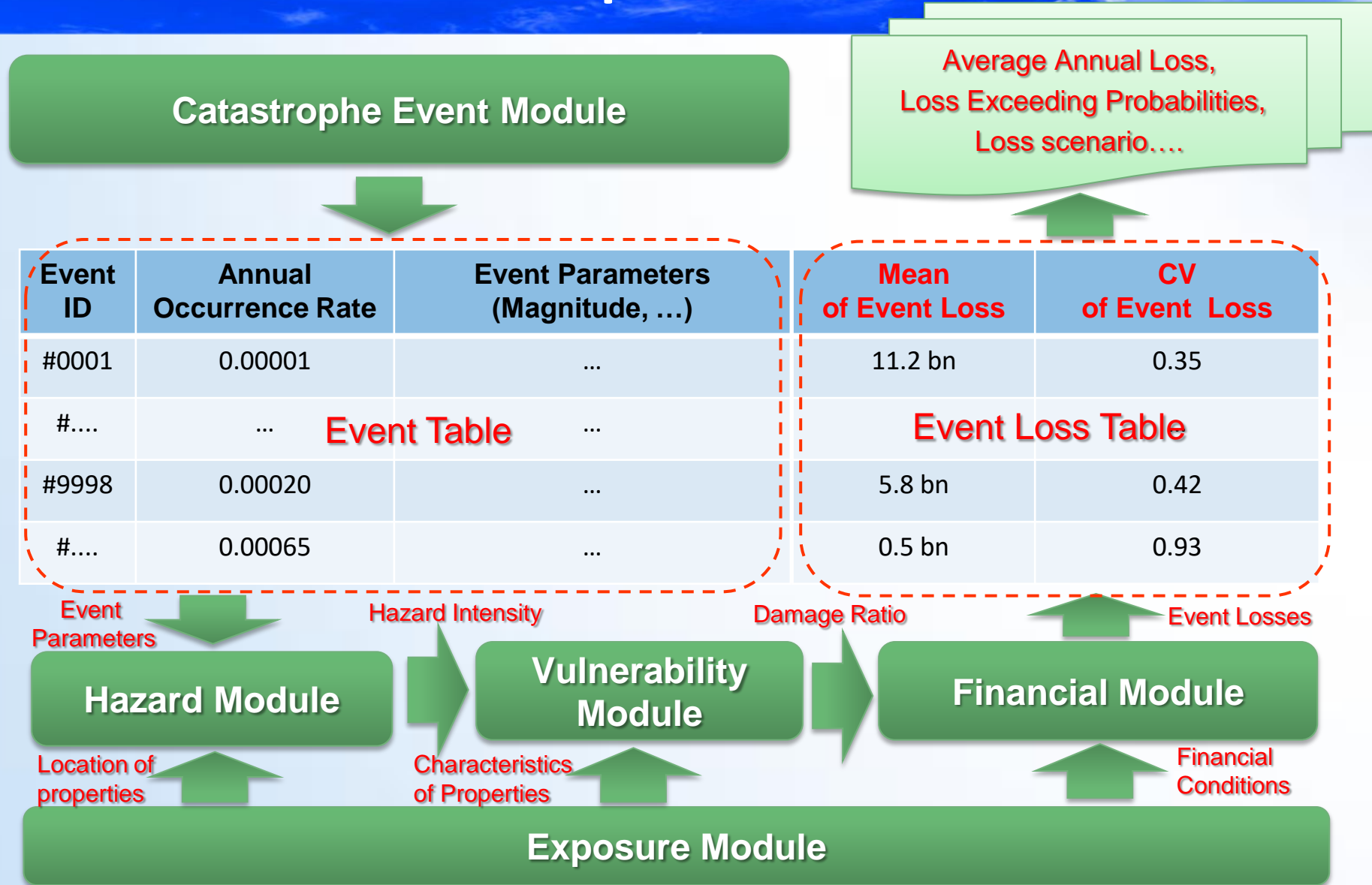
# Framework of Korean Typhoon-Flood Model for Property



# Major Hazard



# General Framework of Catastrophe Model

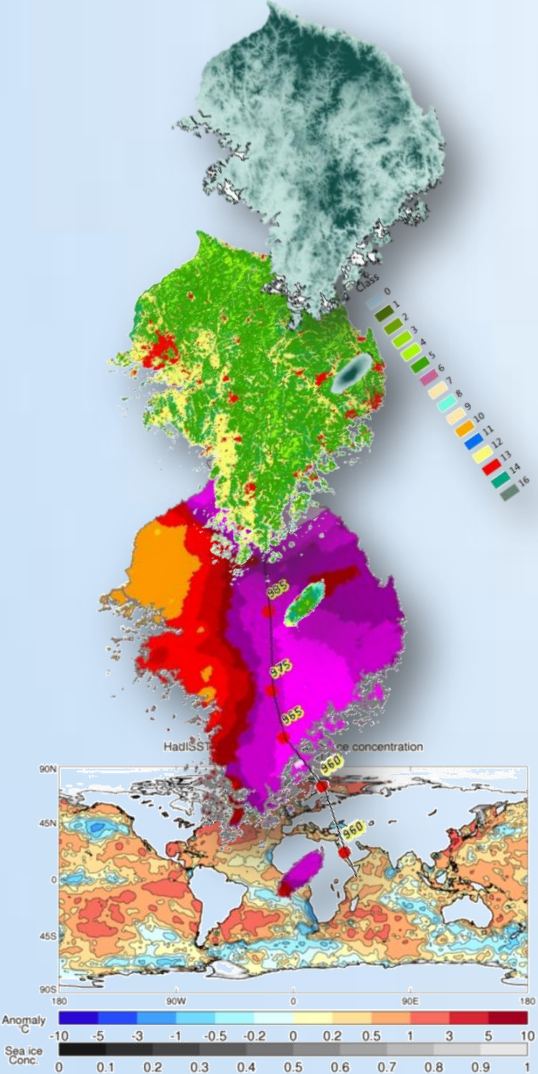
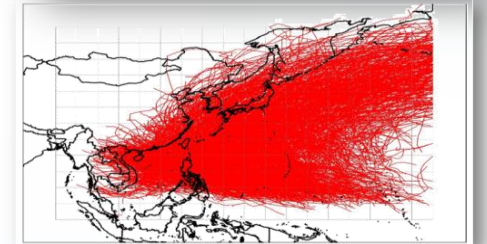
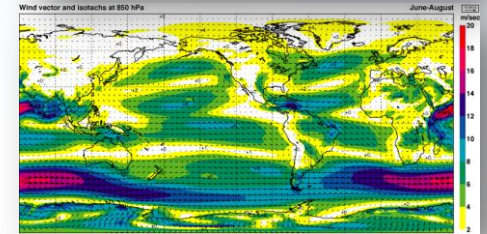
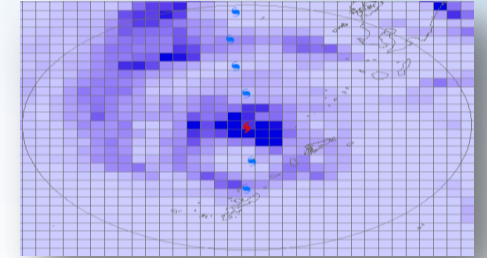
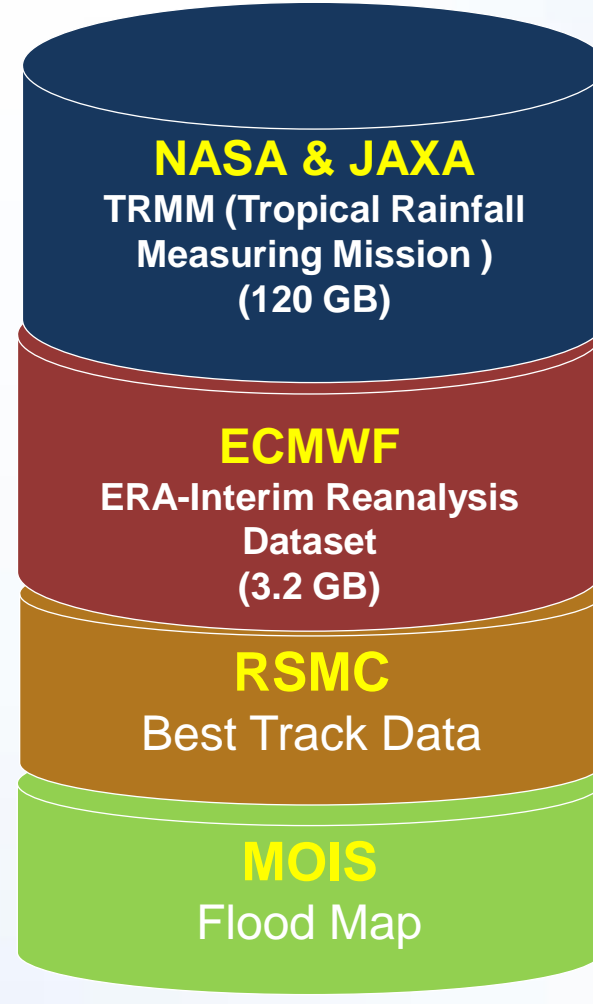
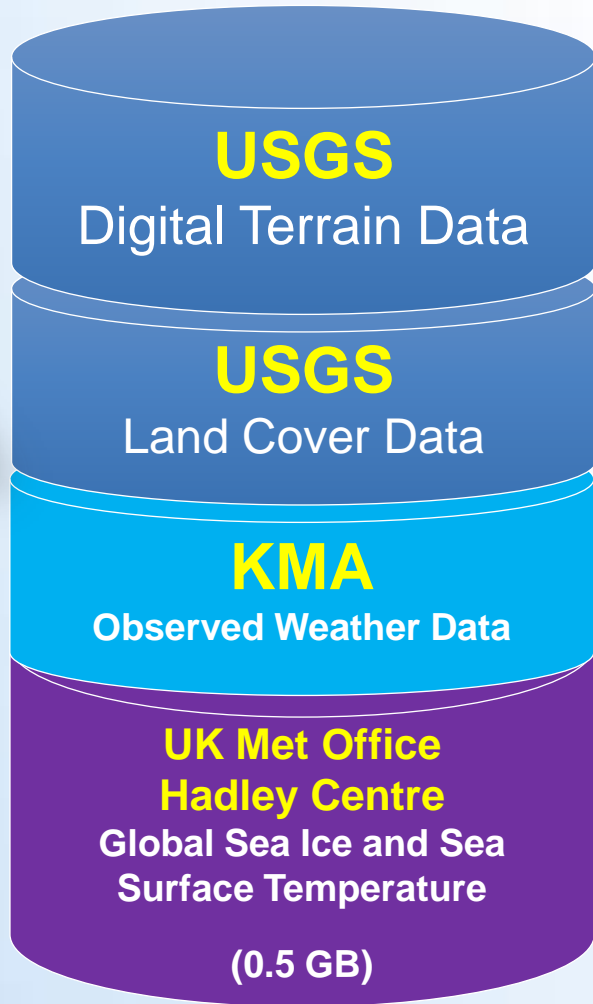




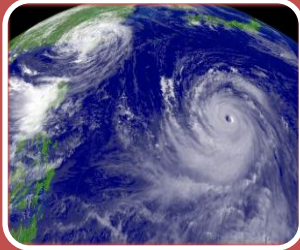
# Methodology of Korean Typhoon-Flood Model for Property



# Main Data Sources to Develop Event & Hazard Modules

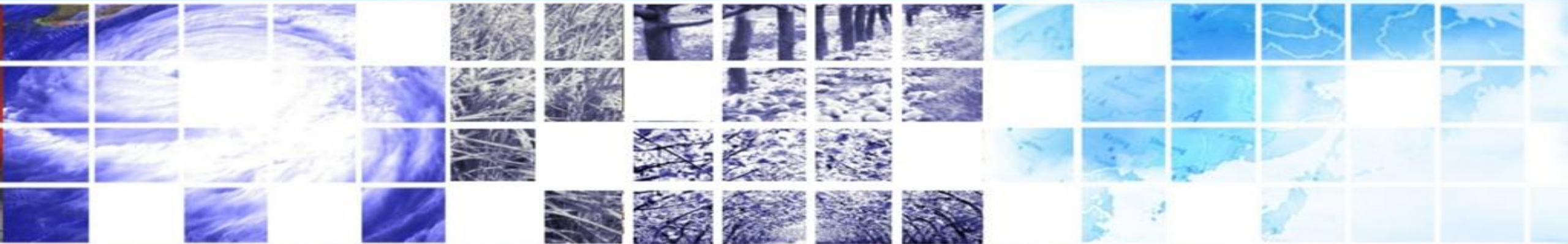






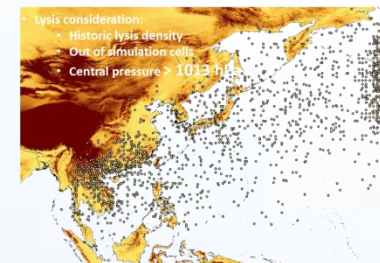
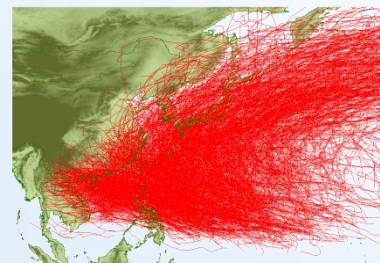
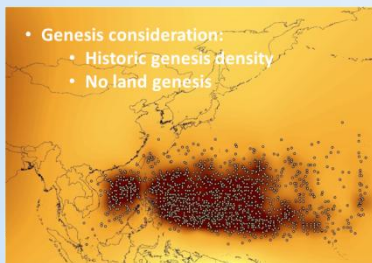
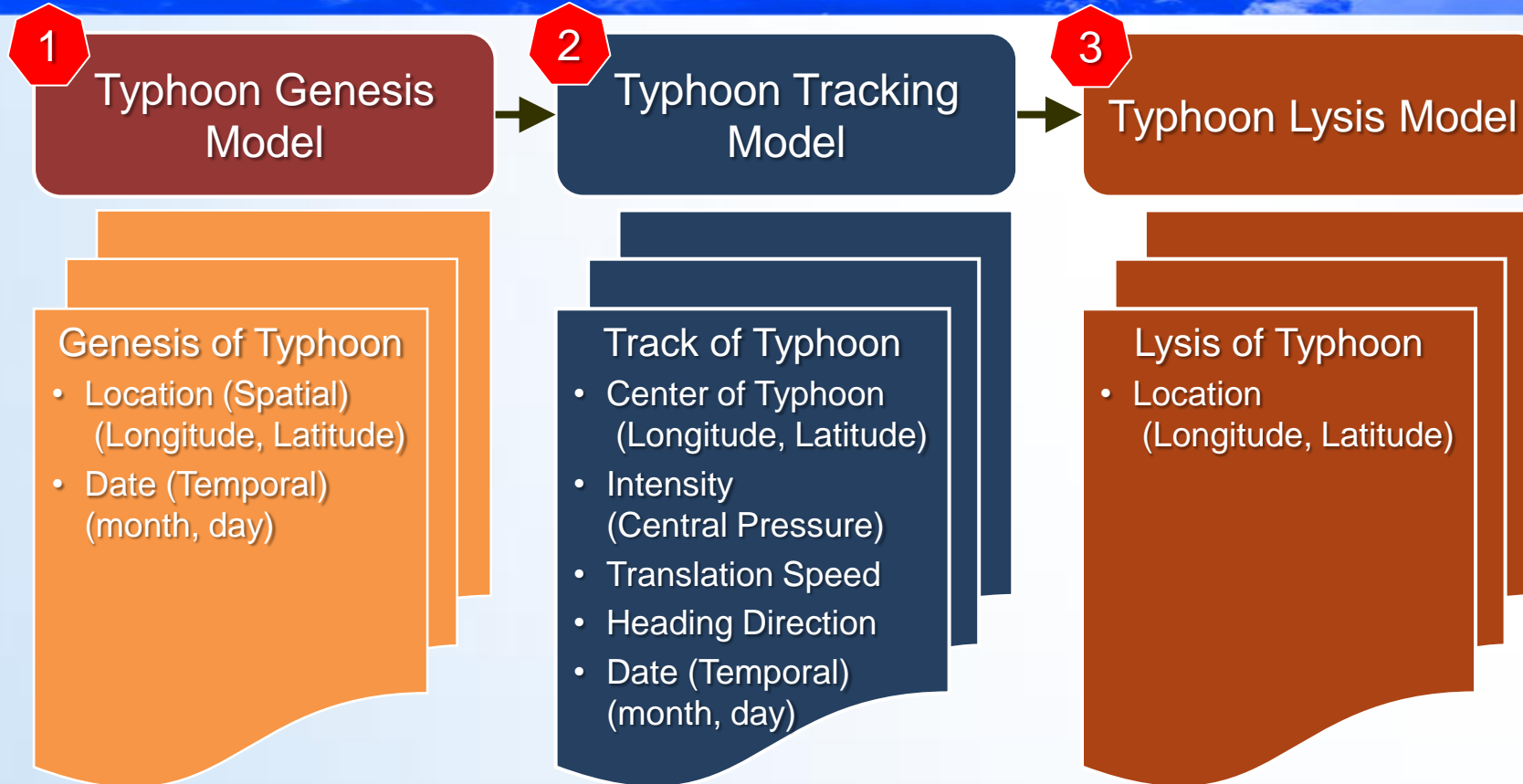
## Event Module

Generate a series of possible typhoon events with full spectrum to the target region(e.g. Western North Pacific or Specific Region)





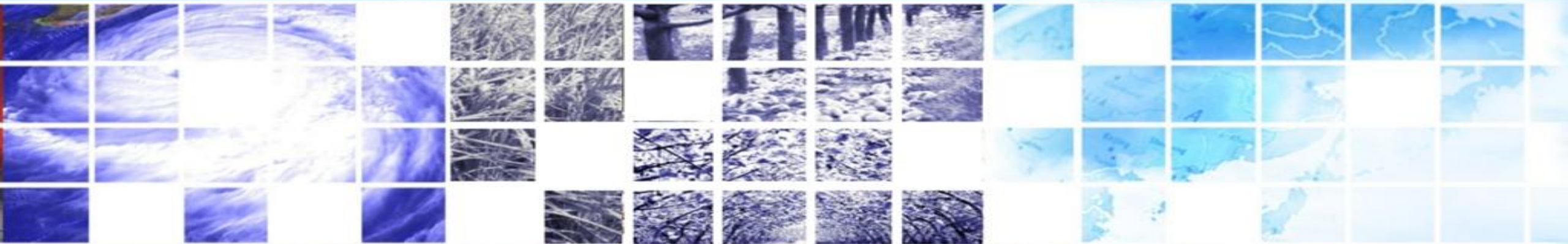
# Generate Stochastic Typhoon Events



# Hazard Module



Calculate Wind speed, Rainfall volume, Flood Intensity of interested sites, based on typhoon's parameters (track, central pressure, translation speed) , sea & atmosphere & site conditions (terrain, land cover).





# Key Factors Considered for Hazard Intensity Estimation



## Wind Speed

- Central Pressure of Typhoon (Typhoon Category )
- Sea Surface Temperature
- Translation Speed of Typhoon (Asymmetry Effect)
- Heading Direction of Typhoon
- Surface Roughness (Land Cover)
- Orography Roughness (Terrain)
- Topographic effect

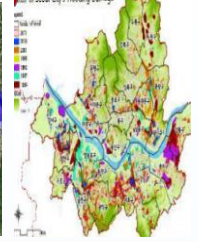
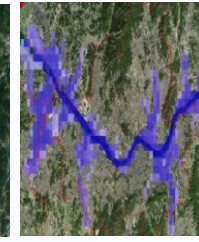
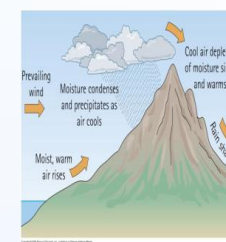
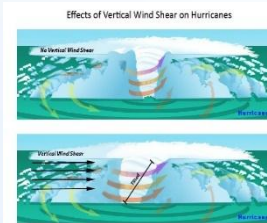
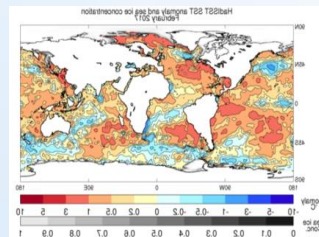
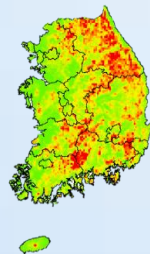
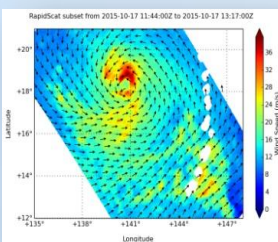
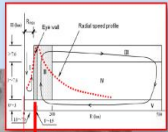
## Rainfall Intensity

- Central Pressure of Typhoon (Typhoon Category )
- Distance to Typhoon Center
- Sea Surface Temperature
- Vertical Wind Shear
- Wind Speed & Direction at Site
- Terrain Effect (Slope & Elevation)

## Flood Intensity

- MOIS\* Flood Map  
\* Ministry of Interior and Safety
- JRC Flood Map
- Historical Inundation Map

Typhoon Wind profile :  
• Willoughby Model  
• Holland Model



# Wind Hazard Module Structure



Event Module

Hazard Module

Typhoon parameters:

- Track(Time, Longitude, Latitude)
- Head Direction
- Translation Speed
- Central pressure

Wind Speed Profile model

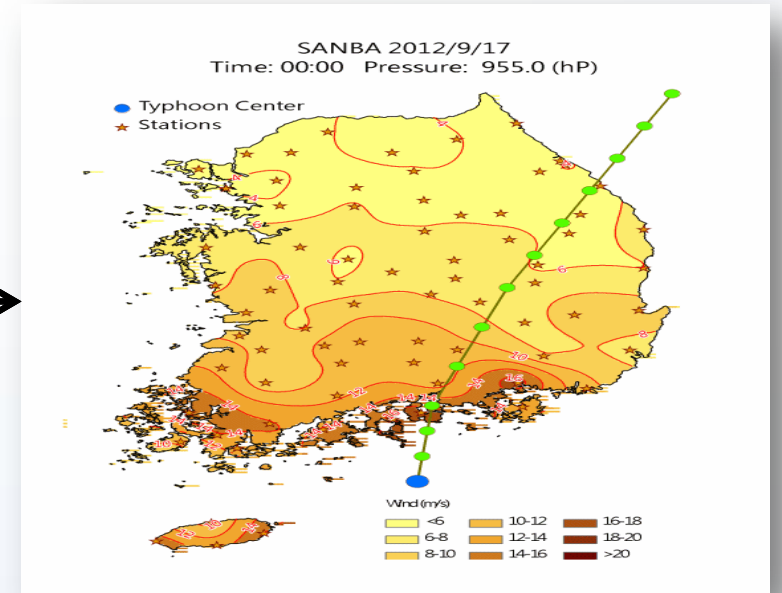
Surface Roughness

Orography Roughness

Topographic Effect

Two Layer Model of the Planetary Boundary Layer

Surface Wind  
(Land cover, Terrain, Topographic Effect)



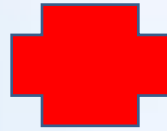


# Rainfall Hazard Module Structure



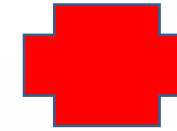
## Meso-Scale Asymmetry

Vertical Wind  
Shear Effect  
Model



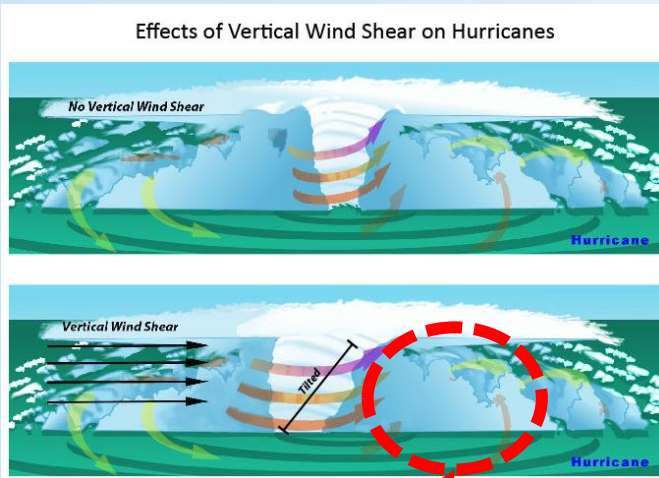
## Symmetry distribution

R-CLIPER  
Model

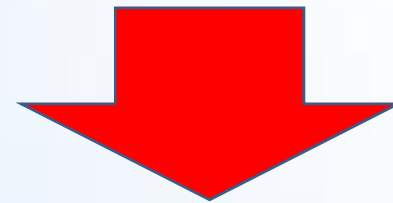


## Small-Scale land effect

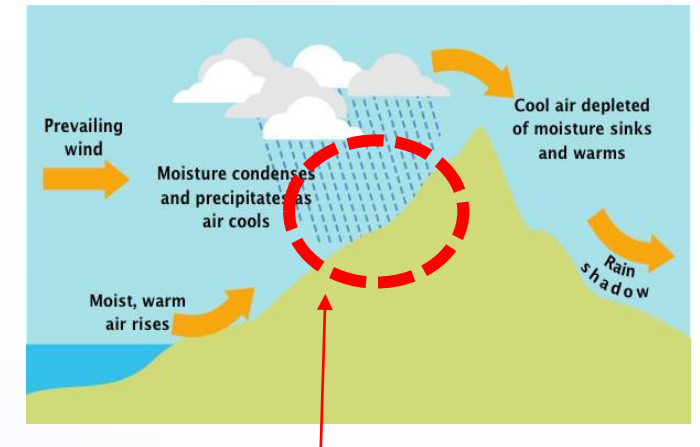
Terrain Effect  
Model



**Rainfall Concentration  
(Left Front of Vertical Shear Direction)**

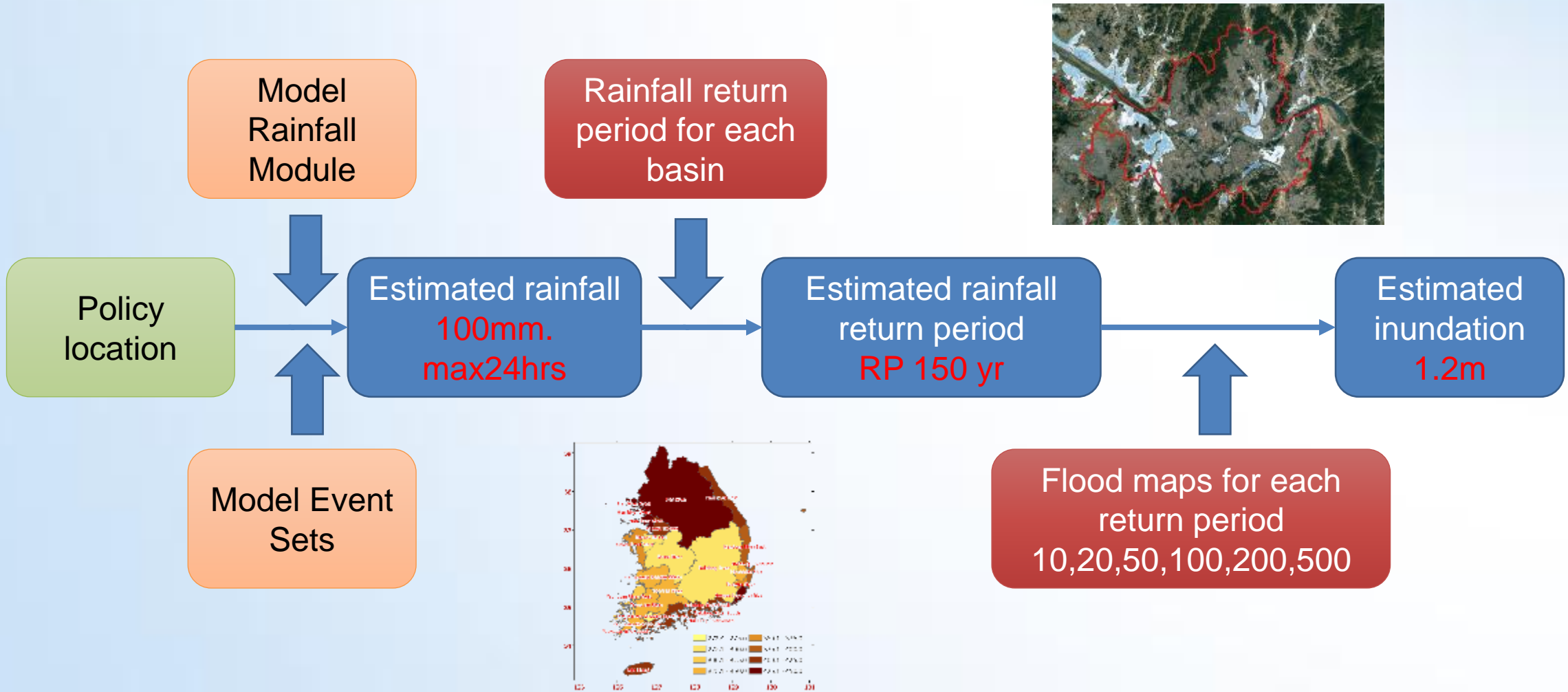


**Typhoon  
Rainfall Model**



**Rainfall Concentration  
(Windward side)**

# Flood Hazard Module Structure

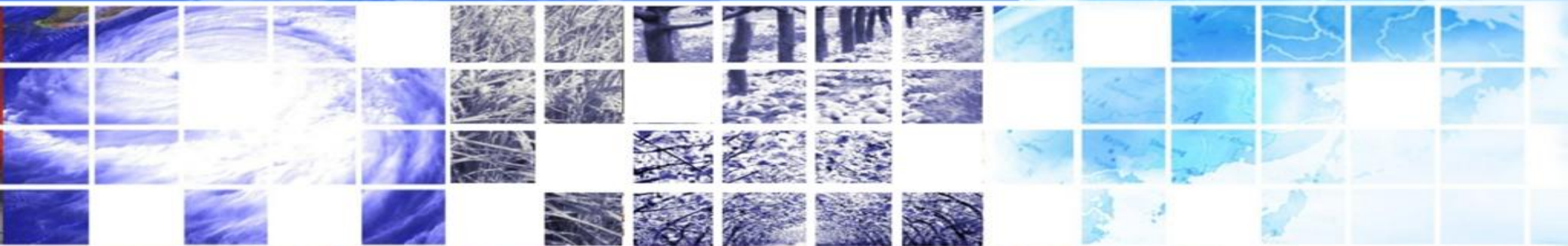




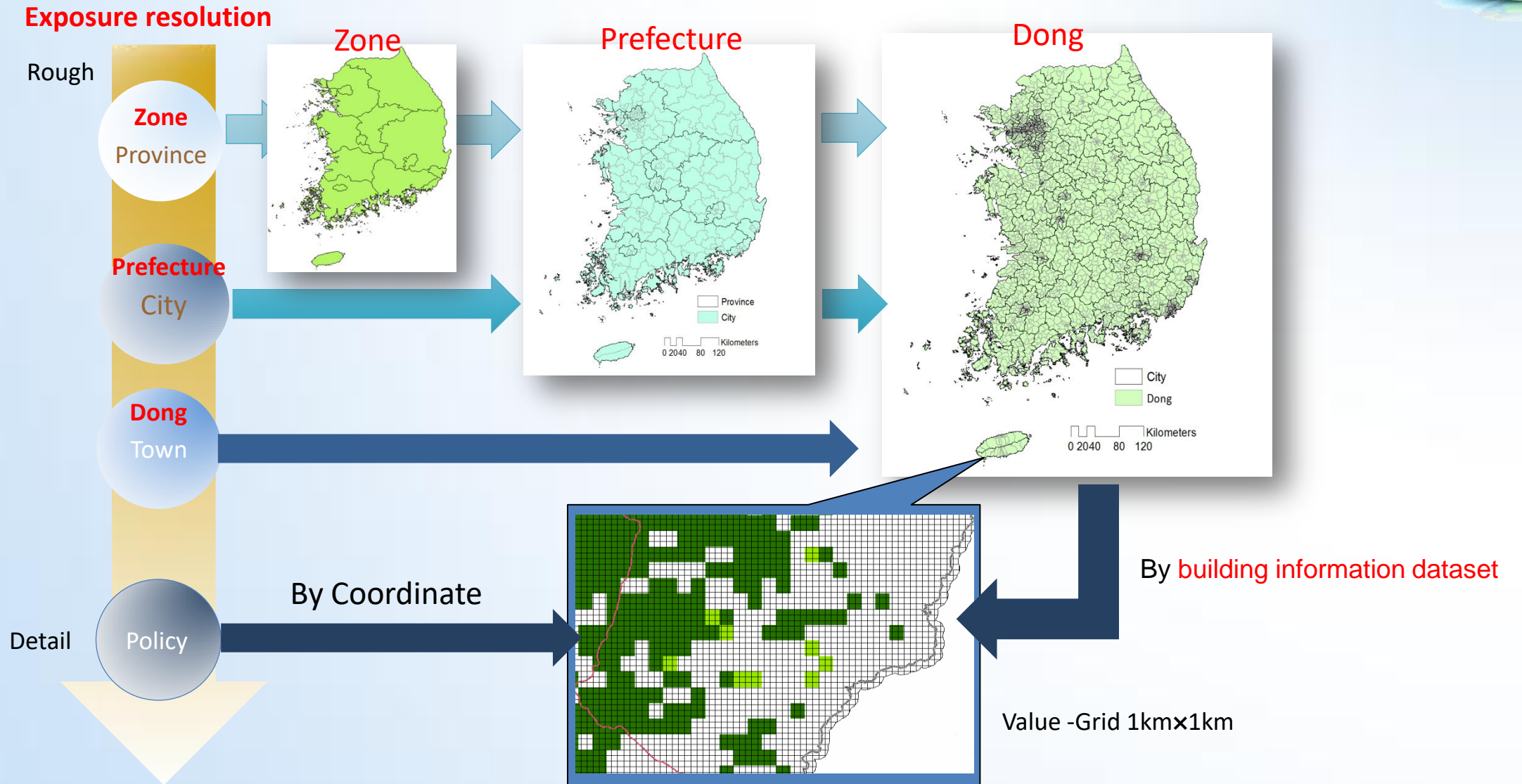


# Exposure Module

Store and provide the information of exposure (risk type, risk location, value, policy conditions)



# Exposure resolution



# Exposure data Source



**Open Data Portal –**  
**Building Information Dataset** (2017.12 updated)  
**(MOLIT, Ministry of Land, Infrastructure and Transport)**

A total of **13.9 millions** buildings in the dataset.



## Major Building Attributes

- Location (GIS shape file)
- Structure type
- Occupancy
- Building height
- Approval date
- Building Area

## Classification of Occupancy

Code	Korean	English
1000	단독주택	House
1001	단독주택	House
1002	다중주택	Multi-House
1003	다가구주택	Multi-Family Housing
1004	공관	Official Residence
2000	공동주택	Apartment House
2001	아파트	Apartment
2002	연립주택	Townhouse
2003	다세대주택	Multi-Family House
2004	생활편의시설	Living Convenience Facility
2005	부대시설	Amenities
2006	복지시설	Welfare Facility
2007	기숙사	Dormitory
3000	1종근린생활시설	Neighborhood Living Facility (Category 1)
3001	소매점	Retail Store
3002	휴게음식점	Restaurant
3003	이(미)용원	Hair Salon
3004	일반목욕장	Common Bathhouse
3005	의원	Clinic
3006	체육장	Athletic Center
3007	마을공동시설	Community Facilities
3008	변전소	Substation
3009	양수장	Pumping Station
3010	정수장	Water Purifier
3011	대피소	Shelter
3012	공중화장실	Public Toilet
3013	세탁소	Laundry
3014	치과의원	Dental Clinic
3015	한의원	Acupuncture Clinic
3016	침술원	Acupuncture
3017	집골원	Osteopenia
3018	조산원	Midwife Clinics
3019	탁구장	Table Tennis Court
3020	체육도장	Gymnasium
3021	마을공회당	Village Hall
3022	마을공동작업소	Community Center
3023	마을공동구판장	Town Hall
3100	공공시설	Public Facilities
3101	동사무소	Government Office
3102	경찰서	Police Office
3103	파출소	Police Box
3104	소방서	Fire Station

## Classification of structure type

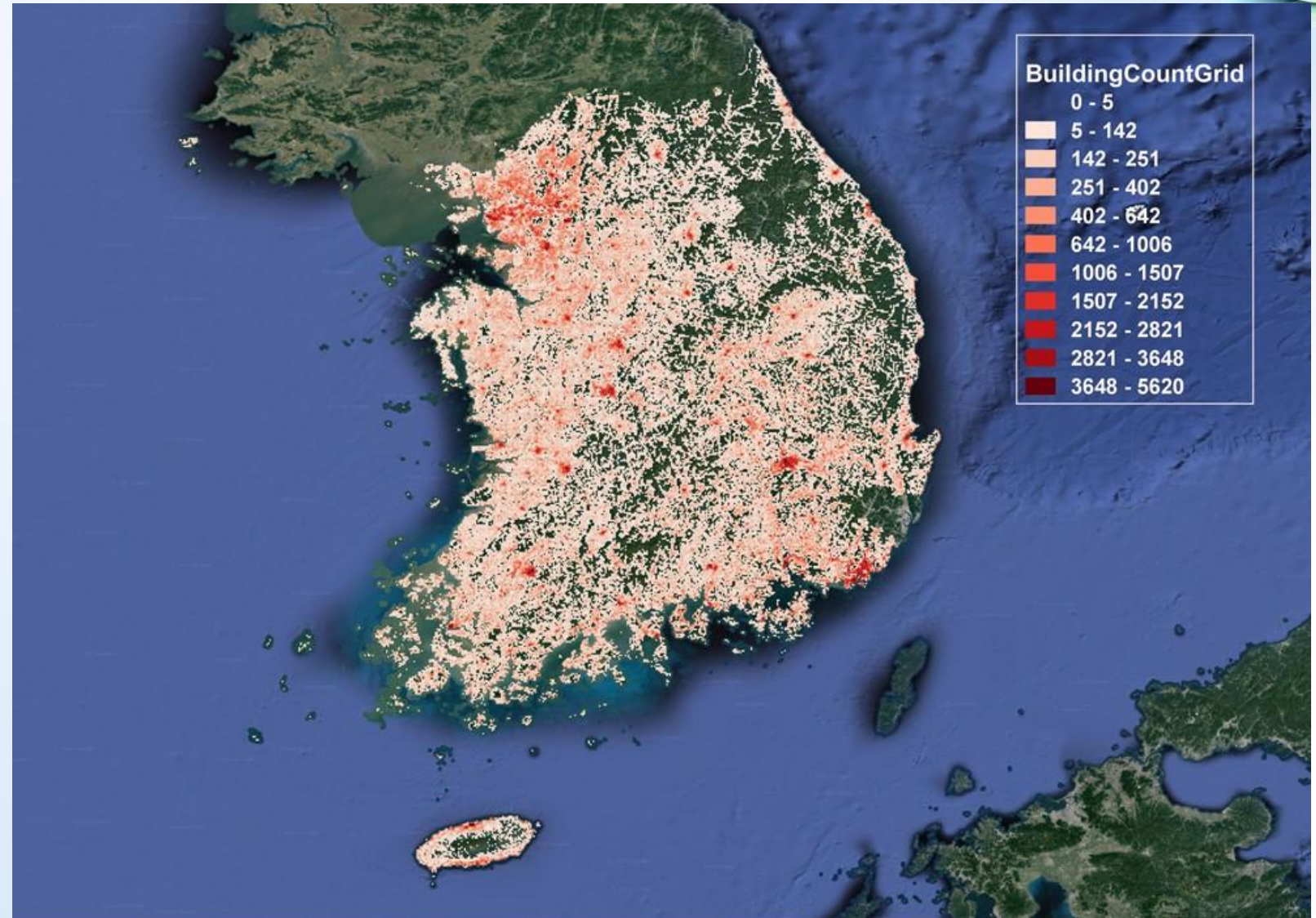
Code	Korean	English
10	조적구조	Mixed structure
11	벽돌구조	Brick structure
12	블록구조	Block structure
13	석구조	Stone structure
19	기타조적구조	Other structure
20	콘크리트구조	Concrete structure
21	철근콘크리트구조	Reinforced concrete structure
22	프리캐스트콘크리트구조	Precast concrete structure
29	기타콘크리트구조	Other Concrete Structure
30	철골구조	Steel structure
31	일반철골구조	General steel structure
32	경량철골구조	Light weight steel structure
33	강파이프구조	Steel pipe structure
39	기타강구조	Other steel structures
40	철골철근콘크리트구조	Steel reinforced concrete structure
41	철골콘크리트구조	Steel frame structure
42	철골철근콘크리트구조	Steel reinforced concrete structure
49	기타철골철근콘크리트구조	Other steel reinforced concrete structures
50	목구조	Wood structure
51	일반목구조	General tree structure
52	통나무구조	Log structure
99	기타구조	Other structures



# Exposure data Source



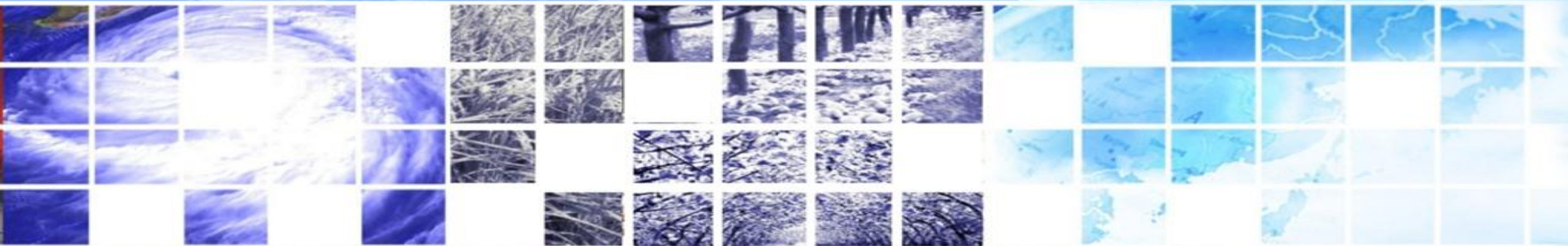
Spatial resolution of  
**1 km x 1km** Grid of  
building information has been  
established as important base of  
Exposure Module.





# Vulnerability Module

Calculate damage ratio of interested target based on Hazard Intensities (wind speed, inundation depth) at site.



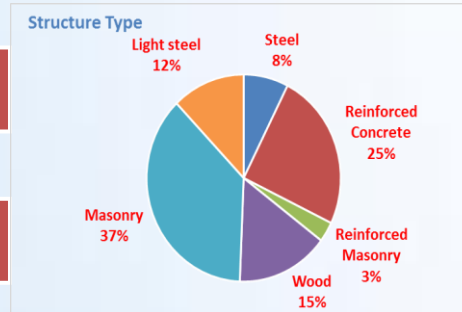


# Factors Considered in Wind Damage Functions



Hazus<sup>®</sup>-MH 2.1

Korea Building Type



■ Building structure + interior

■ Content due to cladding failure and water infiltrate

Building Height

Structure Type

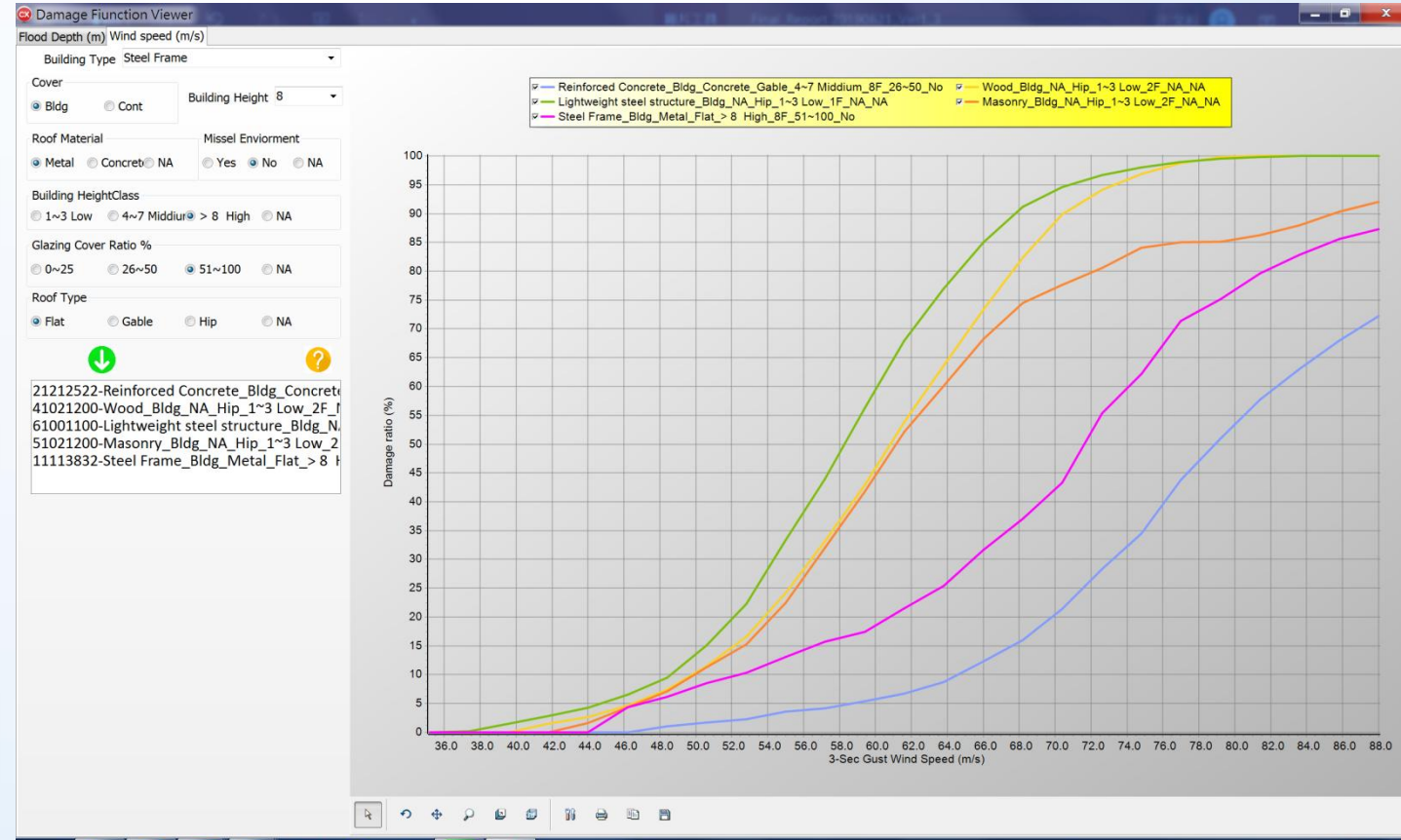
Flying Object Impact

Roof Material

Roof Type

Glazing Coverage

**146**  
Curves



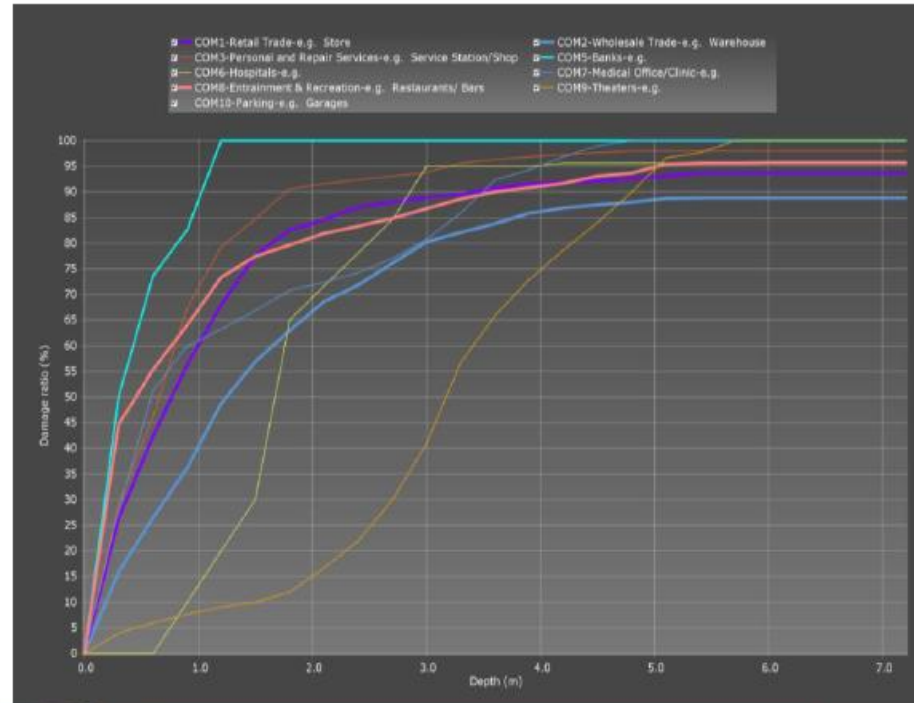


# Factors Considered in Flood Damage Functions



## Flood Damage (Building, Contents)

- ✓ Structure Type
- ✓ Building Height
- ✓ Occupancy
- ✓ Flood Gate
- ✓ Raised Ground
- ✓ .....



A street in the southwestern city of Gwangju is flooded on Aug. 28, 2018, after overnight downpours. (image: Gwangju Nambu Fire Station)- August 28, 2018 by Korea Bizwire in Environment

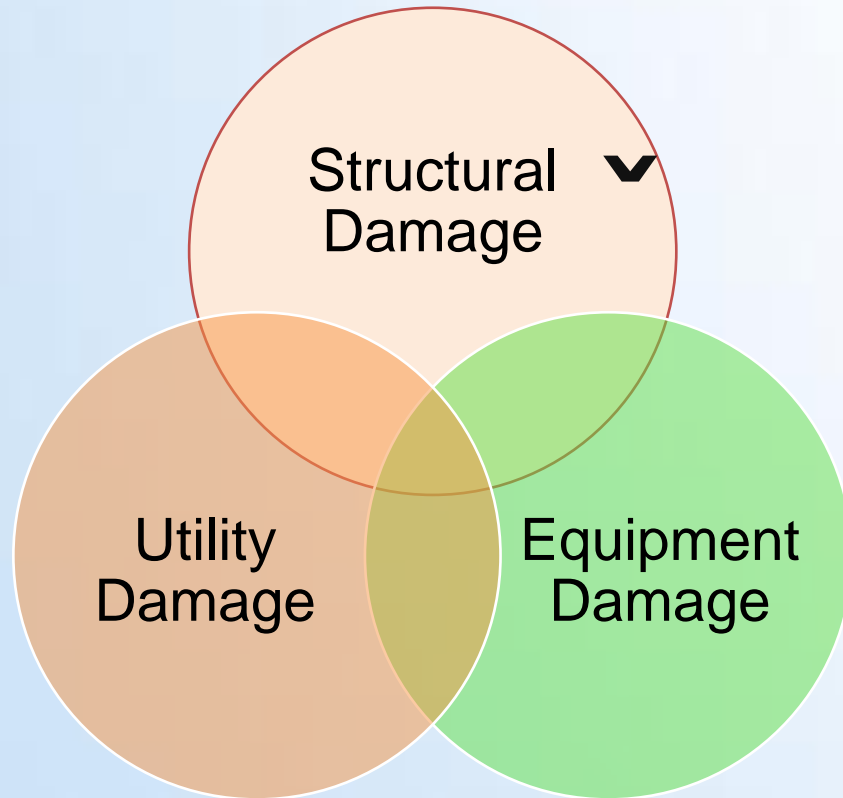
## Flood Hazard (intensity)

- ✓ Inundation depth
- Flow Velocity
- Duration of Inundation
- Water Conditions  
(Salt, Mud, Contamination)

# BI Loss (induced by typhoon-flood event)



**Business Interruption:** The loss of income that a **business** suffers after a disaster



Most business interruption insurance covers the following items:

**Profits**

**Fixed costs**

**Temporary location**

**Commission and training cost**

**Extra expense**

**Employee wages**

**Taxes**

.....

# BI Loss (How to calculate BI Day)

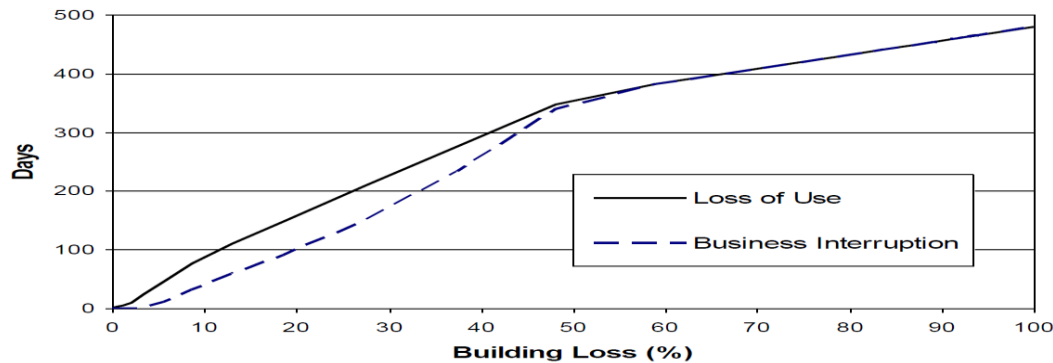


Label	Occupancy Class	Business Interruption Time Multiplier				
		Building Loss Ratio				
		0%	2%	10%	50%	100%
RES3	Multi-Family Dwelling	0	0	0.5	1	1
RES4	Temporary Lodging	0	0	0.5	1	1
RES5	Institutional Dormitory	0	0	0.5	1	1
RES6	Nursing Home	0	0	0.5	1	1
COM1	Retail Trade	0.5	0.1	0.1	0.3	0.4
COM2	Wholesale Trade	0.5	0.1	0.2	0.3	0.4
COM3	Personal and Repair Service	0.5	0.1	0.2	0.3	0.4
COM4	Professional/Technical/Business Services	0.5	0.1	0.1	0.2	0.3
COM5	Banks/Financial Institutions	0.5	0.1	0.05	0.03	0.03
COM6	Hospital	0.5	0.1	0.5	0.5	0.5
COM7	Medical Office/Clinic	0.5	0.1	0.5	0.5	0.5
COM8	Entertainment & Recreation	0.5	0.1	1	1	1
COM9	Theaters	0.5	0.1	1	1	1
COM10	Parking	0.1	0.1	1	1	1
IND1	Heavy Industrial Factory	0.5	0.5	1	1	1
IND2	Light Industrial Factory	0.5	0.1	0.2	0.3	0.4
IND3	Food/Drug/Chemicals Factory	0.5	0.2	0.2	0.3	0.4
IND4	Metals/Minerals Processing Factory	0.5	0.2	0.2	0.3	0.4
IND5	High Technology Factory	0.5	0.2	0.2	0.3	0.4
IND6	Construction	0.5	0.1	0.2	0.3	0.4

(Hazus MH2.1)

ID	OCC_CLASS	SLIGHT(0.2%)	MODERATE(10%)	EXTENSIVE(50%)	COMPLETE(100%)	DESCRIPTION
1	RES	0	60	360		720 Single Family Dwelling
2	RES	0	10	120		240 Mobile Home
3	RES	0	60	480		960 Multi Family Dwelling
4	RES	0	45	360		480 Temporary Lodging
5	RES	0	45	360		480 Institutional Dormitory
6	RES	0	60	480		960 Nursing Home
7	COM	1	9	81		144 Retail Trade
8	COM	1	18	81		144 Wholesale Trade
9	COM	1	18	81		144 Personal and Repair Services
10	COM	2	9	72		144 Professional/Technical Services
11	COM	2	45	90		180 Banks/Financial Institutions
12	COM	2	67.5	270		360 Hospital
13	COM	2	67.5	135		270 Medical Office/Clinic
14	COM	2	90	180		360 Entertainment & Recreation
15	COM	2	90	180		360 Theaters
16	COM	0.5	60	180		360 Parking
17	IND	5	90	240		360 Heavy
18	IND	1	18	72		144 Light
19	IND	2	18	72		144 Food/Drugs/Chemicals
20	IND	2	18	72		144 Metals/Minerals Processing
21	IND	4	27	108		216 High Technology
22	IND	1	12	48		128 Construction
23	RES	0	46.7	360		640 Average
24	COM	2	90	180		360 Average
25	IND	5	90	240		360 Average

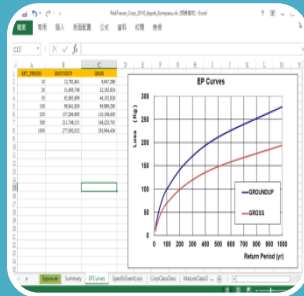
(Hazus 99)



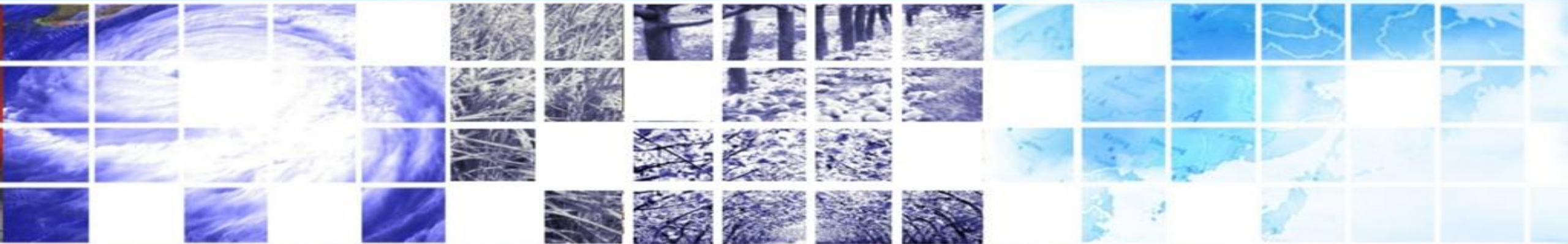
$$N = N_{lou}(R_{building}) \cdot Mod(R_{building})$$



# Financial Module



Calculate possible losses based on different financial perspective, e.g. ground up loss, insurance loss (event losses , loss exceeding probabilities, annual average loss).

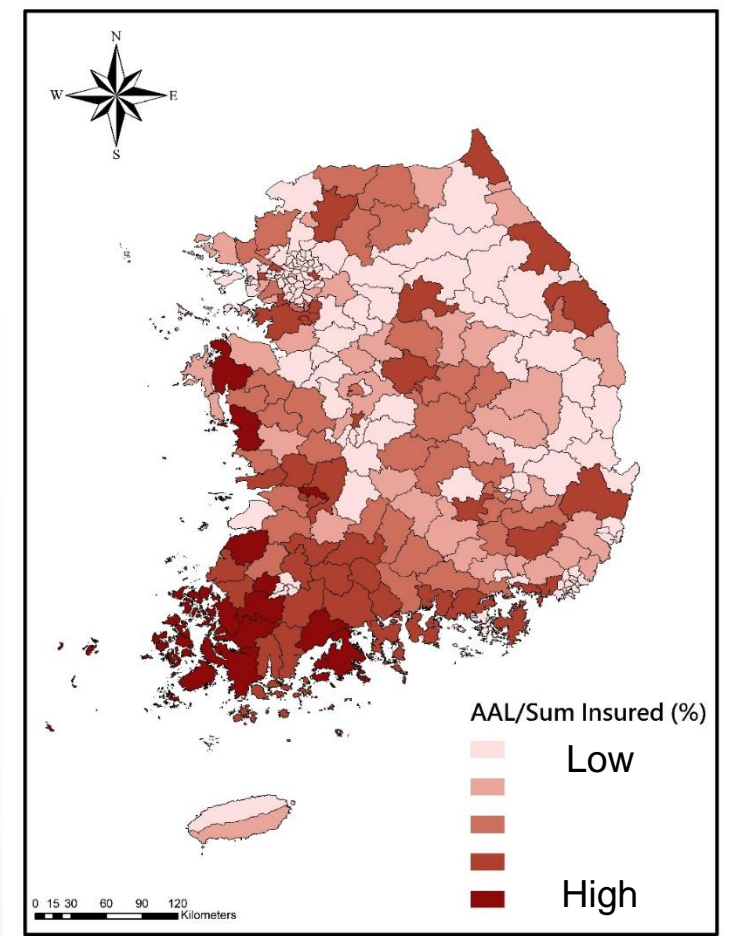
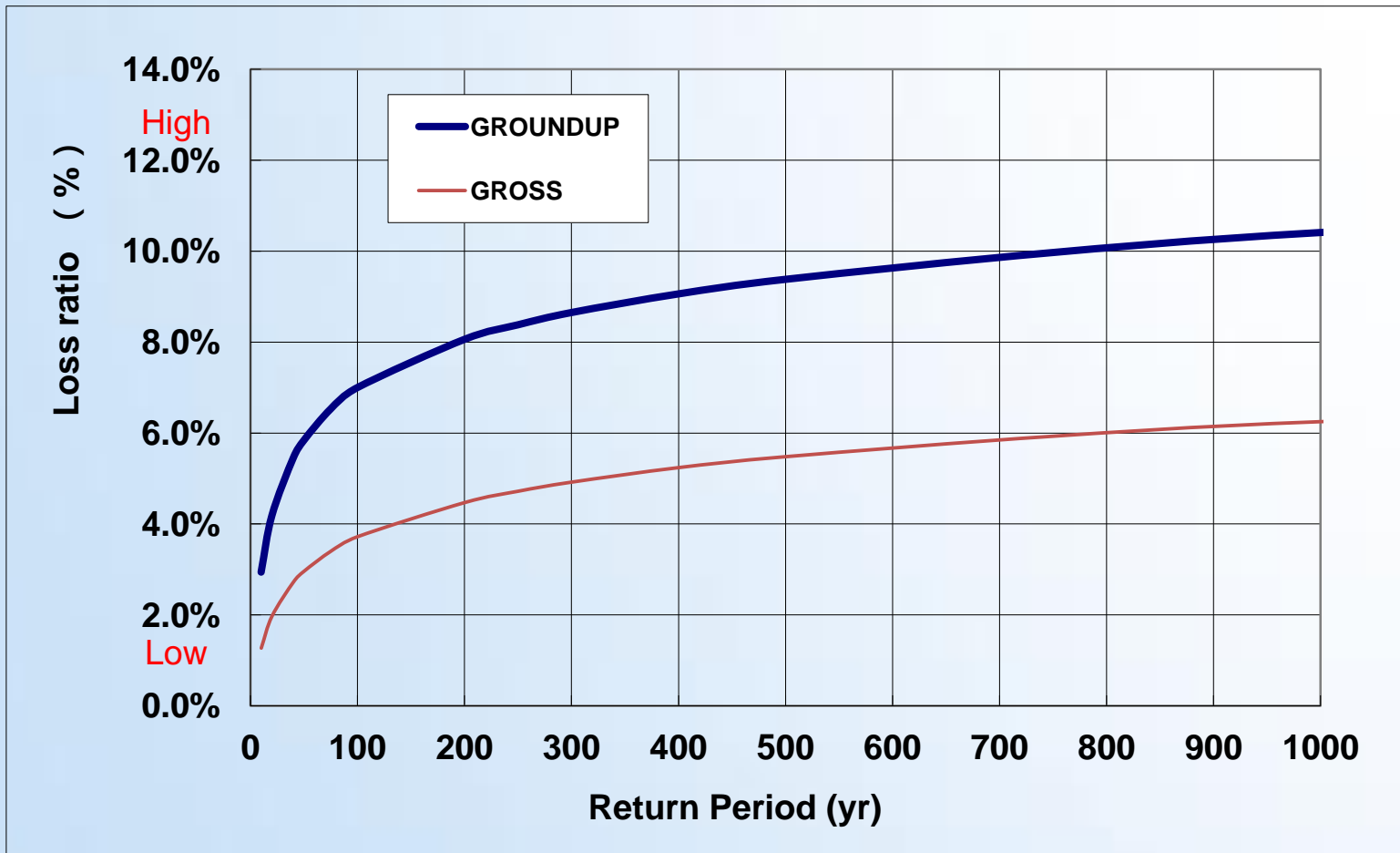


# Major Model Results – PML Curve & AAL



PML (Probable Maximum Loss) Curve

AAL (Average Annual Loss)





# Brief Introduction of KIDI Pandemic Model

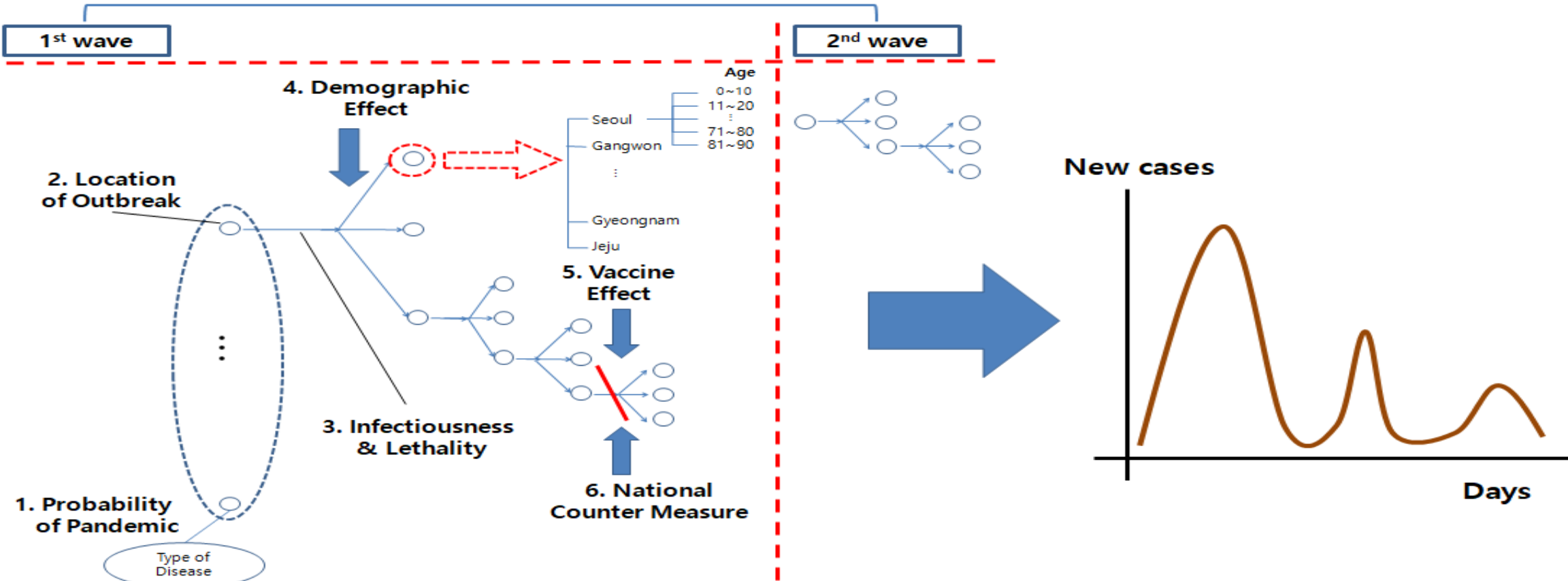




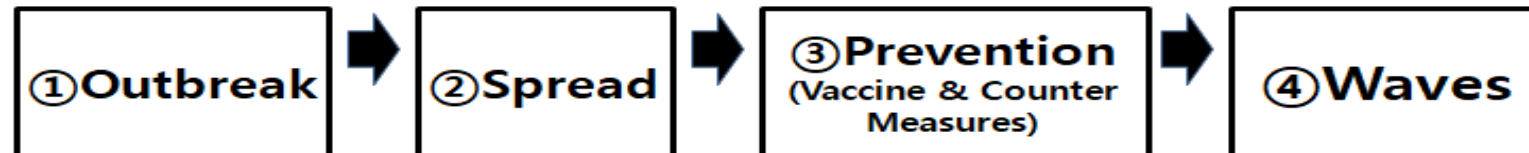
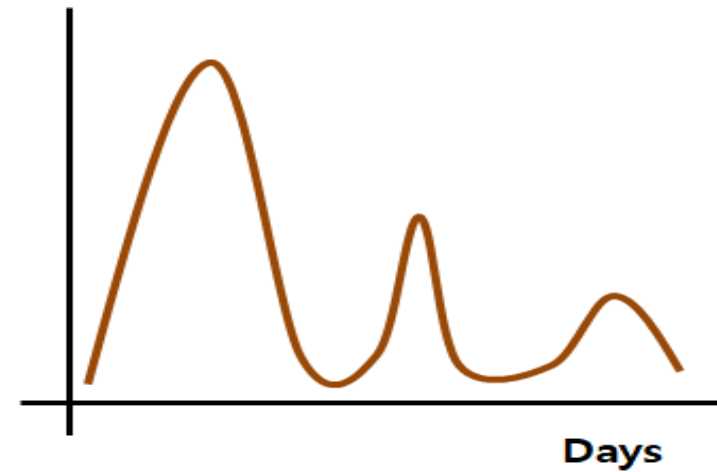
# KIDI Pandemic Model Overview



## 7. Pandemic Lifecycle



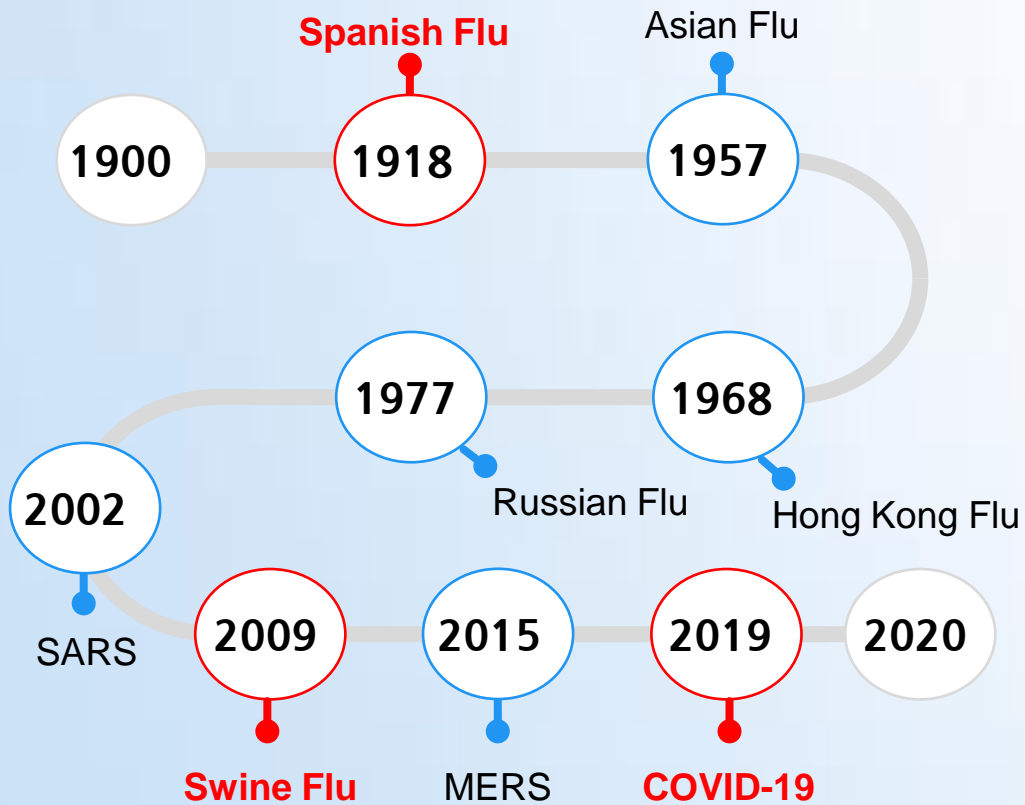
New cases



# Pandemic Model – Outbreak(Probability of Pandemic)



## Outbreak Frequency



\* Influenza Virus: Spanish / Asian / Russian / Hong Kong / Swine  
Corona Virus : SARS / MERS / COVID-19

## Incursion of Pandemic (to Korea)



### 01 Outbreak Frequency

Ex) Influenza occurs every 10 years

### 02 Outbreak location

Ex) Outbreak location of Influenza : USA

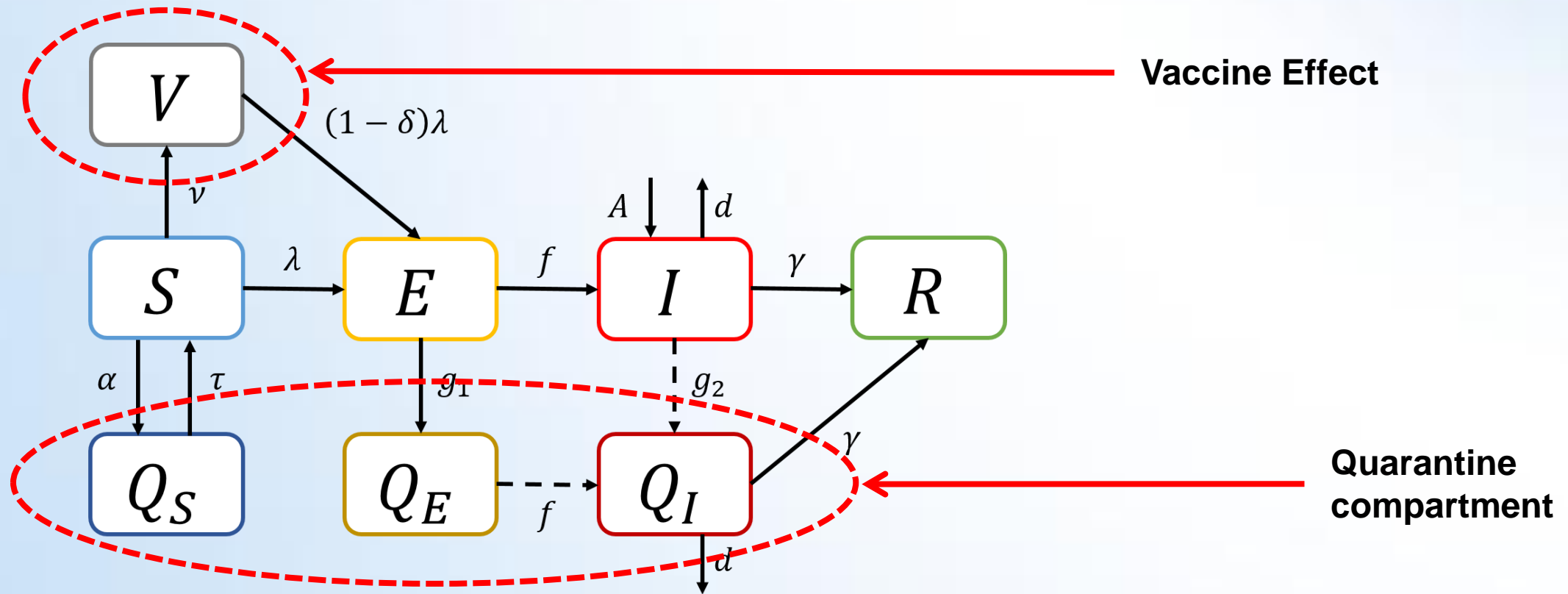
### 03 Probability of Incursion

Ex) From USA to Korea : 10%

# Pandemic Model – Spread



## SEIR(Susceptible-Exposed-Infectious-Removed) Model





# Pandemic Model – Prevention



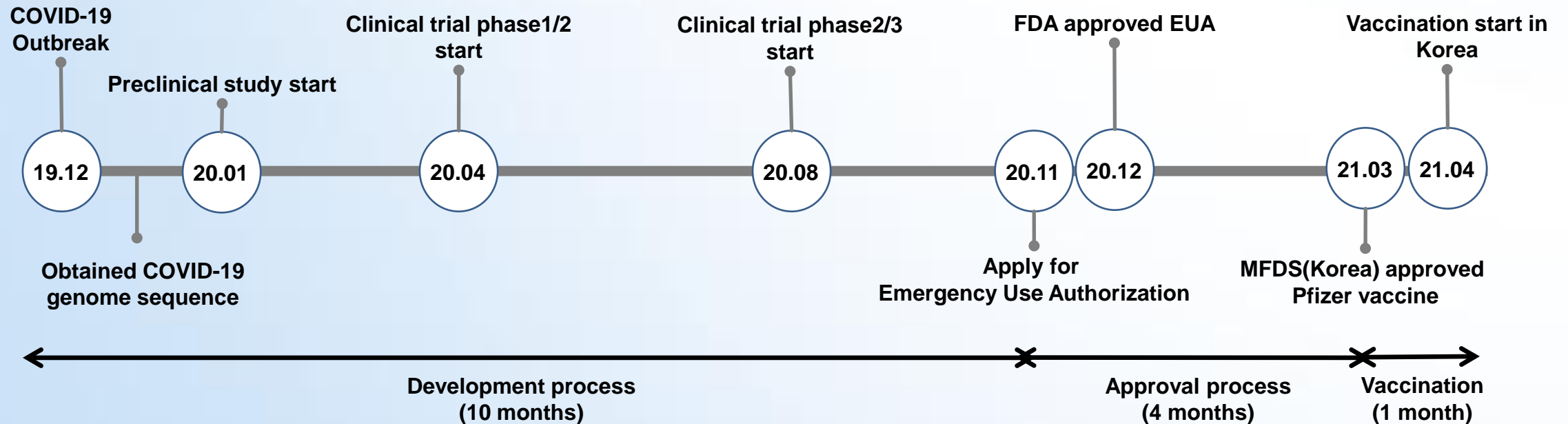
## Vaccine Effect

- Vaccine development & approval process
- Vaccine efficacy

## Counter Measure

- Social Distancing
- Lockdown

### <Pfizer vaccine development & approval process (EUA)>



# Pandemic Model – Waves



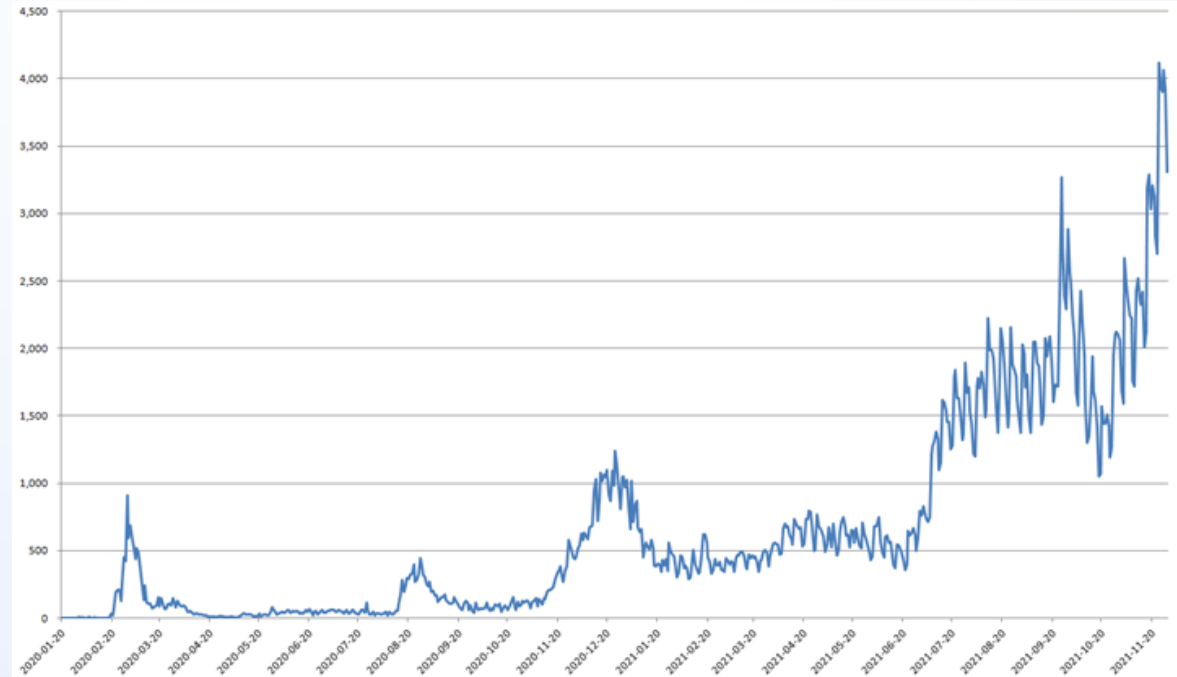
## Duration

- Pandemic is not a “one time” event
- Periods of illness may come in multiple “Waves”

Disease	Duration	Period (yy/mm/dd)
SARS	8 months	'02.11.16. - '03.07.05.
Swine Flu	18 months	'09.04.24. - '10.08.10.
MERS (Korea)	7 months	'15.05.20. - '15.12.23.
COVID-19	-	'19.12.01. - Present

Data source : WHO

## <Daily cases in Korea (COVID-19)>



**Thank You for your attention**

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