3rd NIES International Forum
Kuala Lumpur, January 23-24, 2018

Impacts of Climate Change on Human Health and Adaptation Strategies in Indonesia

Presented by:
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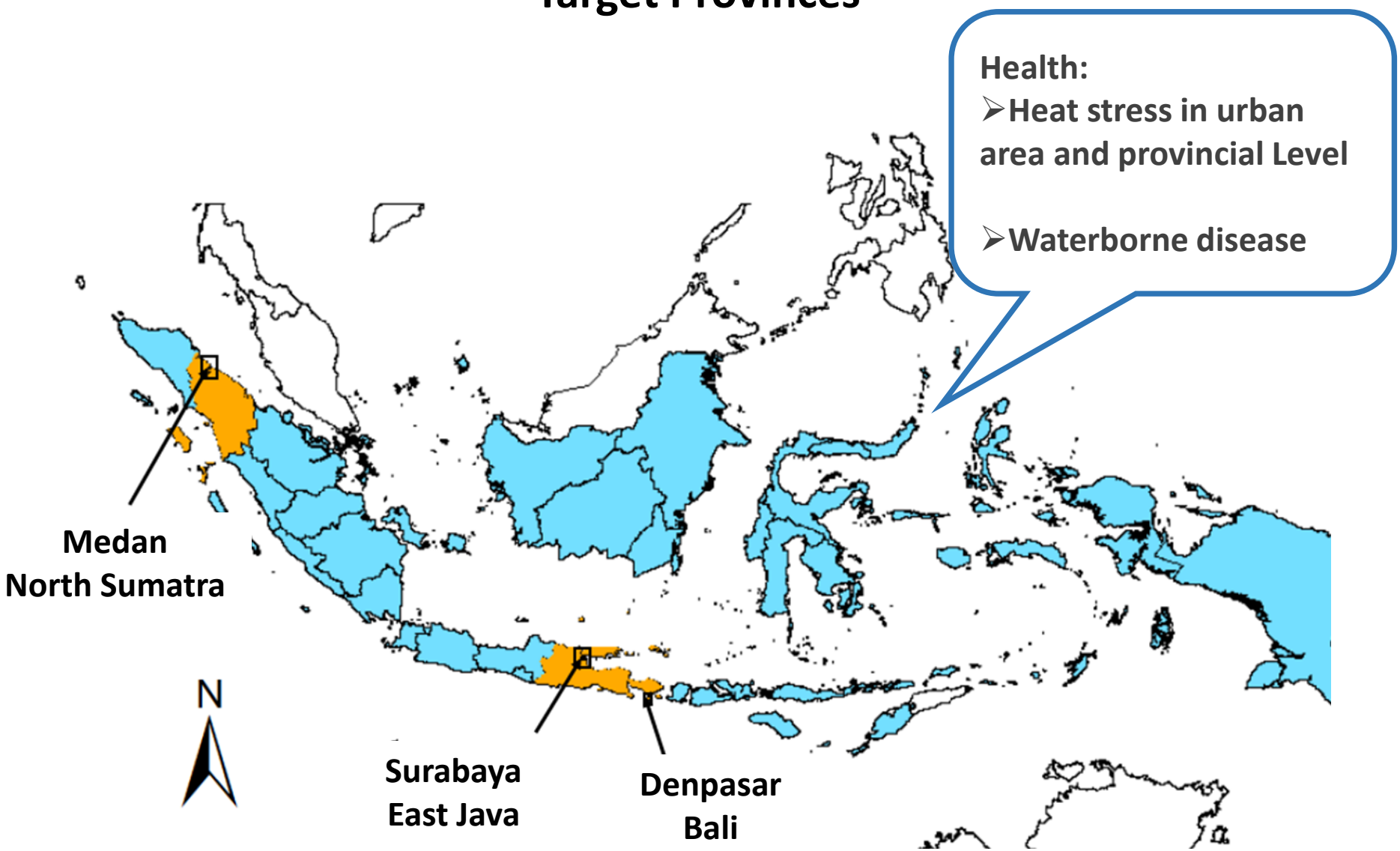
The University of Tokyo

Supported by ministry of Environment Japan in collaboration with BAPPENAS

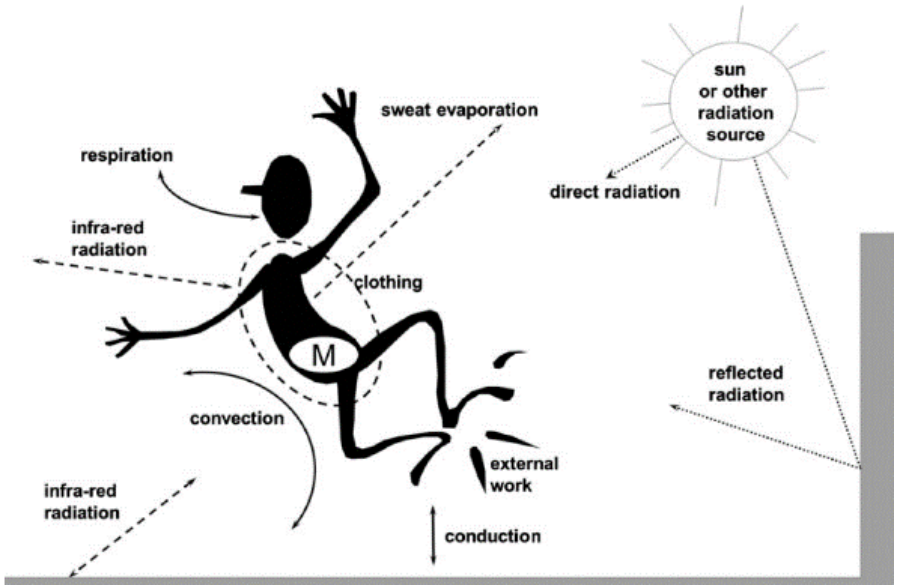
Target Provinces



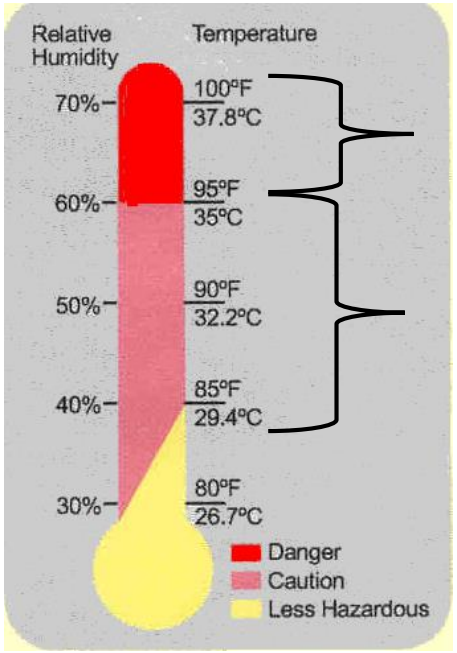
I
The Impacts of Climate Change on Urban Heat Stress

Urban Heat stress

Heat Stress: Condition under which body is unable to cool itself suffiently to maintain healthy temperature



(*Havenith, 2001*)



Danger

Caution

Source: US Department of Labor, 2002

Causes of heat stress:

- Heat exposure
- Hot and crowded conditions
- Lack of air flow
- Dehydration

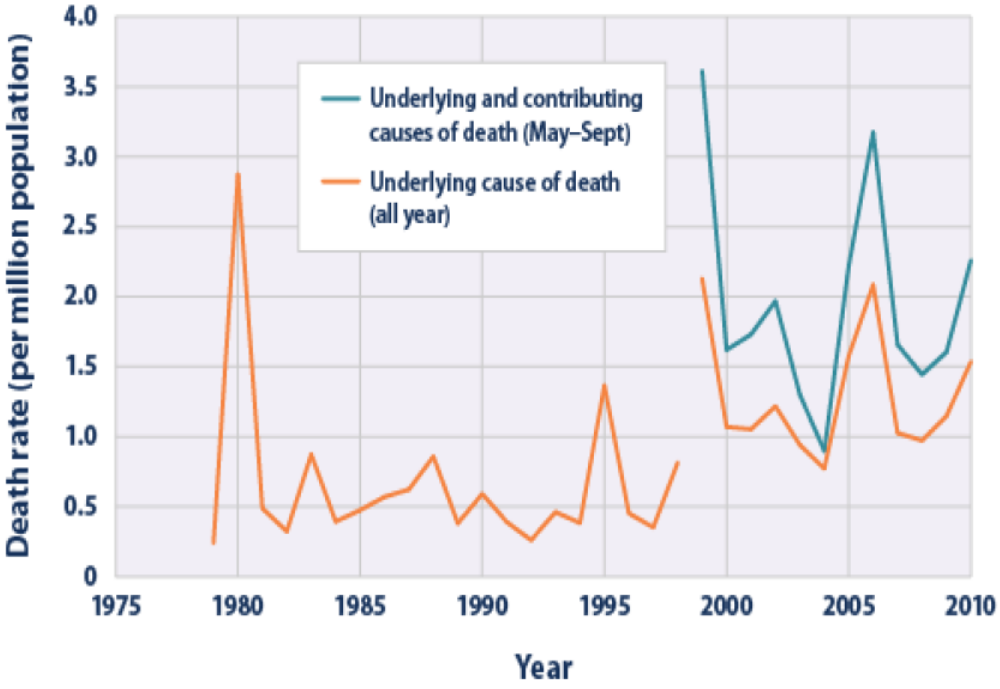
People most at risk of heat-related illness:

- Elderly people
- Babies and young children
- People on medications
- Outdoor worker
- Living without air conditioning

(*Source: Department of Health & Human Services of Victoria, 2016*)

Impact of Urban Heat Stress

Mortality due to heat related illness



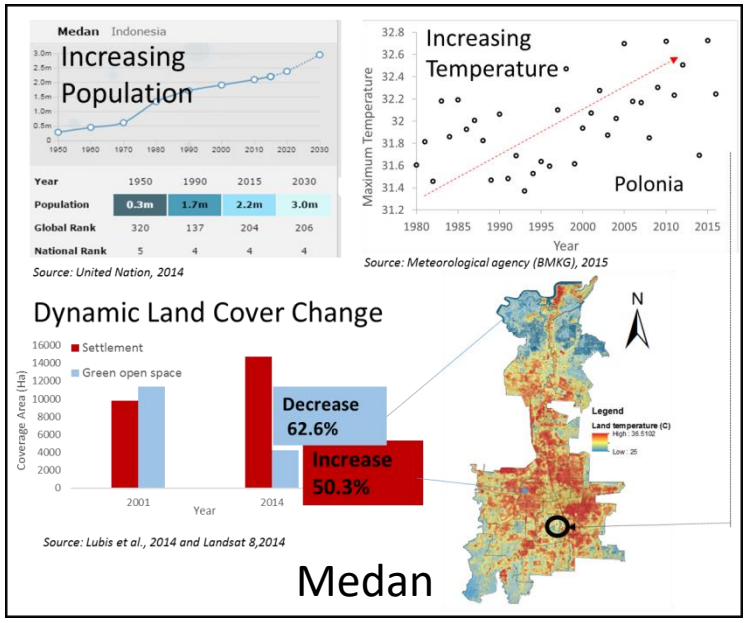
Source :
U.S. Centers for Disease Control and Prevention, 2014

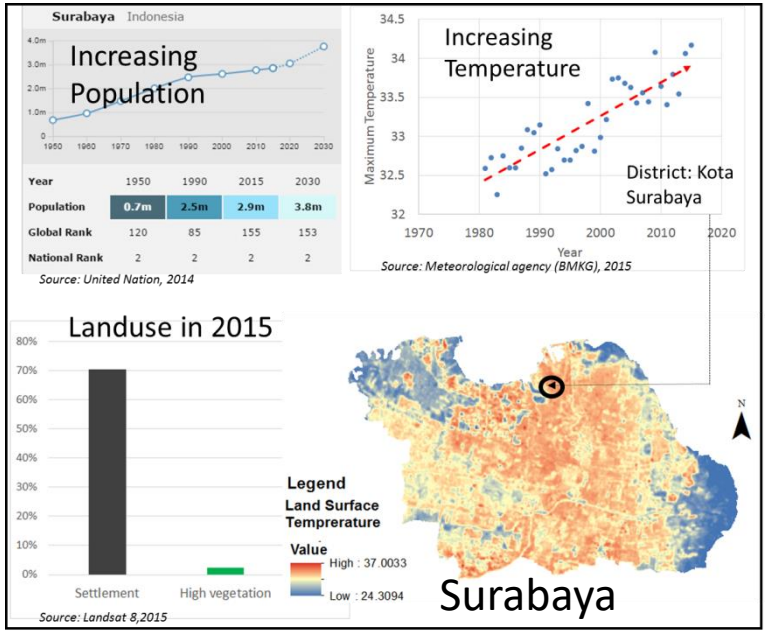
People with cardiovascular and respiratory illness

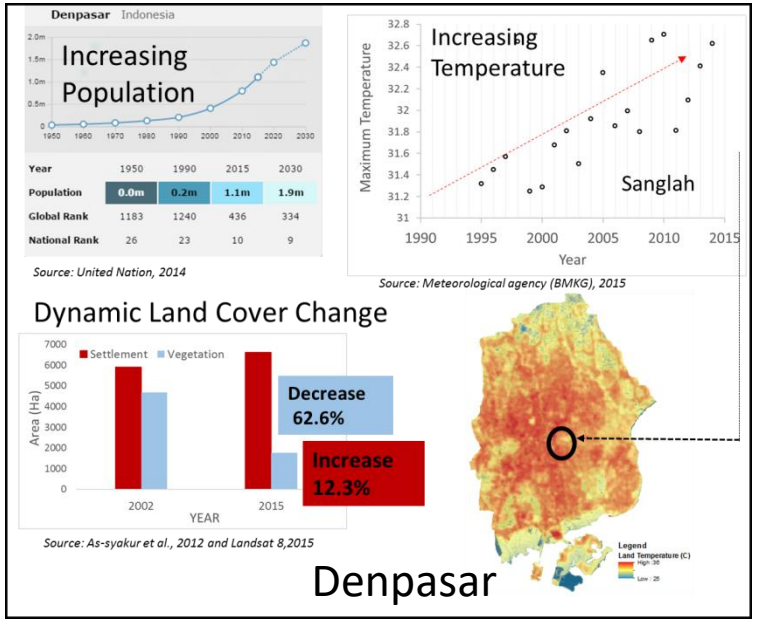
Vulnerable for Heat Related Mortality

Source: Reid et al., 2009; Laadi et al., 2012; USEPA, 2014

General condition







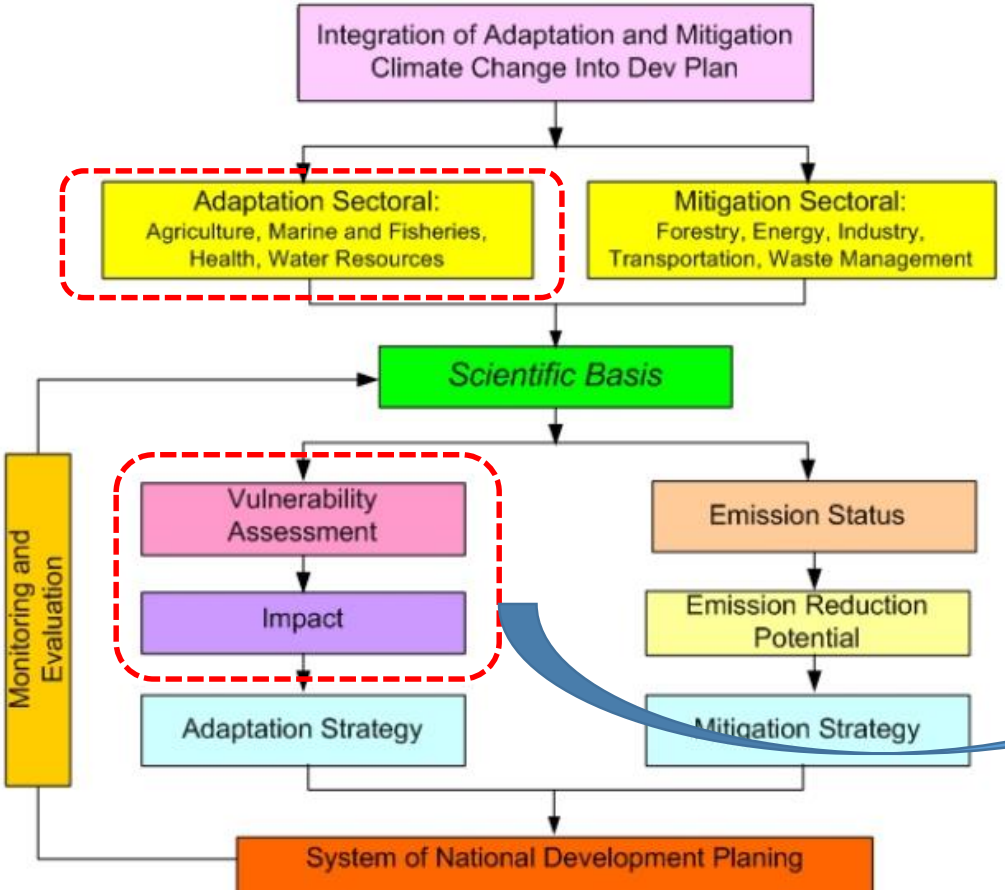
Increasing population density

Increasing building and concrete coverage

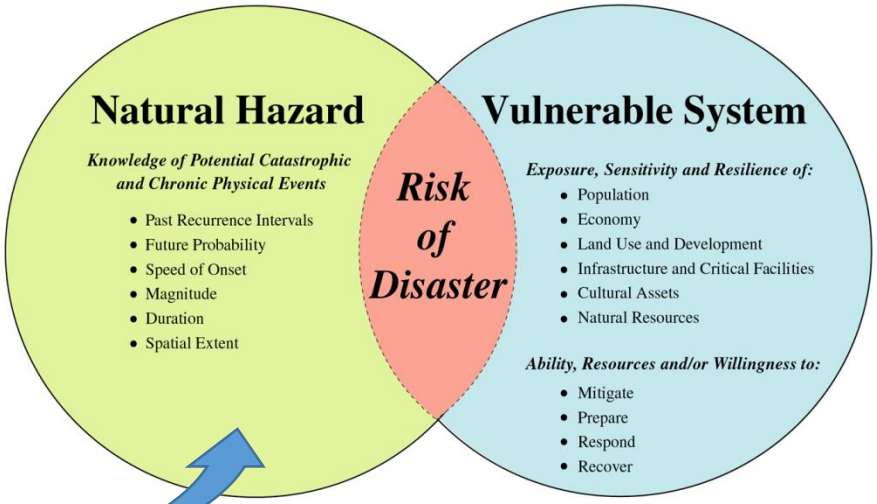
Increasing temperature in central city

Urban Heat Stress

Road map Development Approach by BAPPENAS



Risk: Likelihood of asset damage/ loss due to an extreme event.

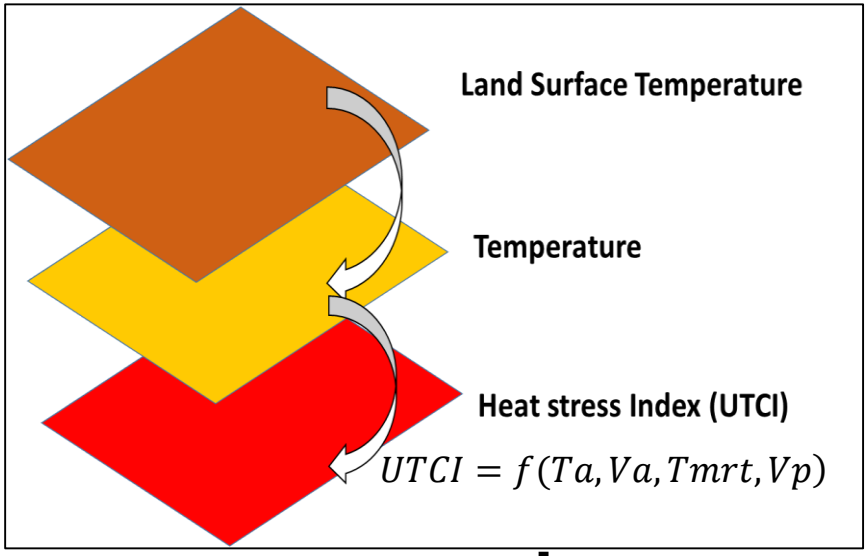


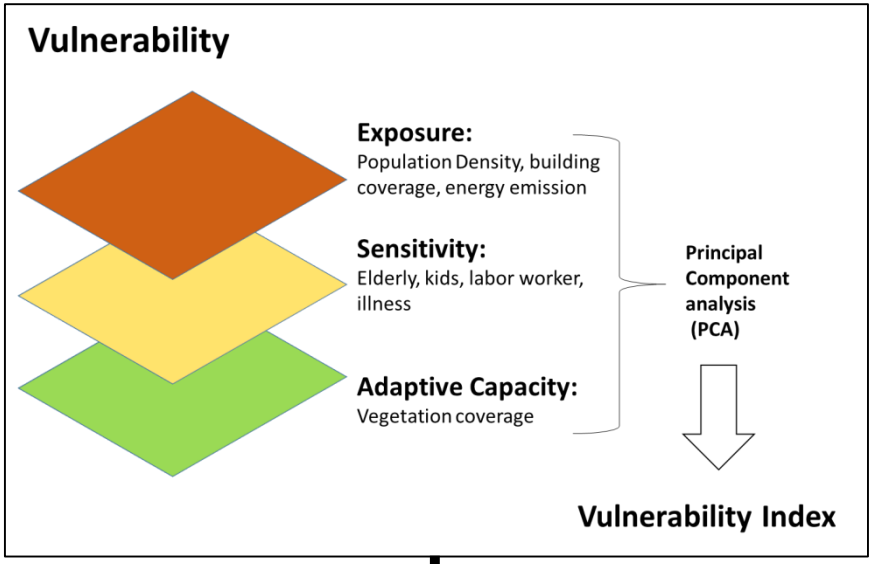
Venn diagram modified from Wood, 2011 (http://pubs.usgs.gov/fs/2011/3008)

ICSSR(Indonesia Climate Change Sectoral Road map),2009

Research Flow

Hazard Map for Heat





Hazard	No stress	Moderate	Strong	Very Strong	Extreme
Vulnerability	1	2	3	4	5
Very Low (1)	1	2	3	4	5
Low (2)	2	4	6	8	10
Medium (3)	3	6	9	12	15
High (4)	4	8	12	16	20
Very high (5)	5	10	15	20	25

Risk Map

UTCI (Universal Thermal Climate Index)

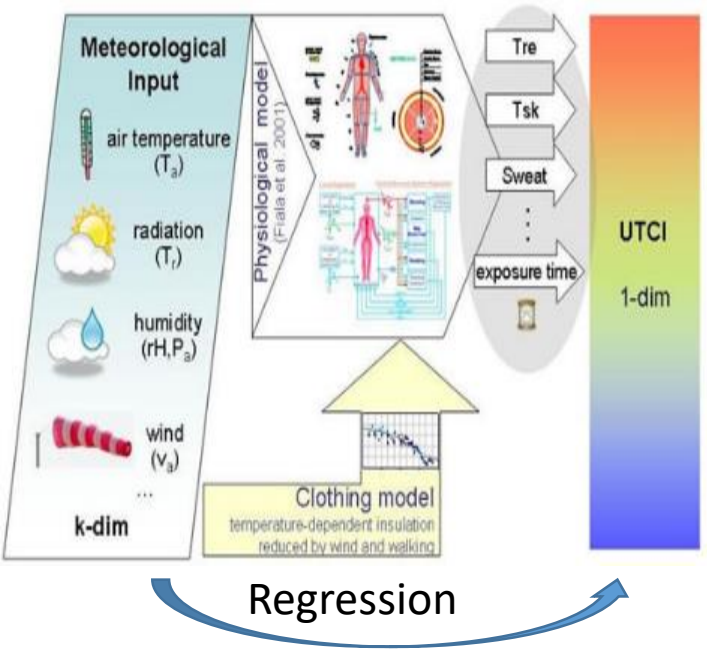
Ambient temperature which provide the same human physiological response by combining the influence of temperature, humidity, wind speed and radiation on outdoor working condition.

$$UTCI = f(Ta, Va, Tmrt, Vp)$$

Where:

Ta: temperature Tmrt: mean radiant temperature (calculated from Solar Radiation)

Va: wind speed Vp : water vapor (calculated from relative humidity (RH) and Ta)



Assumption:

walk: 4km/h

weight : 74kg

fat:14%

metabolic rate : 135W/m^2

UTCI (°C) range	Stress Category
above +46	extreme heat stress
+38 to +46	very strong heat stress
+32 to +38	strong heat stress
+26 to +32	moderate heat stress
+9 to +26	no thermal stress
+9 to 0	slight cold stress
0 to -13	moderate cold stress
-13 to -27	strong cold stress
-27 to -40	very strong cold stress
below -40	extreme cold stress

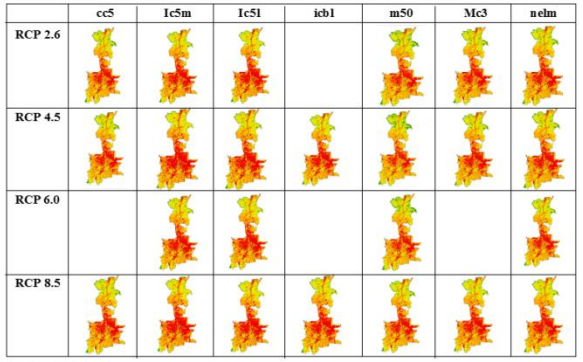
Source :*Fiala et al. 2012* and *Havenith et al. 2011*

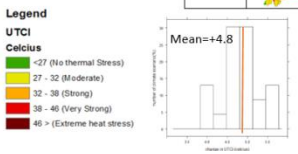
Future Projection with various Climate Change Scenario

UTCI (Heat Stress Index) in Medan

UTCI Baseline Period (1980-2005)

UTCI Future Period (2018-2042)

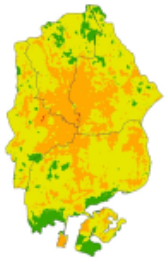




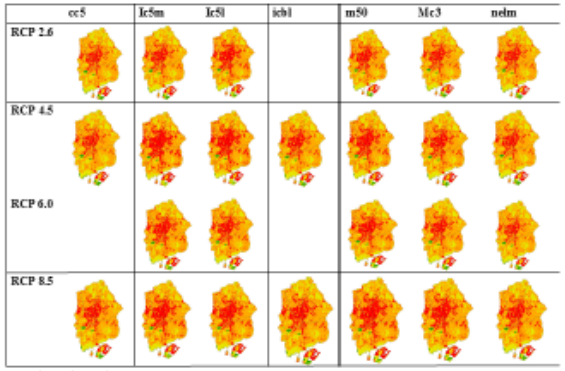
In Future projection; The average of heat stress index will increase 4.8°C which caused increasing the heat stress status from strong heat stress into very strong heat stress. In particular, Southern part of Medan Area.

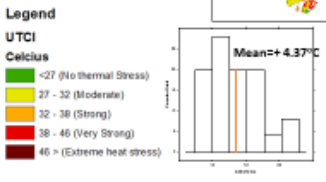
UTCI (Heat Stress Index) in Denpasar

UTCI Baseline Period (1981-2005)



UTCI Future Period (2018-2042) with various climate scenario

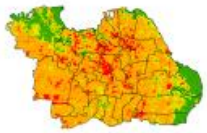




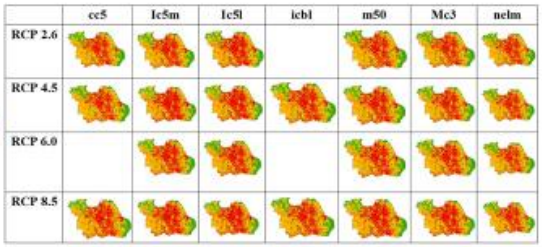
In Future projection; Heat stress index increase 4.37°C which caused increasing the heat stress status from strong heat stress into very strong heat stress. In particular, Central part of Denpasar Area.

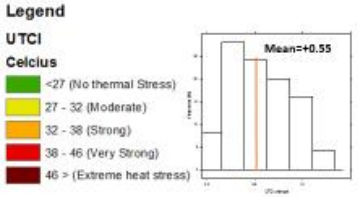
UTCI (Heat Stress Index) in Surabaya

UTCI Baseline Period (1981-2005)

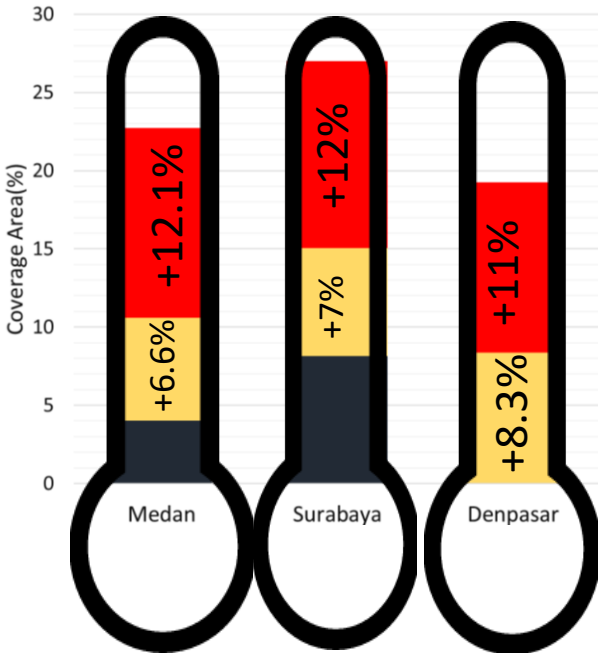


UTCI Future Period (2018-2042) with various climate scenario





In Future projection; The average of heat stress index will increase 0.55°C which caused increasing the heat stress status from strong heat stress into very strong heat stress, particularly in central part of SurabayaArea.

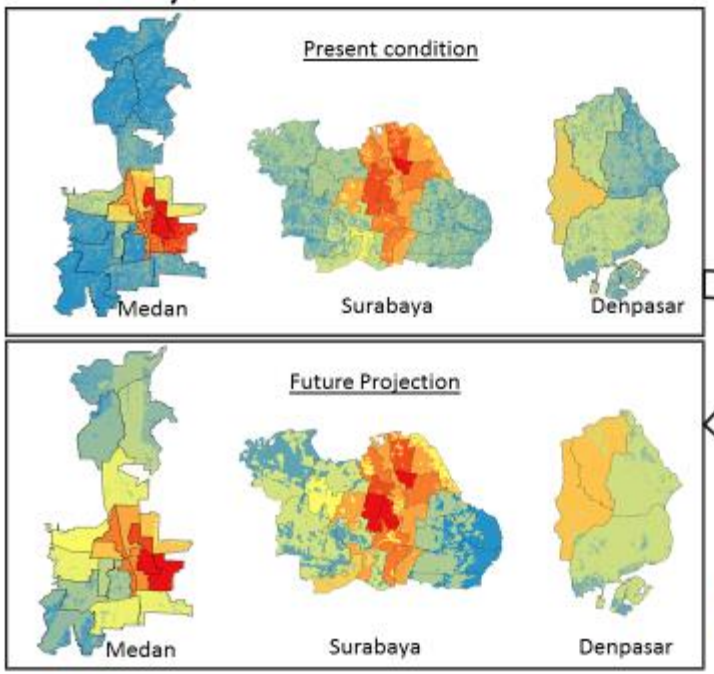


Climate Change

Growing Urbanization

Current Urbanization

Vulnerability

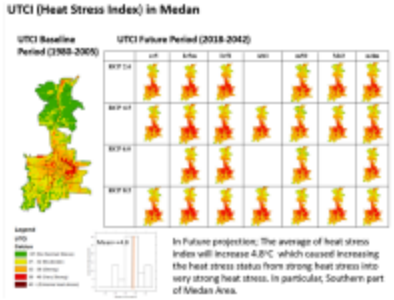


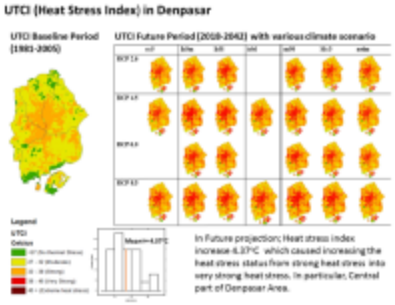
Social demographic data

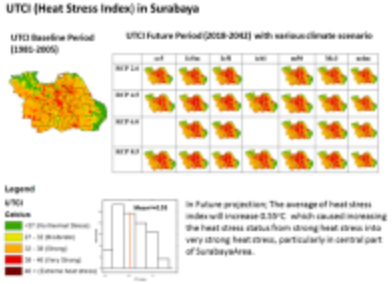
Increase

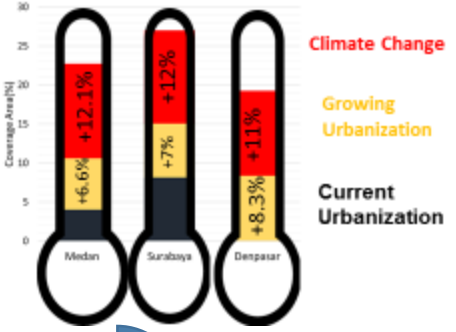
Vulnerability Index
High : 5.198
Low : -0.517

Future Projection with various Climate Change Scenario

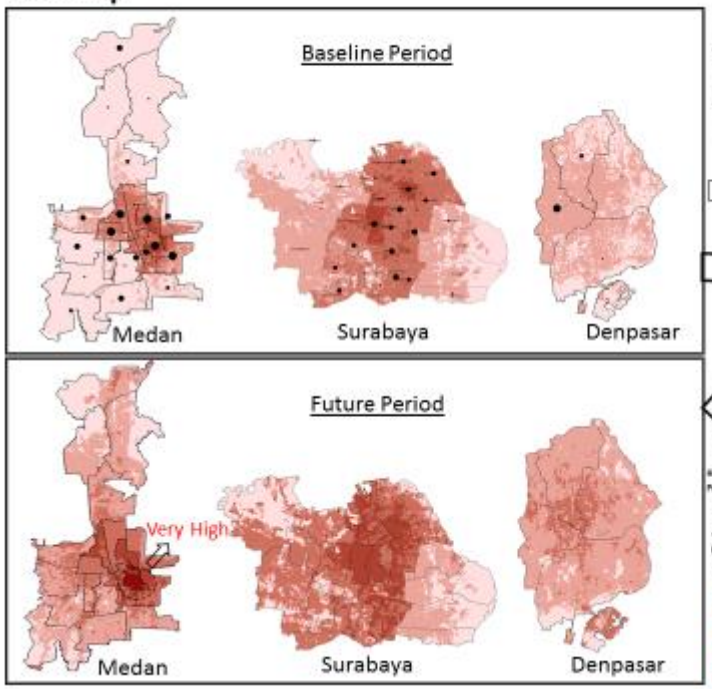


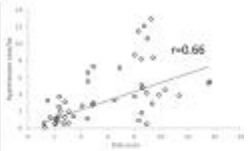






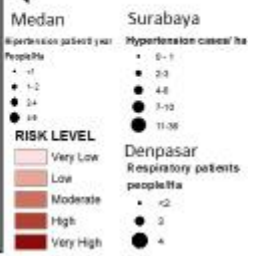
Risk Map





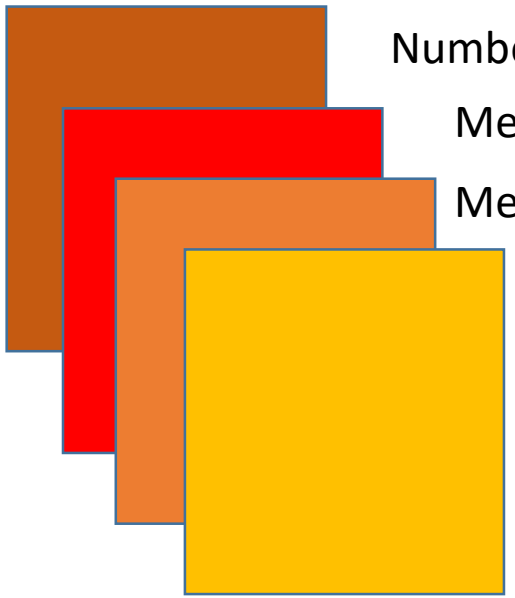
Positive correlation with hypertension cases

Increase Risk Level



Economic Loss

Component



Number of hypertension patient

Medical cost: Direct

Medical cost: indirect

Reference: Indonesia Social Insurance Administration Organization (BPJS) Report at PKU Muhammadiyah Yogyakarta 2014

Workforce productivity → Day loss x average salary/day

Medan

$ 12 million/ year → $ 38 million/ year

Surabaya

$ 35 million/ year → $ 46 million/ year

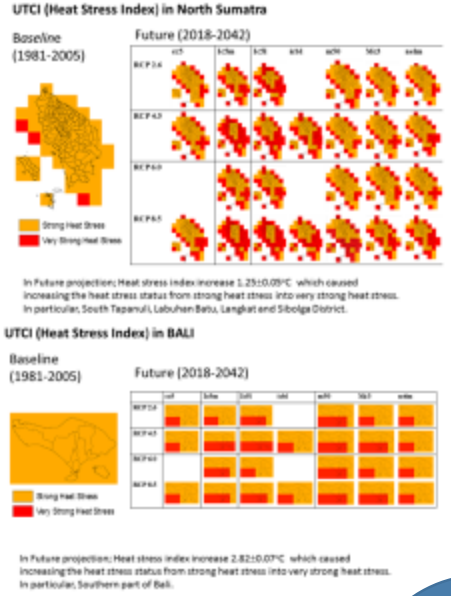
Denpasar

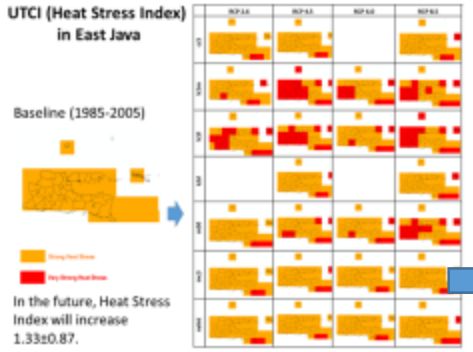
$ 10 million/ year → $ 15 million/ year

No	ADAPTATION OPTIONS	Effort	Cost	Effect
A. Information in public				
1	Rising awareness of citizens to heat risk, especially vulnerable groups (children, elderly, sick person, outdoors workers)	Int.	Int.	High
2	Raising awareness of public health agency and local government, and rising their preparedness	Low	Low	Low
3	Public health agency and local government preparedness	High	Int.	Low
4	Heat warning systems	Int.	Int.	Int.
B. Urban Structure				
5	Urban greening and water landscape	High	High	Int.
C. Technology				
7	Subsidies for air conditioner	Low	High	Int.
8	Electrical vehicle	High	High	High
9	Energy efficient appliances	High	High	Int.
10	Public transport	High	High	High

II
The Impacts of Climate Change on Heat Stress in Provincial Level

Hazard→UTCI (Heat Stress Index)

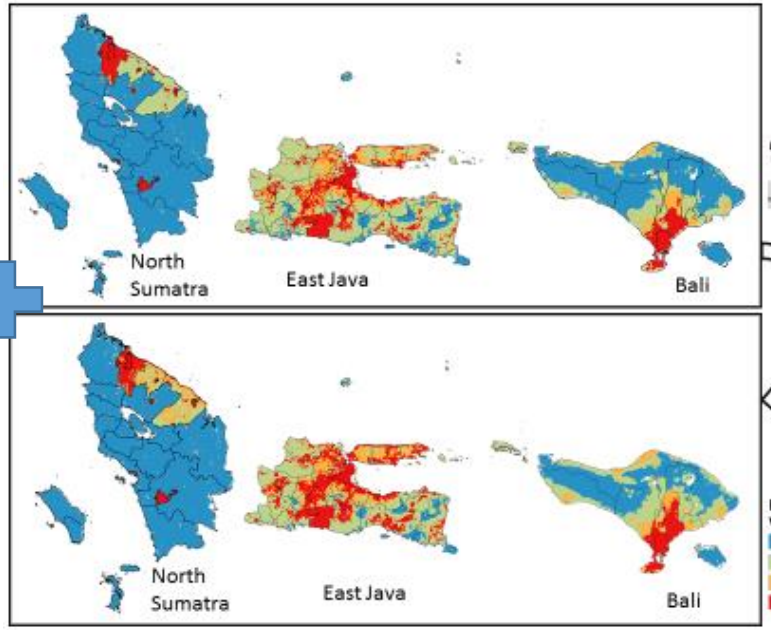




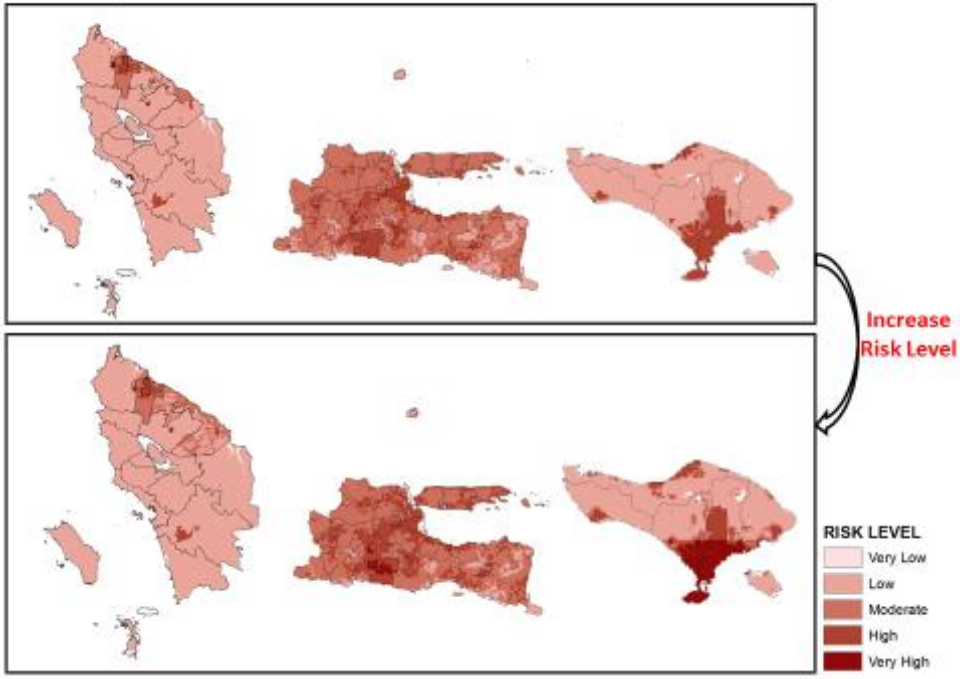
The heat stress increased from strong heat stress to very strong heat stress

The heat stress increased mainly closed to the coastal area

Vulnerability

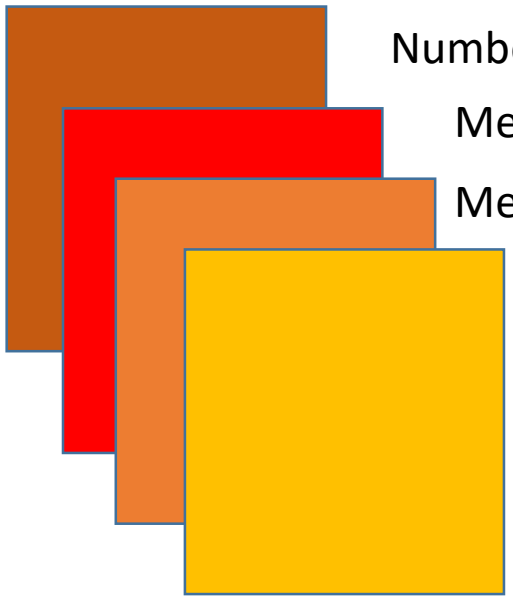


Risk Map



Economic Loss

Component



Number of hypertension patient

Medical cost: Direct

Medical cost: indirect

Reference: Indonesia Social Insurance Administration Organization (BPJS) at PKU Muhammadiyah Yogyakarta 2014

Workforce productivity → Day loss x average salary/day

North Sumatra

$ 4.8 billion/ year → $ 5 billion/ year

East Java

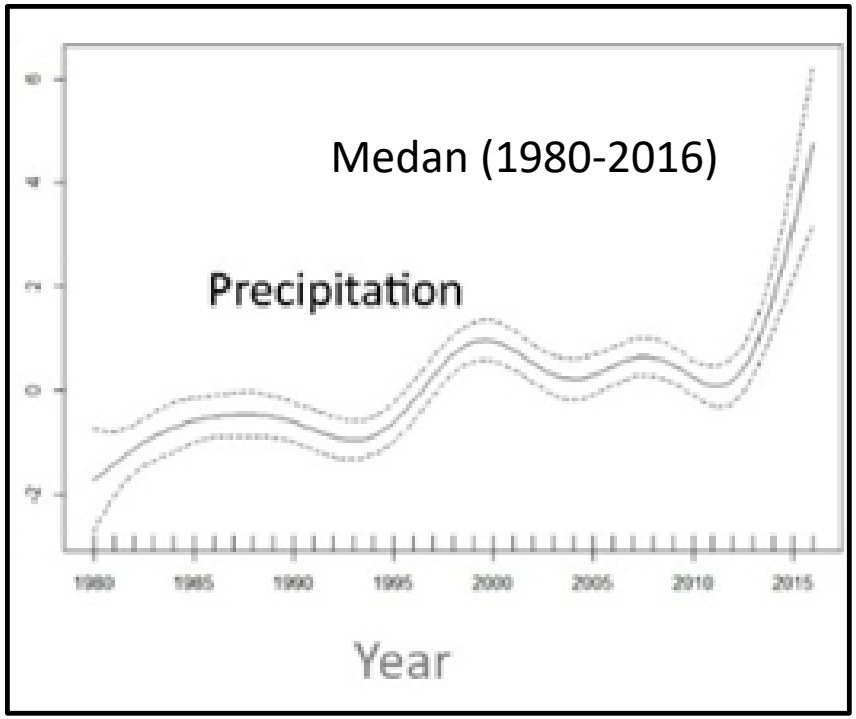
$ 5.2 billion/ year → $ 5.8 billion/ year

Bali

$ 0.5 billion/ year → $ 1.3 billion/ year

No	ADAPTATION OPTIONS	Effort	Cost	Effect
A. Information in public				
1	Rising awareness of citizens to heat risk, especially vulnerable groups (children, elderly, sick person, outdoors workers)	Int.	Int.	High
2	Raising awareness of public health agency and local government, and rising their preparedness	Low	Low	Low
3	Public health agency and local government preparedness	High	Int.	Low
4	Heat warning systems	Int.	Int.	Int.
B. Urban Structure				
5	Greening and water landscape	High	High	Int.
C. Technology				
7	Subsidies for air conditioner	Low	High	Int.
8	Energy efficient appliances	High	High	Int.
9	Public transport	High	High	High

Introduction

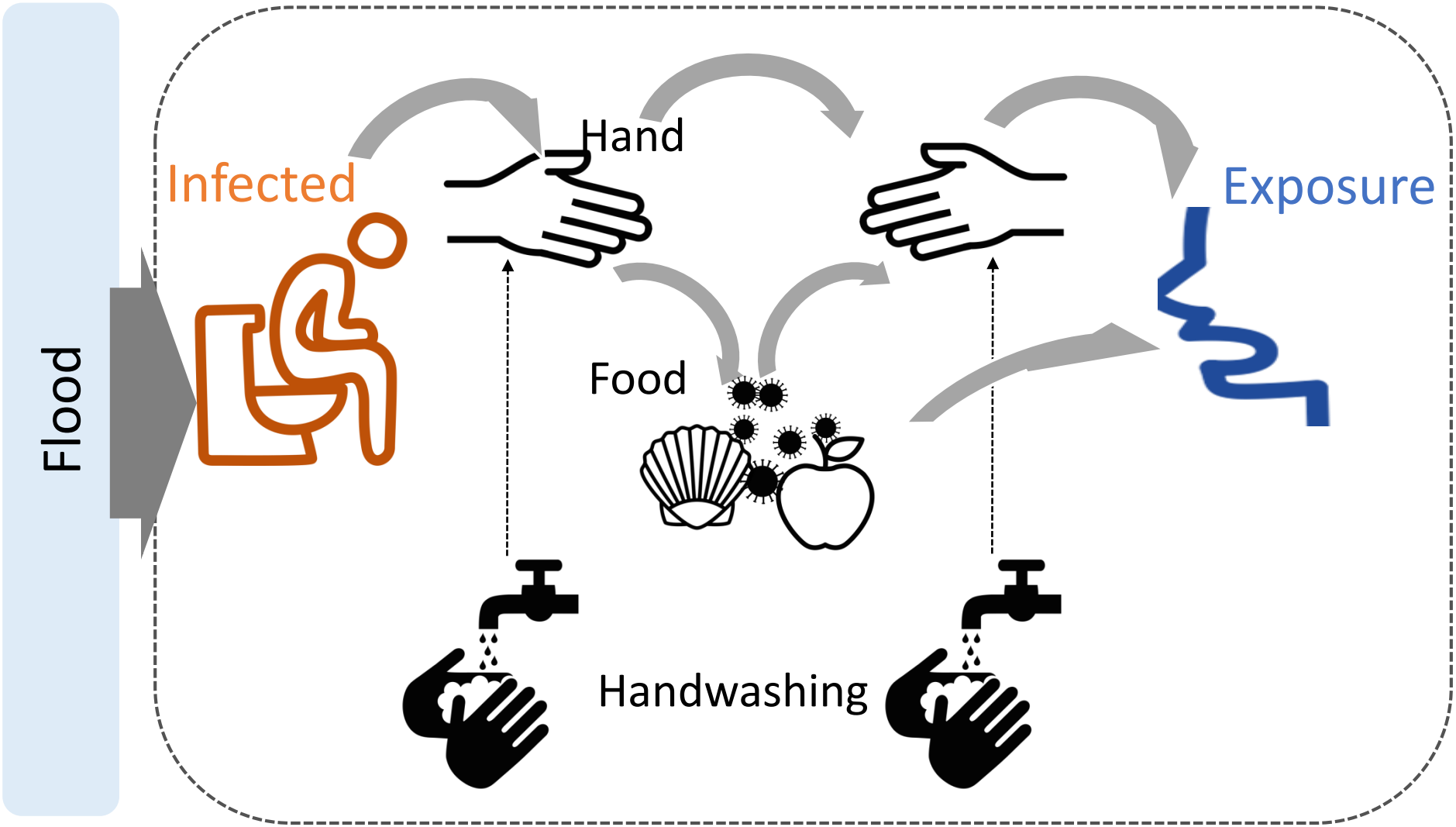


Waterborne Disease Risk

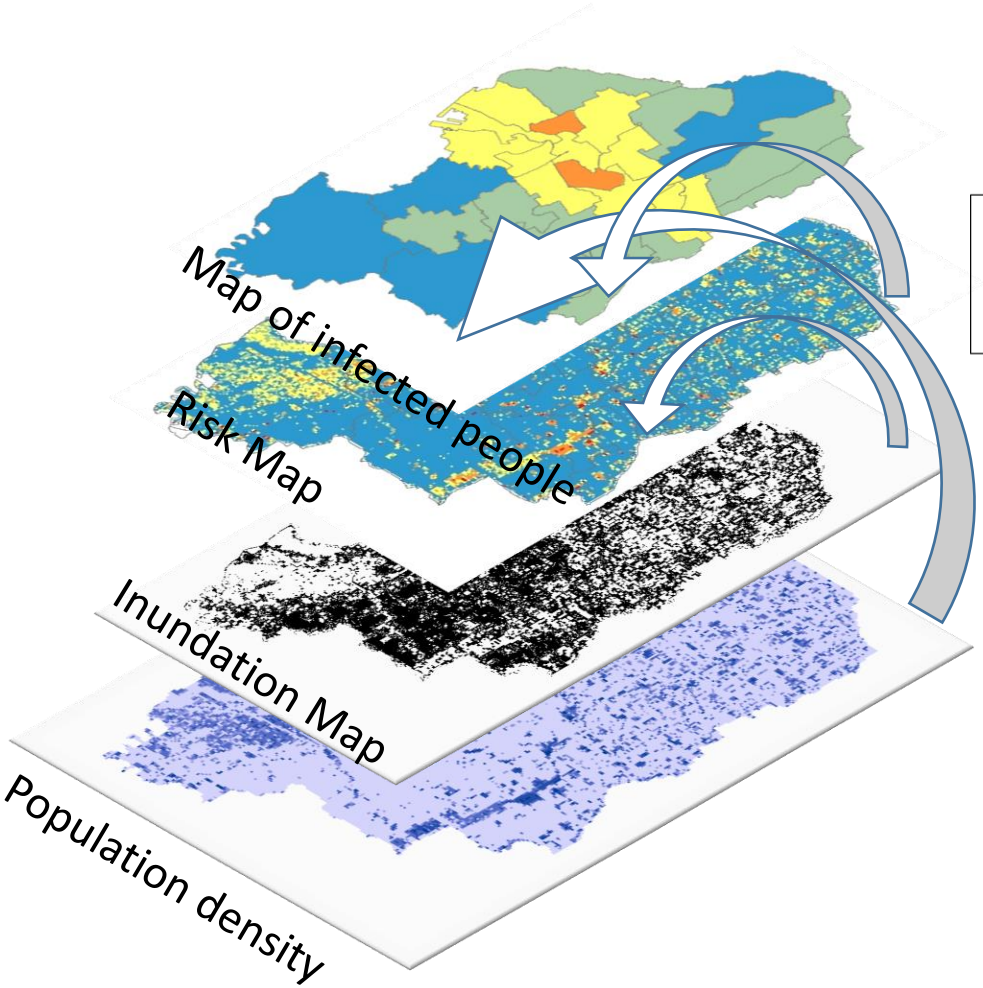
Risk Assessment

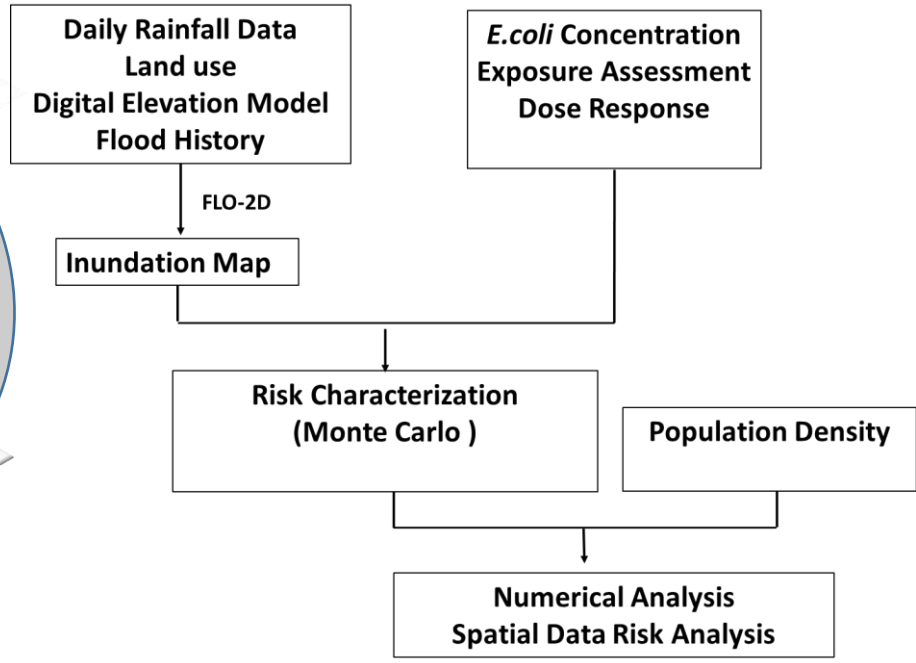
Determine the risk of infection from exposure to pathogens in flood water

Transmission routes of norovirus infection



Flow chart

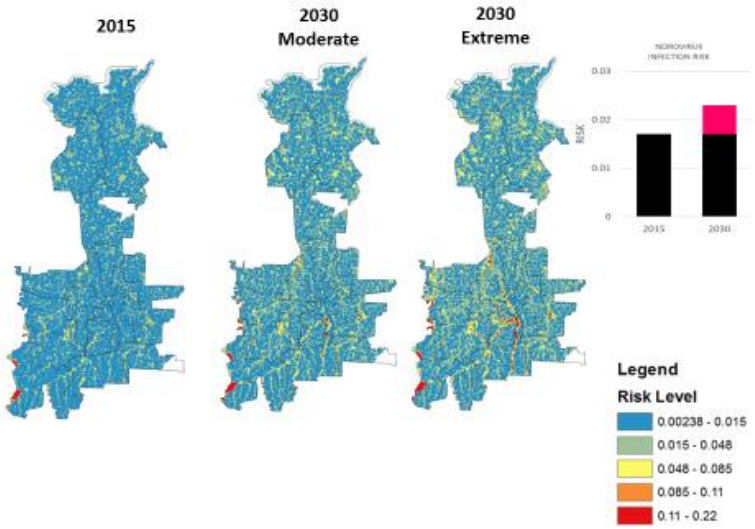

Map of infected people
Risk Map
Inundation Map
Population density


Daily Rainfall Data
Land use
Digital Elevation Model
Flood History
FLO-2D
Inundation Map
E.coli Concentration
Exposure Assessment
Dose Response
Risk Characterization
(Monte Carlo)
Population Density
Numerical Analysis
Spatial Data Risk Analysis

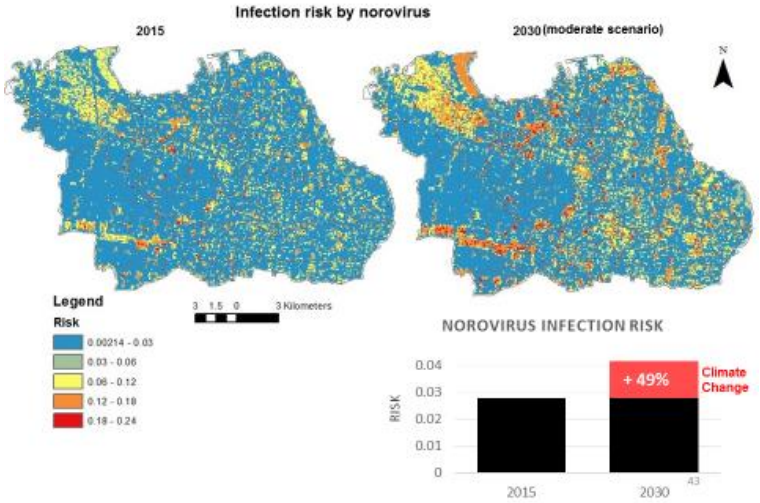
III
The Impacts of Climate Change on Waterborne Disease

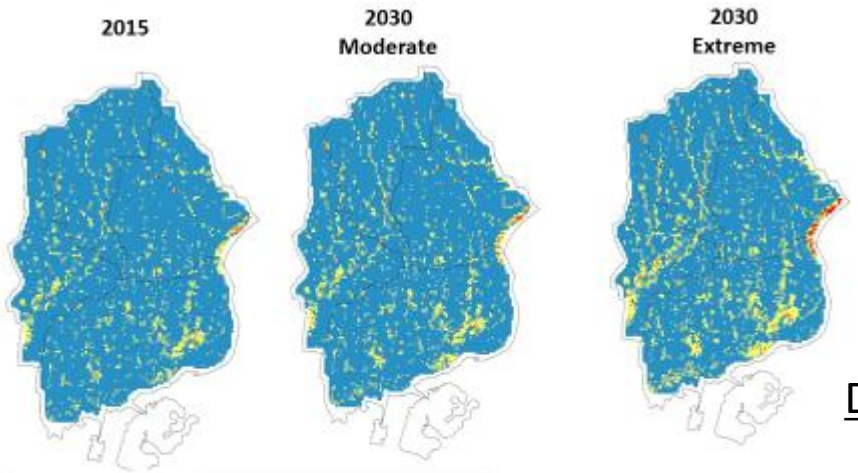
Infection Risk by Norovirus

Medan

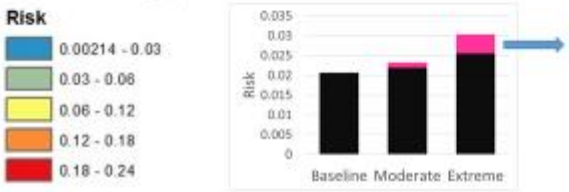


Surabaya





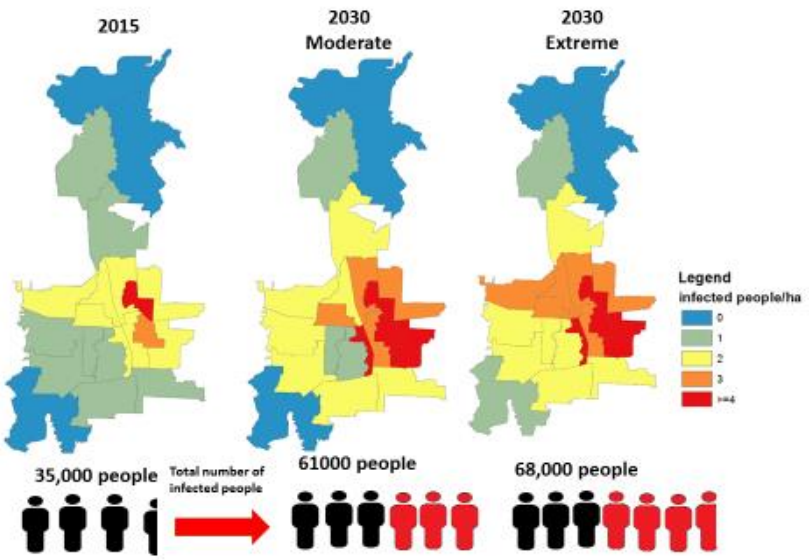
Denpasar



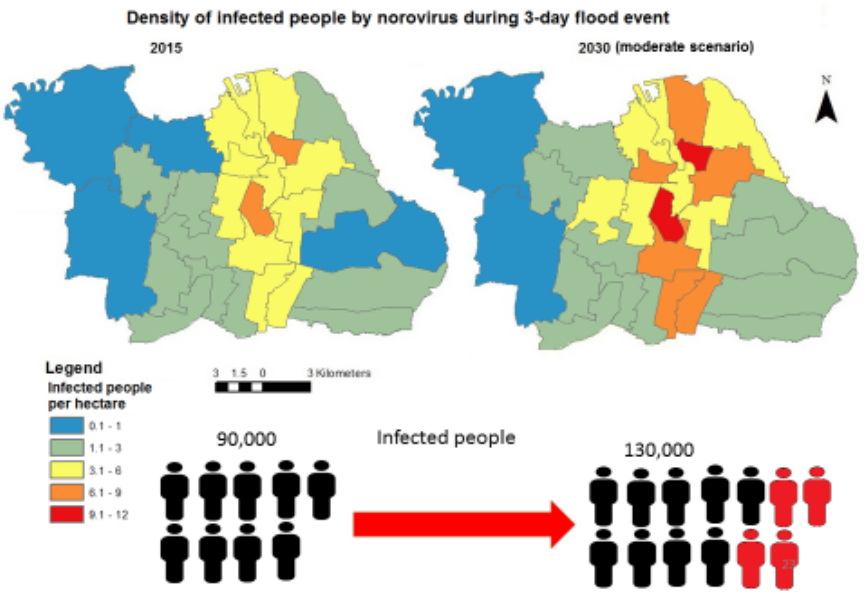
Increase 23% due to climate change

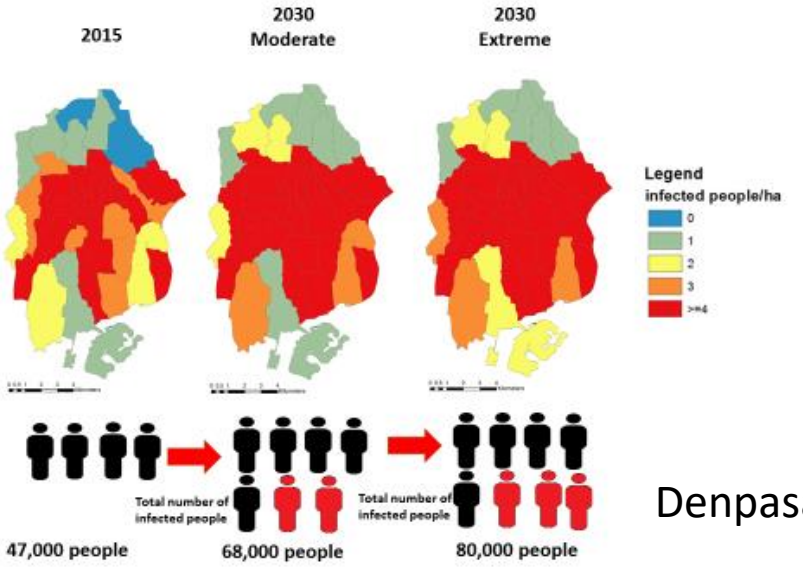
Infected People by Norovirus

Medan



Surabaya

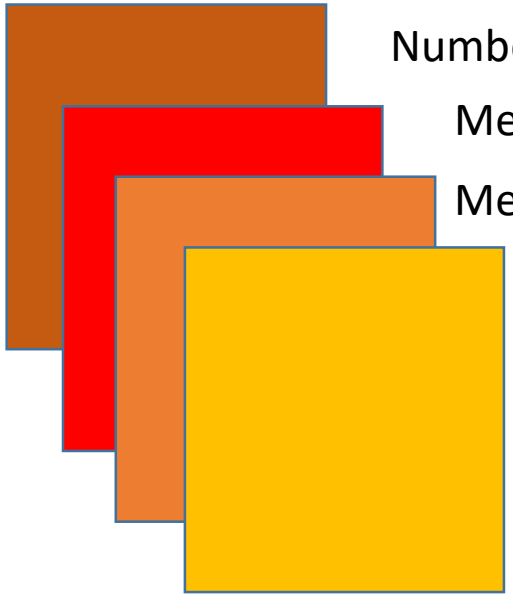




Denpasar

Economic Loss

Component



Number of dhiarea patient

Medical cost: Direct

Medical cost: indirect

Reference: Indonesia Social Insurance Administration Organization (BPJS) at PKU Muhammadiyah Yogyakarta 2014

Workforce productivity → Day loss x average salary/day

Medan

$ 6.6 million/ year → $ 9 million/ year

Denpasar

$ 8.8 million/ year → $ 15 million/ year

Surabaya

$ 17 million/ year → $ 24 million/ year

No	ADAPTATION OPTIONS	Effort	Cost	Effect
A. Providing information in public				
1	Rising awareness (behavior during the flood and hygiene)	Int.	Int.	High
B. Urban Planning				
2	Improve drainage system	High	High	High
3	Increasing green space to reduce run-off	High	High	Int.
4	Improving storm water detention pond	High	High	Int.
5	Leak-proof septic tank and sewage system	High	High	High
C. Technology				
6	Improving waste water treatment	High	High	High

Thank you