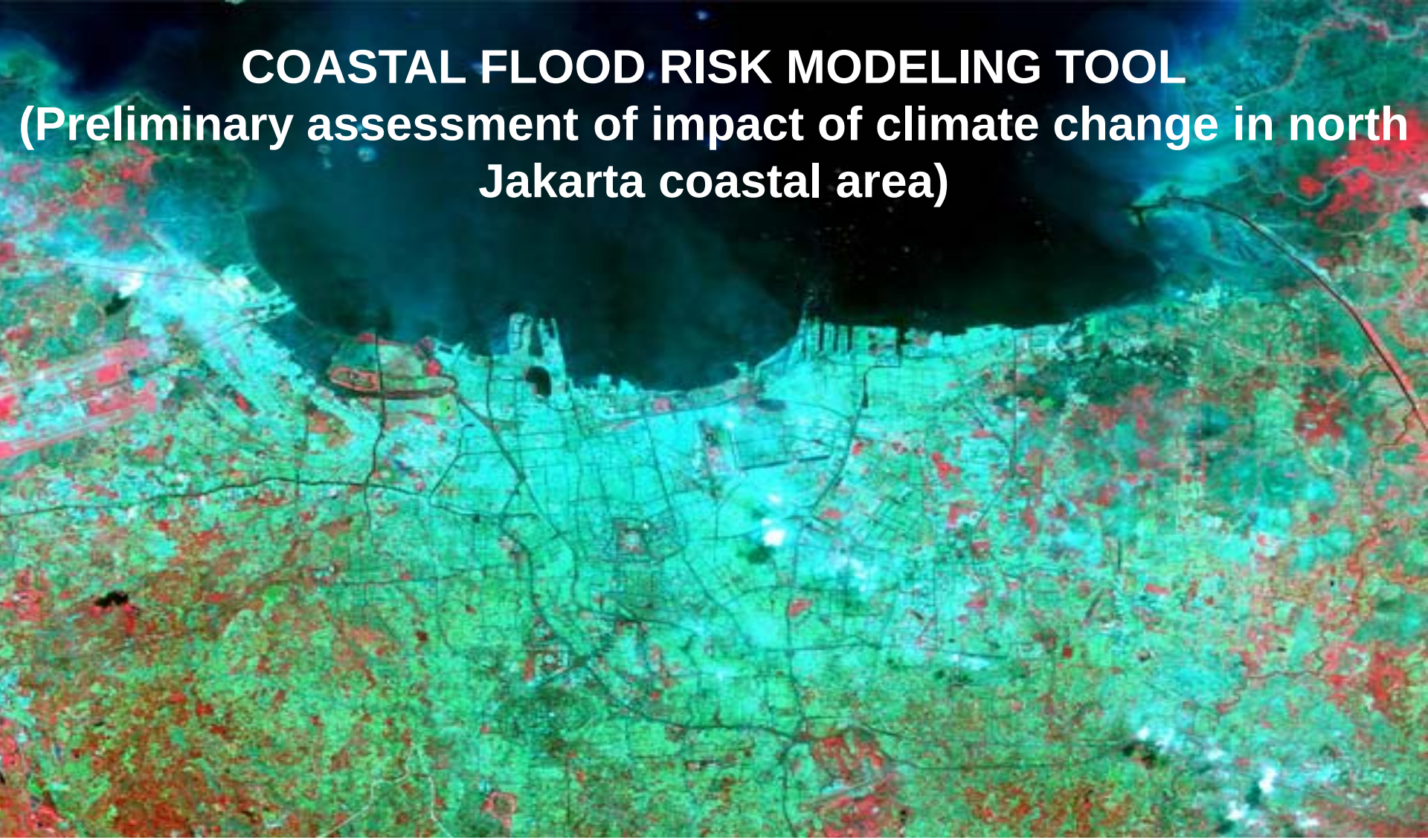
COASTAL FLOOD RISK MODELING TOOL
(Preliminary assessment of impact of climate change in north Jakarta coastal area)

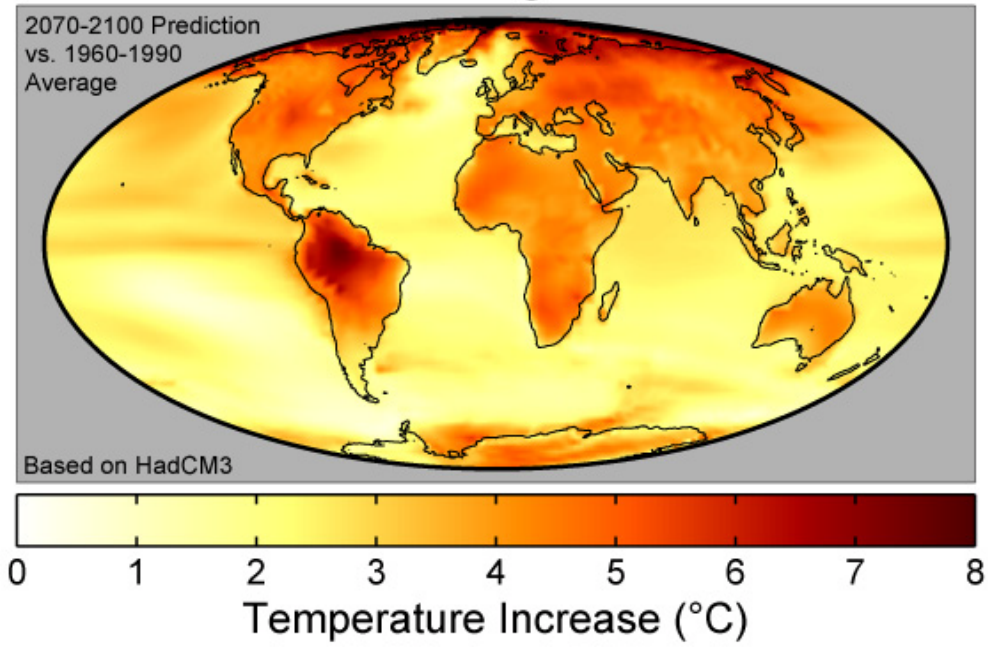


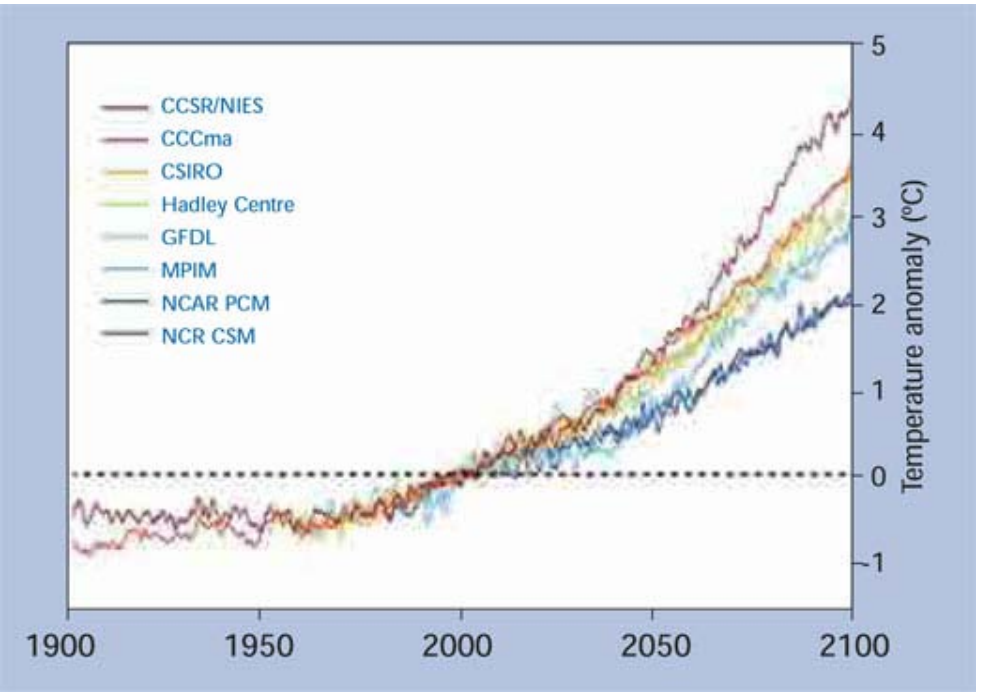
Prof. Dr. rer.nat. Muh Aris Marfai, M.Sc
Dr. Philip Ward

Workshop-Seminar Jakarta Climate Adaptation tools
The pathway towards city reseliency, 21st August 2014-Balai Kota DKI

Introduction and problem identification

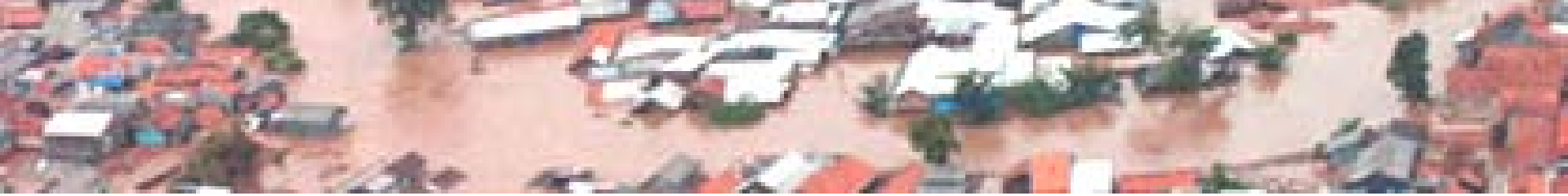
Global Warming Predictions



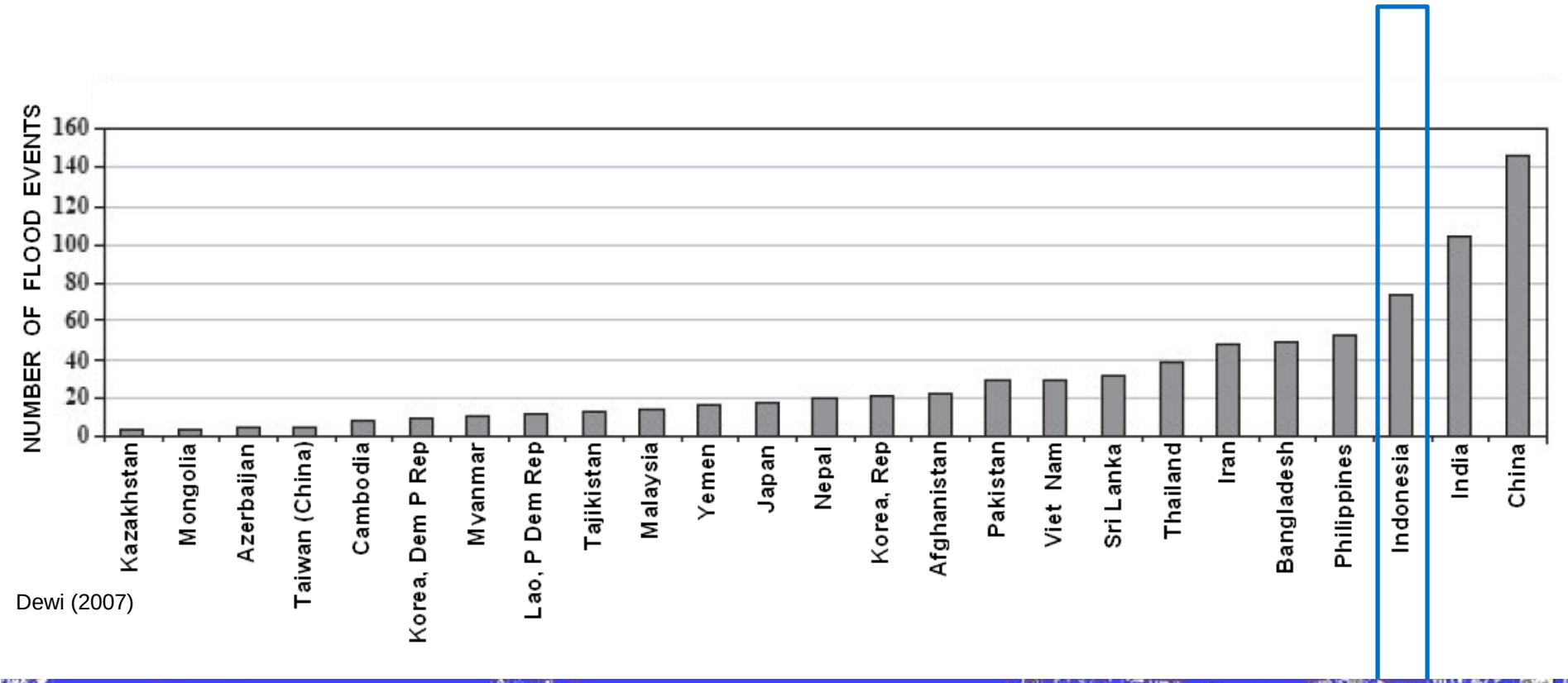


CLIMATE CHANGE

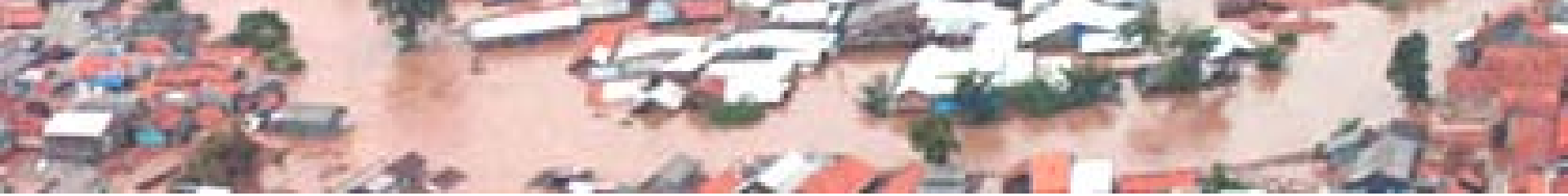
- Changes on Temperature
- Changes on Precipitation
- Sea Level Rise



Sea level rise and increasing flood hazard



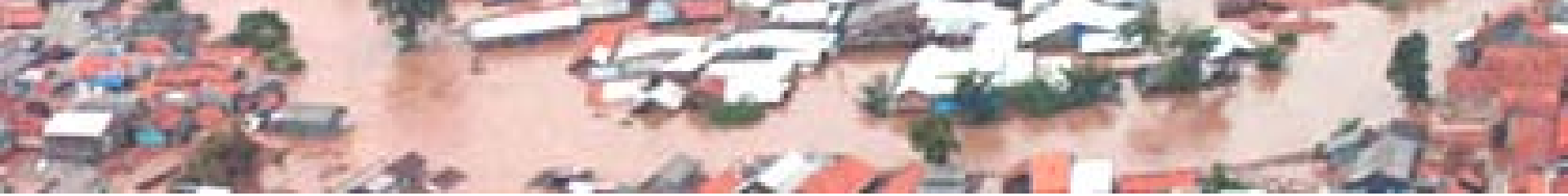
Dewi (2007)



Country	SLR scenario (cm)	Land loss	
		Km²	%
Europe			
The Netherlands	100	2165	6.7
Germany	100	13900	3.9
Poland	100	1700	0.5
West Africa			
Senegal	100	6000	3.1
Nigeria	100	18000	2.0
Benin	100	230	0.2
Asia			
Bangladesh	100	29846	20.7
India	100	5763	0.4
Indonesia	60	34000	1.9
Malaysia	100	7000	2.1
Pakistan	200	1700	0.2
Vietnam	100	40000	12.1

Severe impacts on coastal Ecosystem

Nicholls and Mimura (1998)

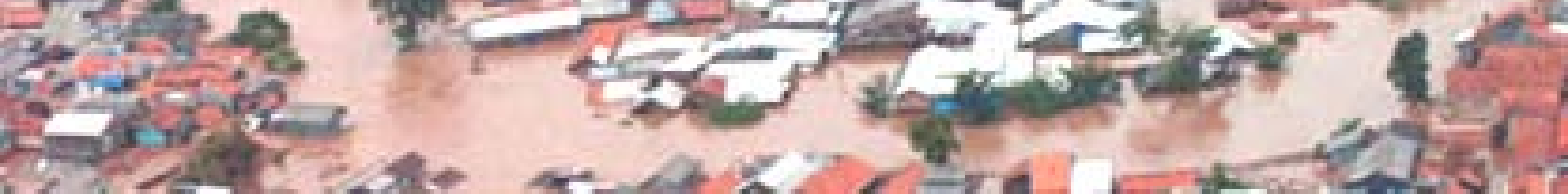


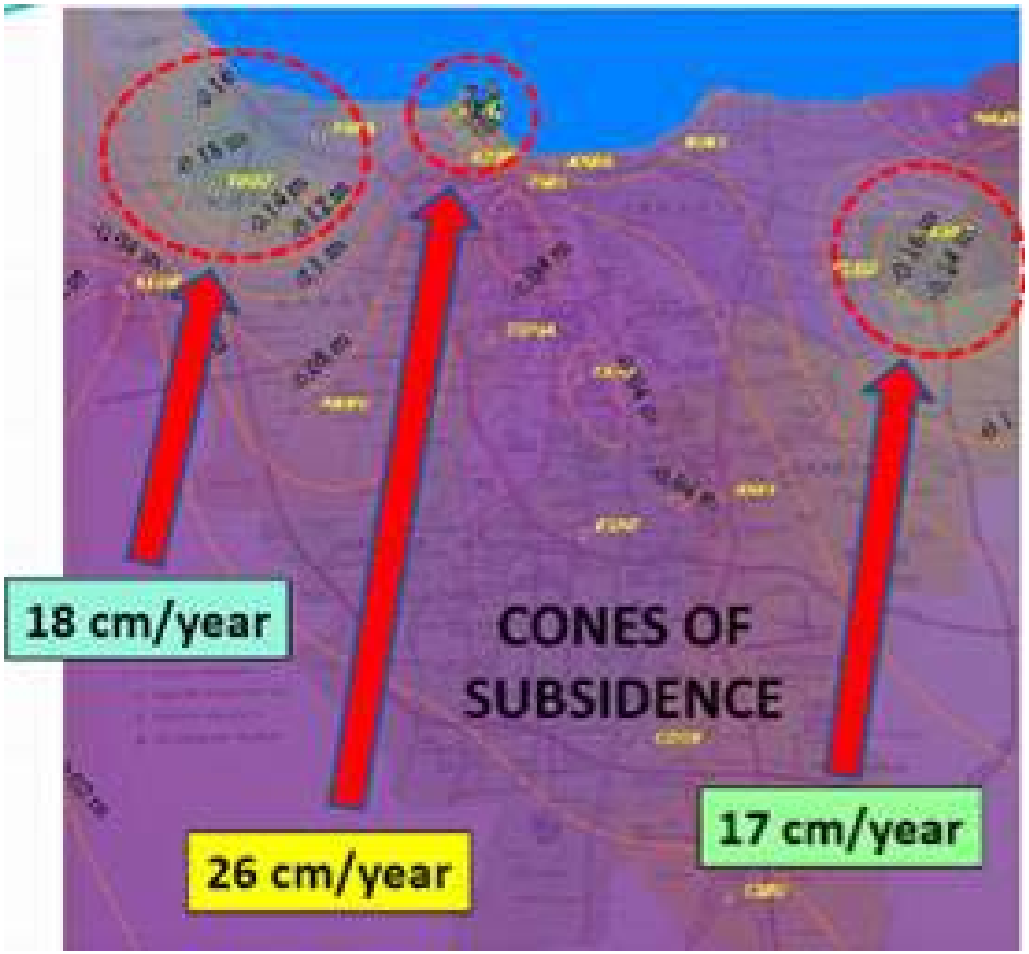
Sea Level Rise and Jakarta

- Jakarta, as the most populated city in Indonesia, is predicted to suffer from major losses due to severe impact of sea level rise.
- Several impacts caused by sea level rise to the man-made urban ecosystem in Jakarta are: increasing coastal flooding, damages on the settlement and infrastructure, increasing environmental sanitation problem, increasing vector borne disease and health problems.
- urban settlement and business area are the largest area affected by coastal inundation

Factor leading higher vulnerability of coastal flood hazards

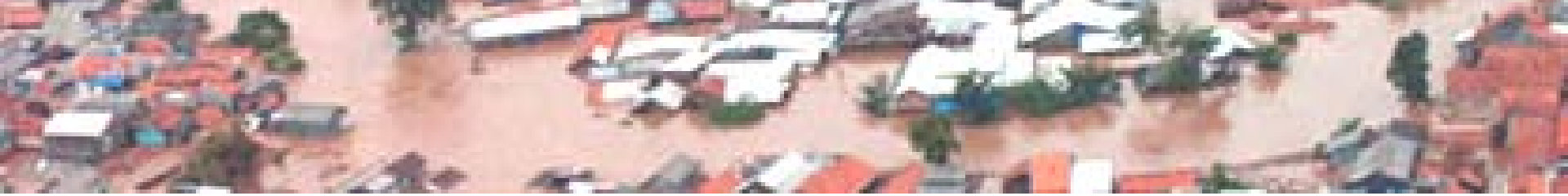
Land use changes

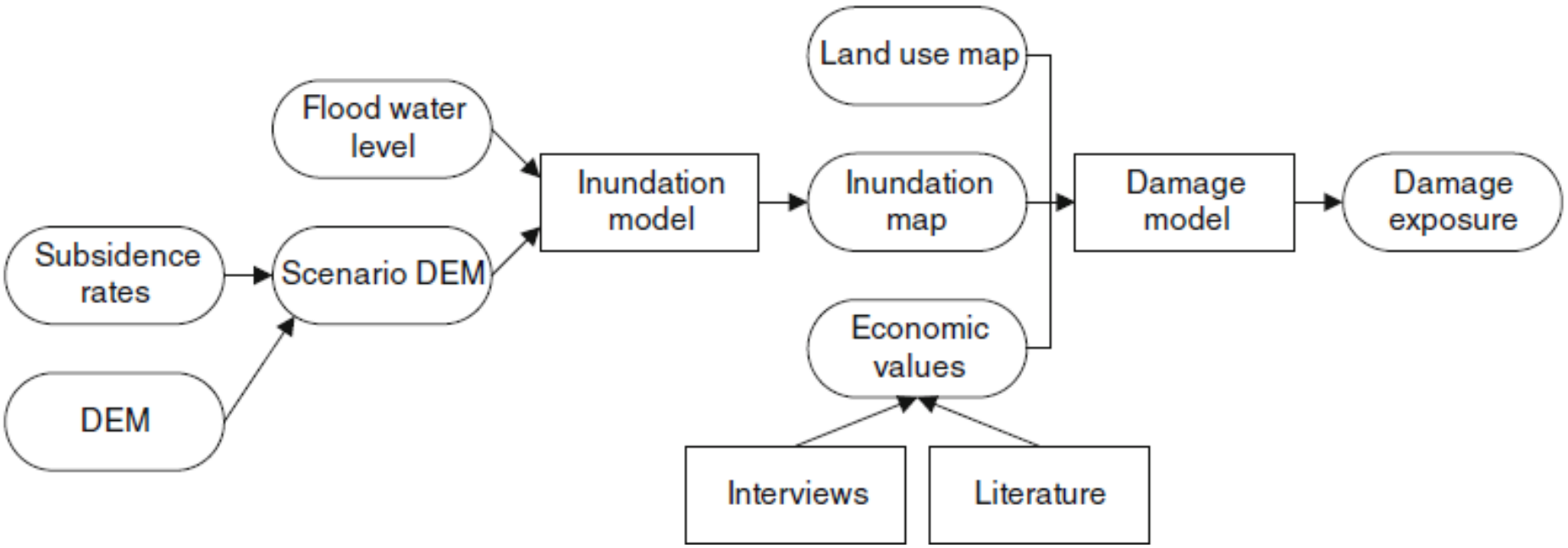




Abidin 2007

Method and Tool for assesing impact of climate change in coastal area




Land use map
Flood water level
Inundation model
Inundation map
Damage model
Damage exposure
Subsidence rates
Scenario DEM
DEM
Economic values
Interviews
Literature

Calculation of future water level using Nicholls methods, with in the three sea level equation

Scenario (i): $WL = S100$ (Eq. 1)

Scenario (ii): $WL = SLR_{2070S} + (€ \times S100) + SUB_{NATURAL}$ (Eq. 2)

Scenario (iii): $WL = SLR_{2070S} + (€ \times S100) + SUB_{NATURAL} + SUB_{ANTROPOGENIC}$ (Eq. 3)

Where:

WL = Water level

S100 = 1 in 100 year extreme water level

€ = Storm enhancement factor

SLR_{2070S} = Global mean sea level rise in 2070S

$SUB_{NATURAL}$ = Total natural subsidence in 2070S

$SUB_{ANTROPOGENIC}$ = Total human-induced subsidence in 2070S

No	Models	2070S (in meter)	€	S100 (in meter)	NATURAL (in meter)	ANTROPOGENIC (in meter)	WL (in meter)
1	Scenario (i)	-	-	1.596	-	-	1.596
2	Scenario (ii)	0.5	1.1	1.596	1.250	-	3.506
3	Scenario (iii)	0.5	1.1	1.596	1.250	0.5	4.006

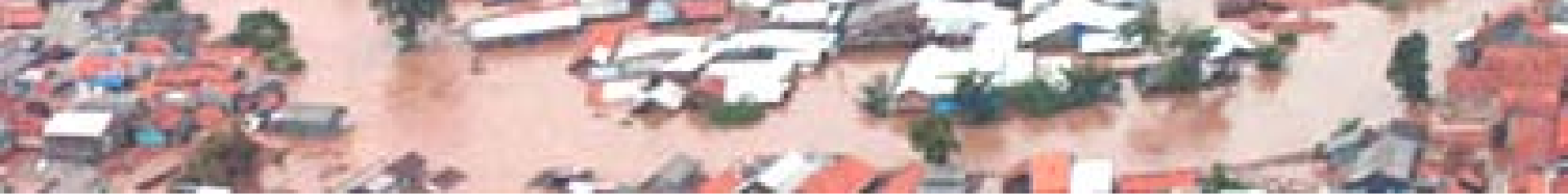
(-) not formulated in equation

Exposure to extreme sea level from DIVA database

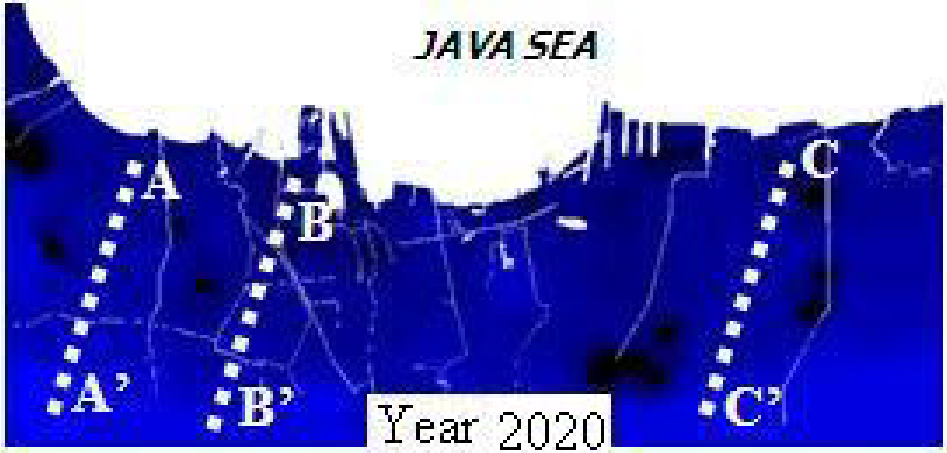
No	Extreme Sea Level	Sea Level Rise (in meter)
1	S1 (1 in 1 year)	1.082
2	S10 (1 in 10 year)	1.329
3	S100 (1 in 100 year)	1.596
4	S1000 (1 in 1000 year)	1.880

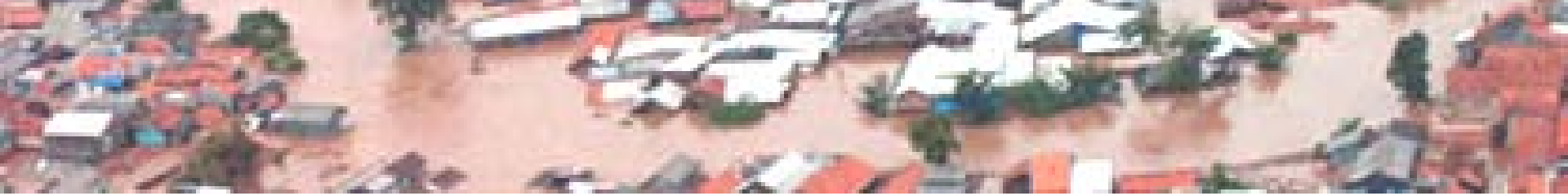
Result

Spatial Model and Analysis of Vulnerability

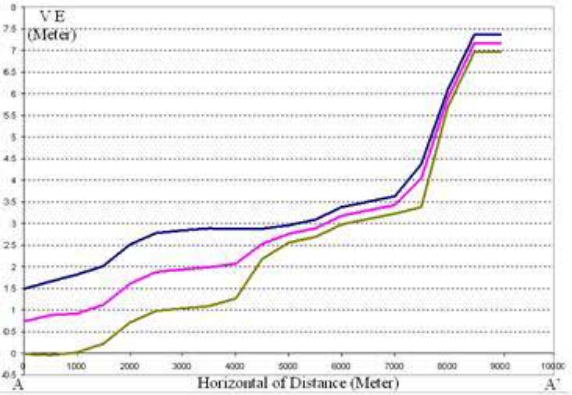


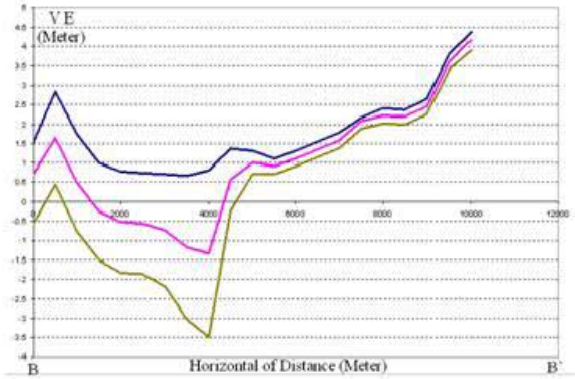
Digital Elevation Model

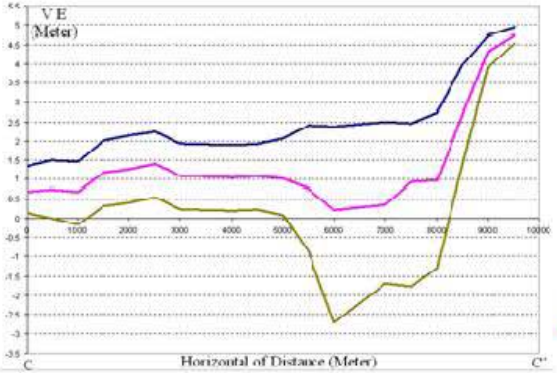


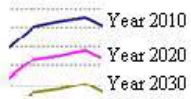


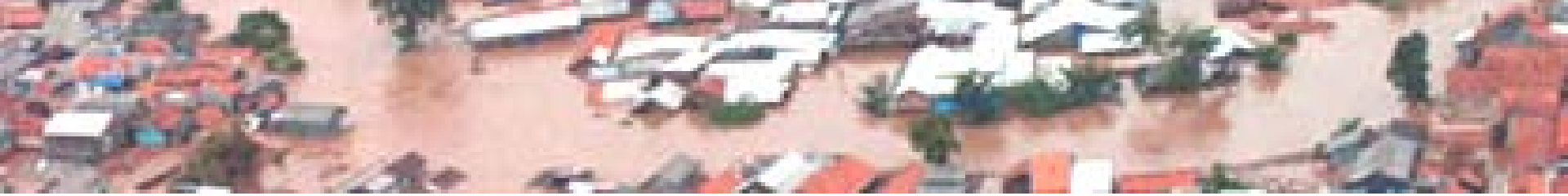
Cross profilling



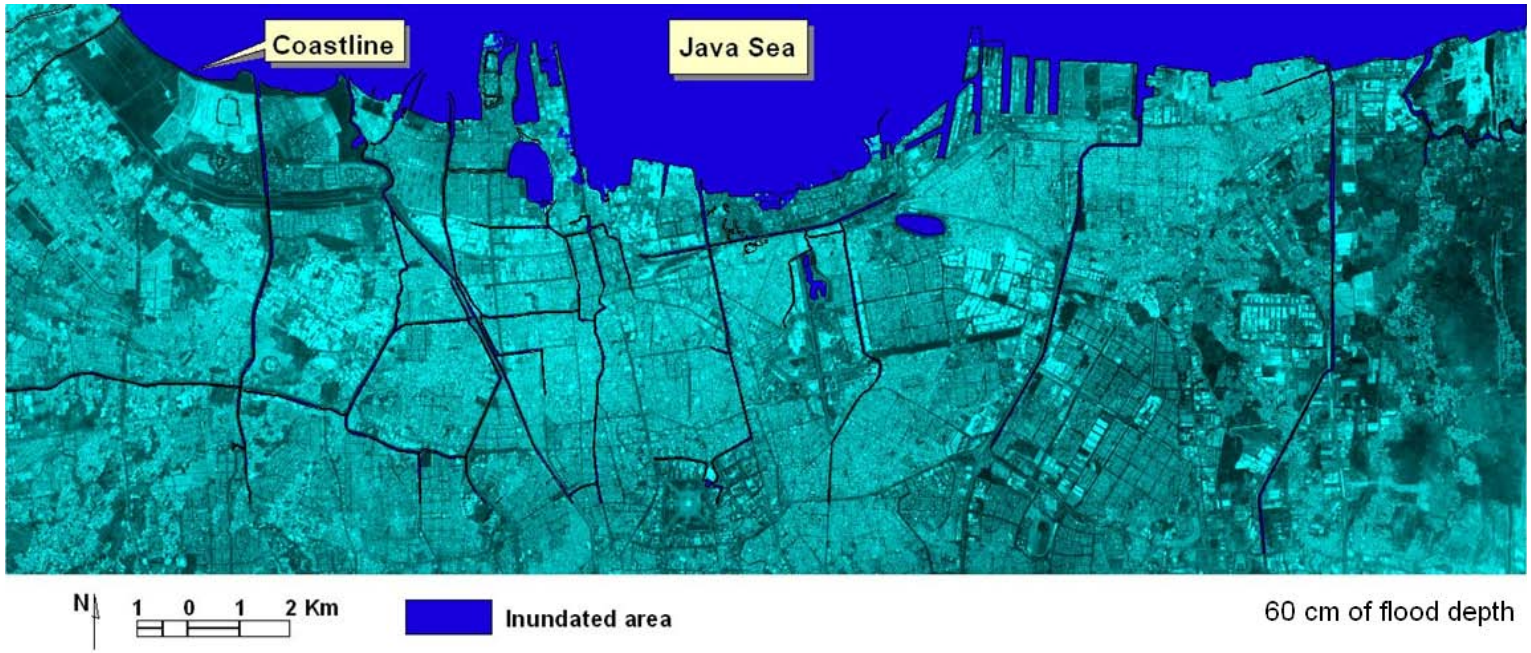


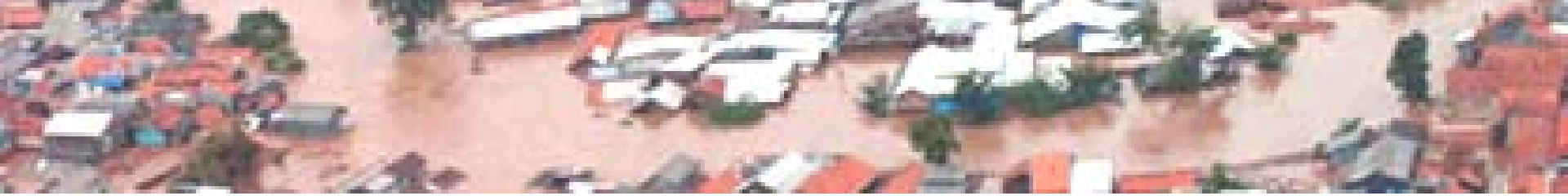




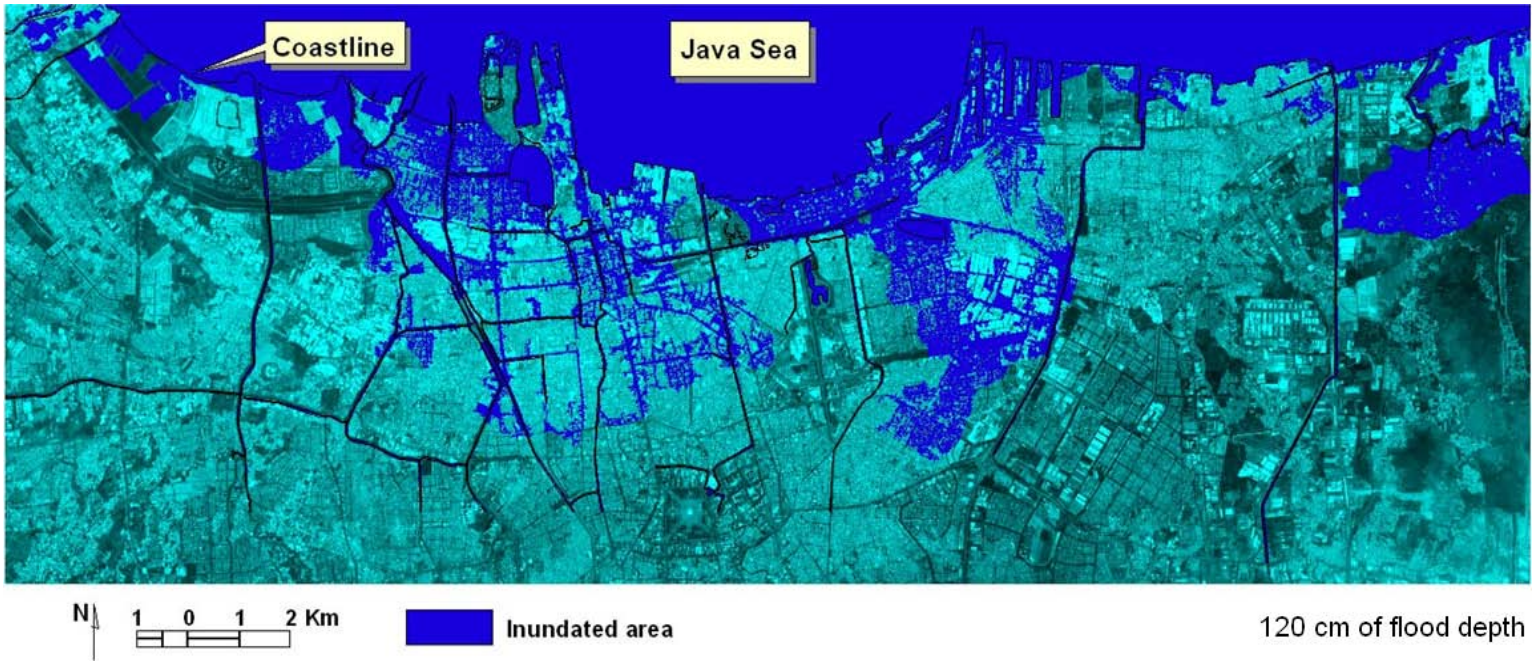


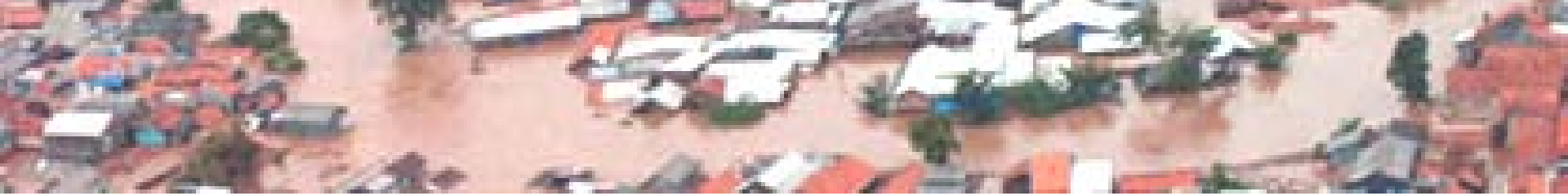
Hazard Modelling



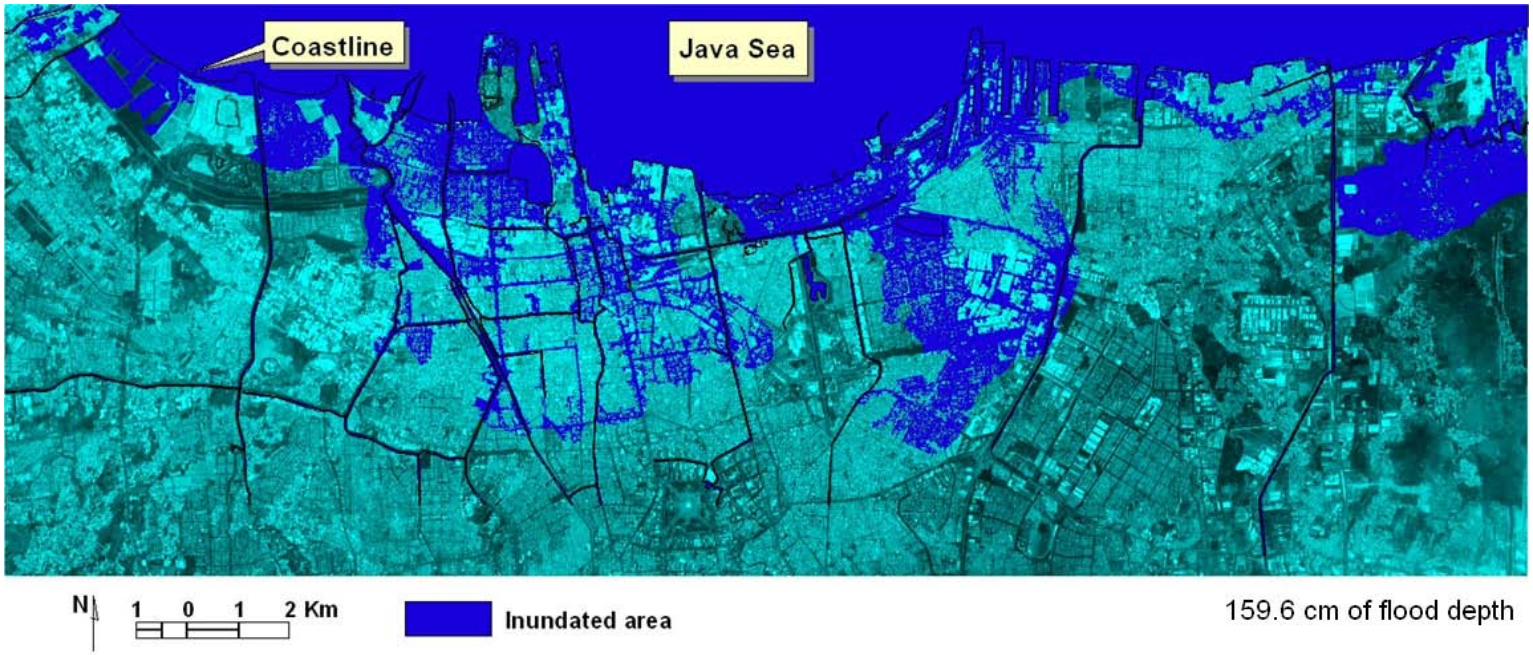


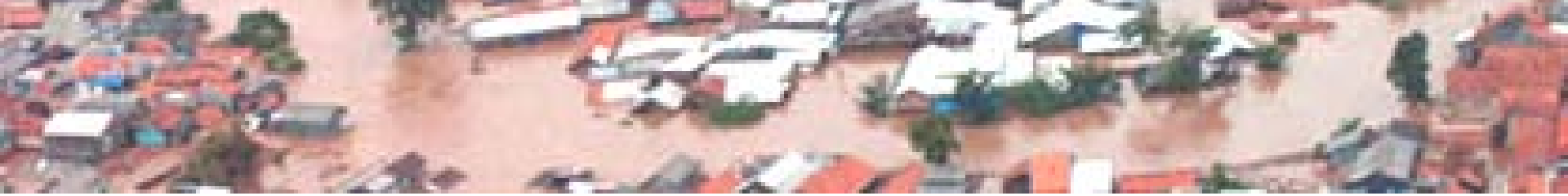
Hazard Modelling



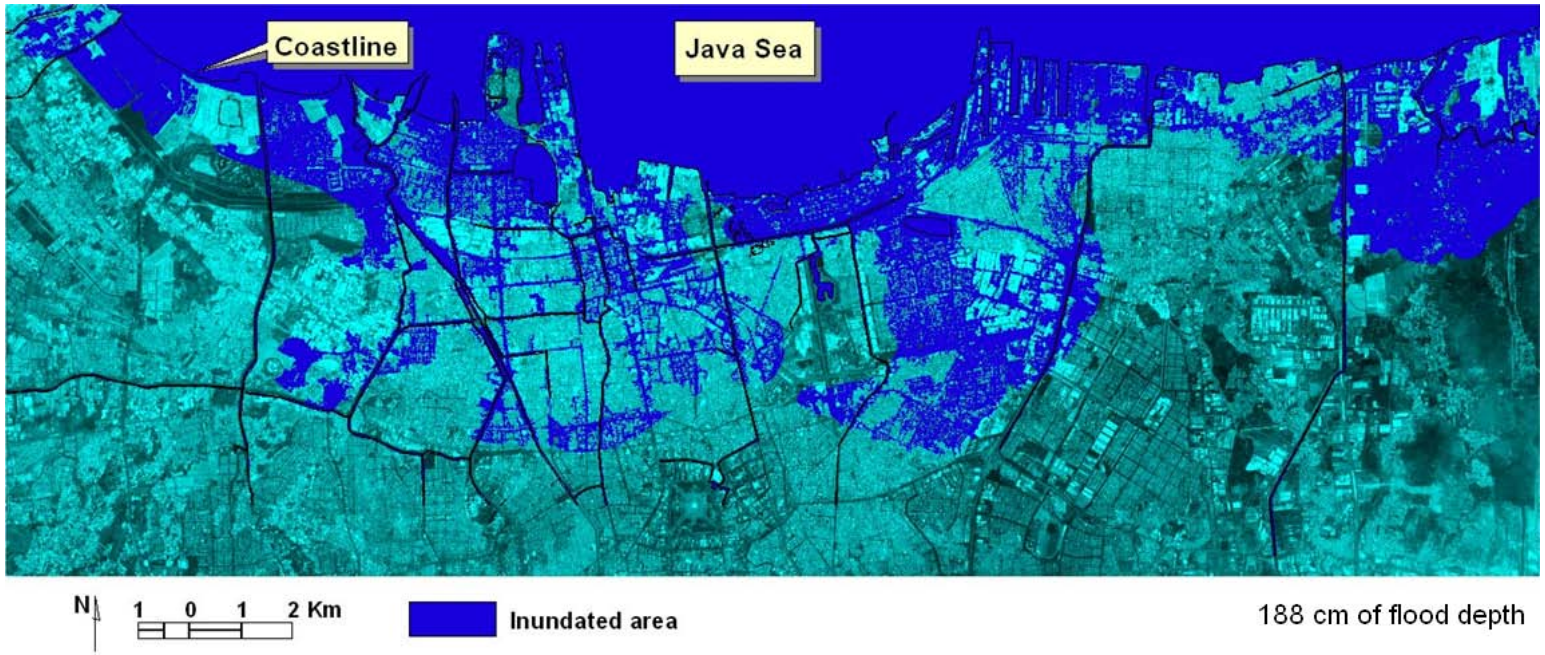


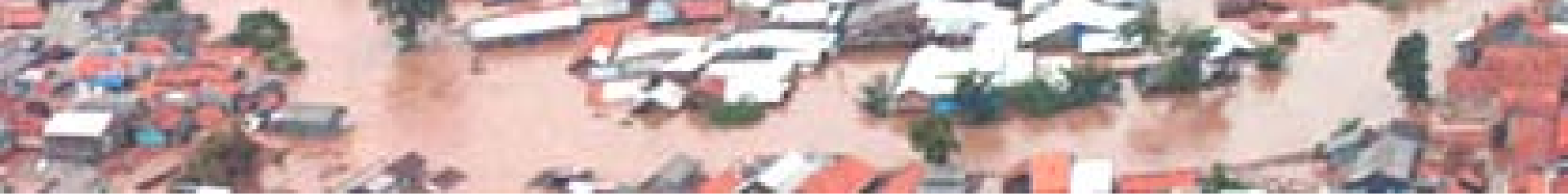
Hazard Modelling



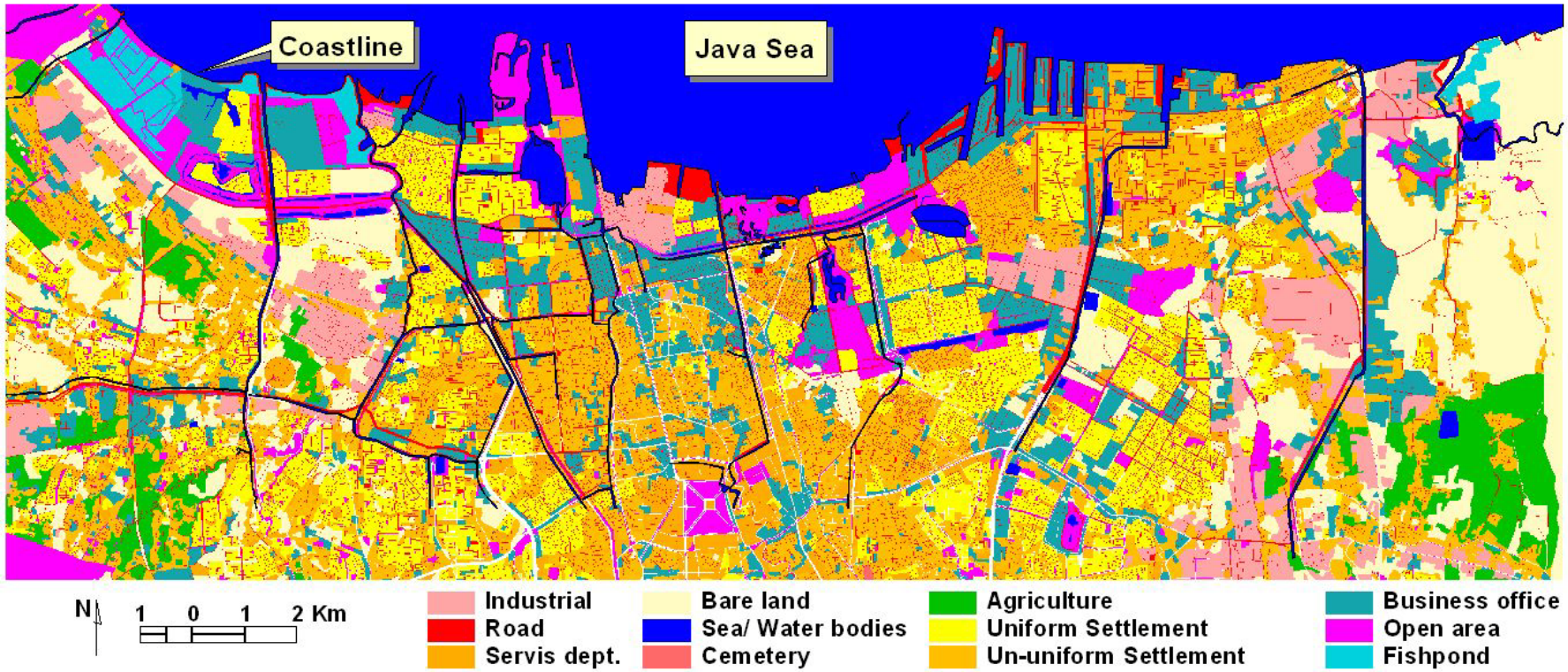


Hazard Modelling

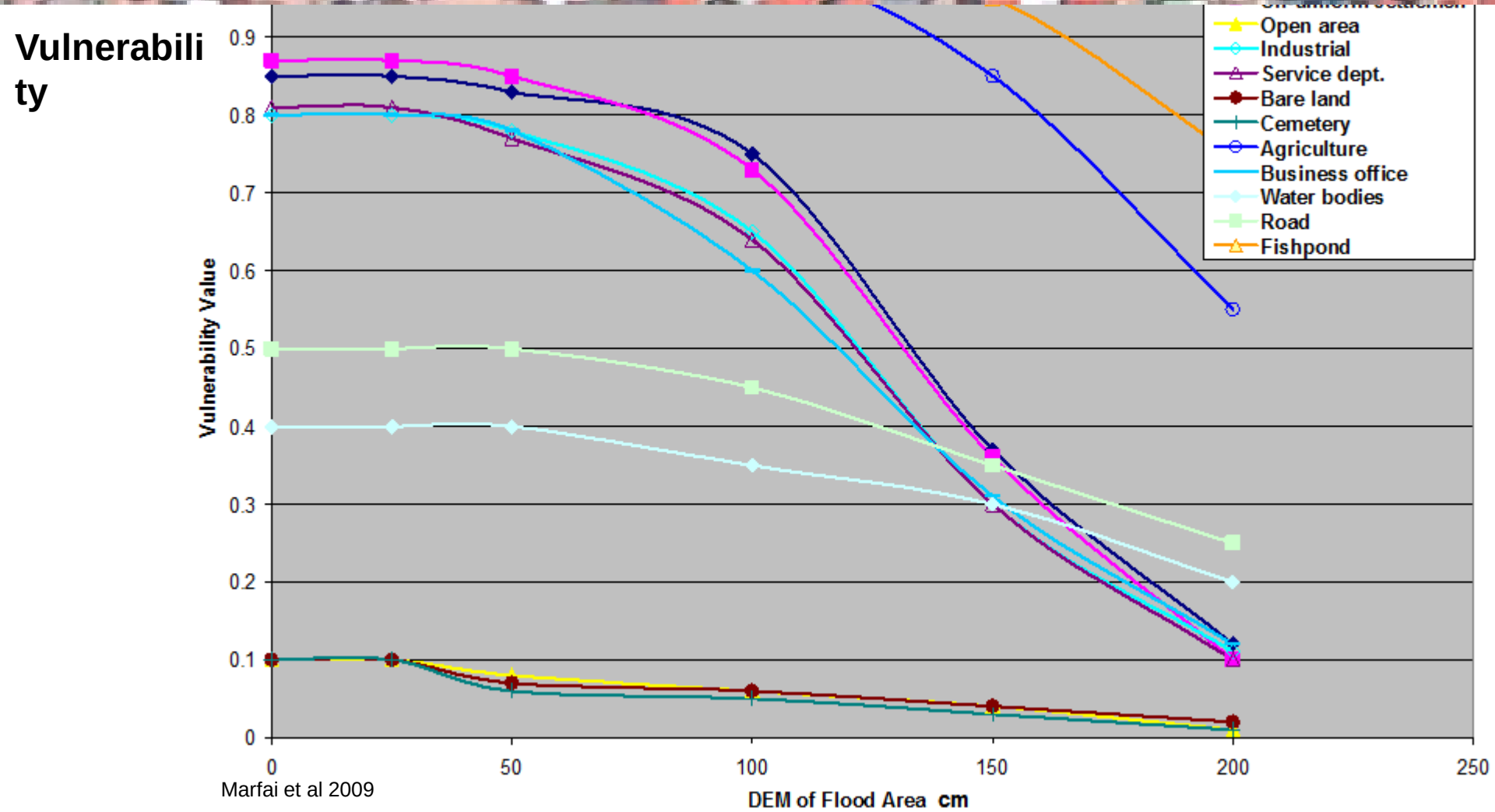




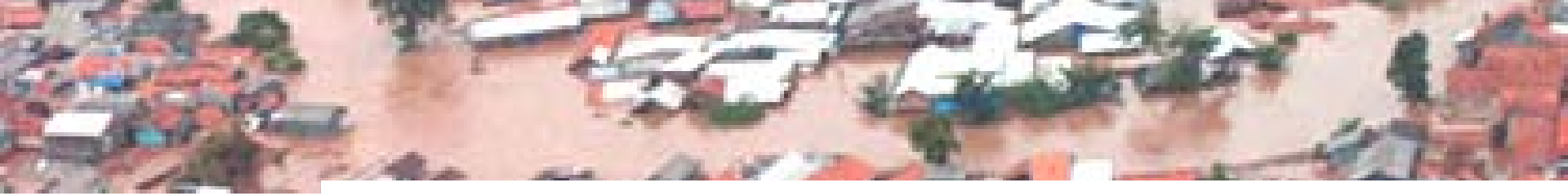
Element at Risk



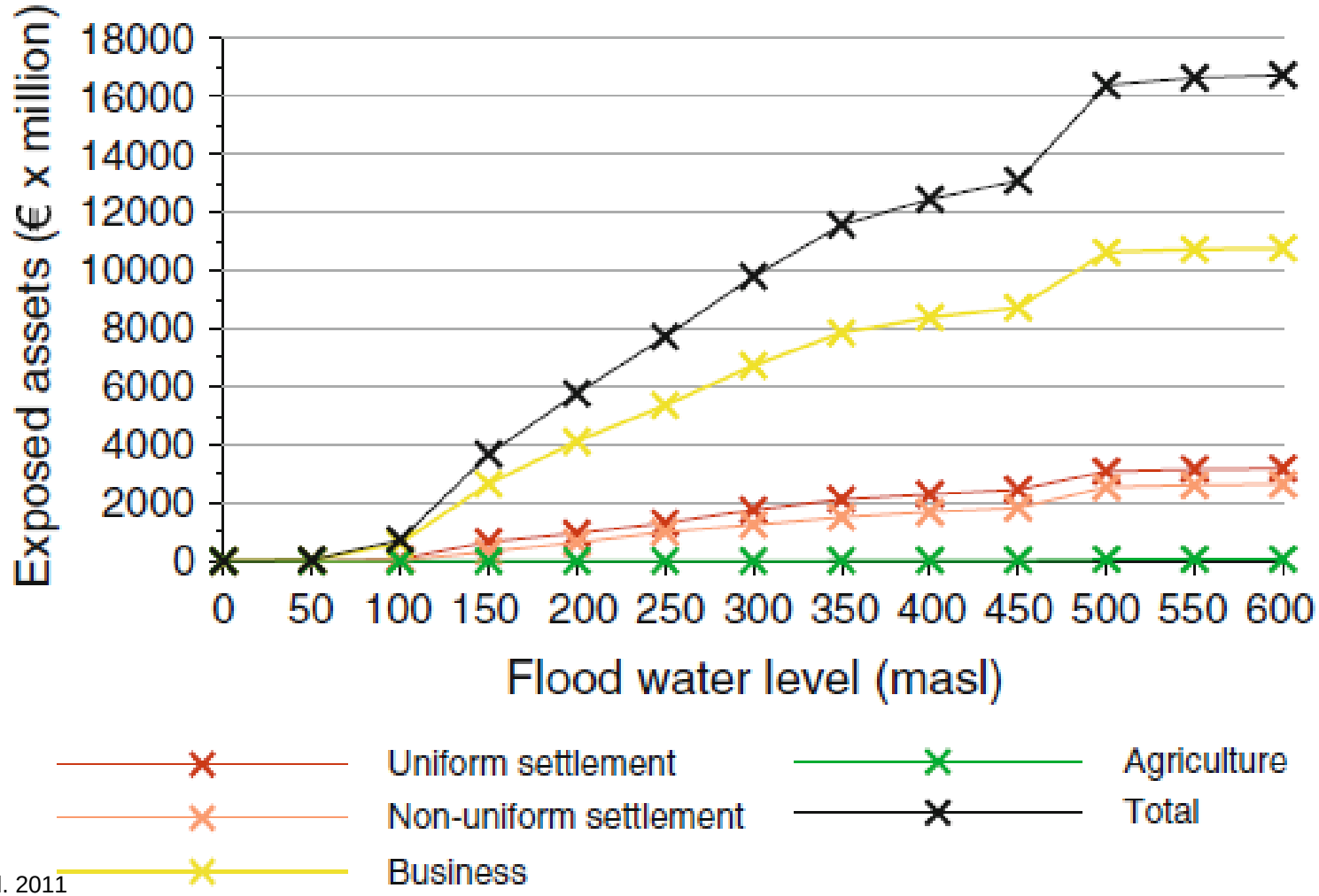
Vulnerability



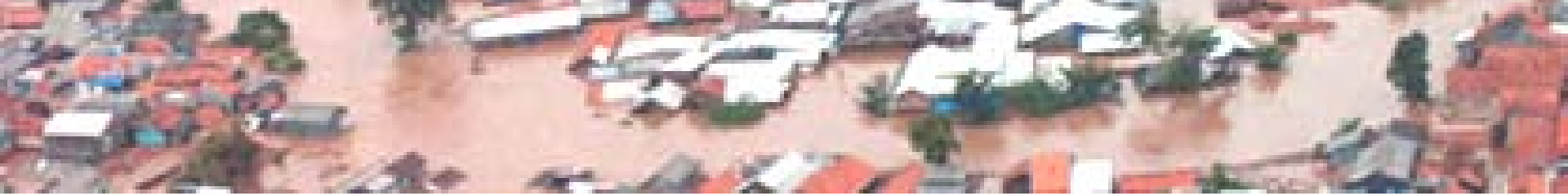
Marfai et al 2009



Risk

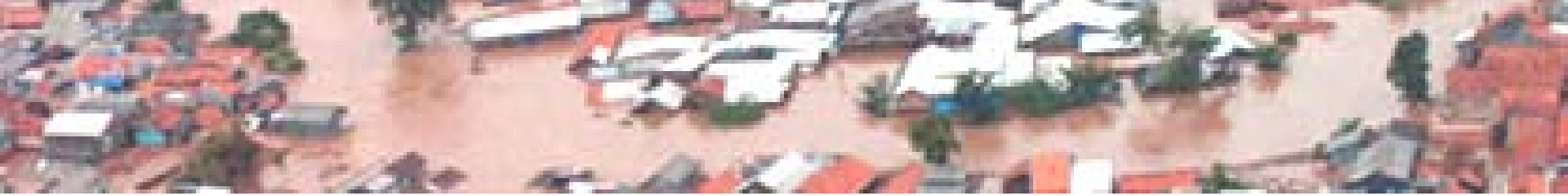


Ward et al. 2011



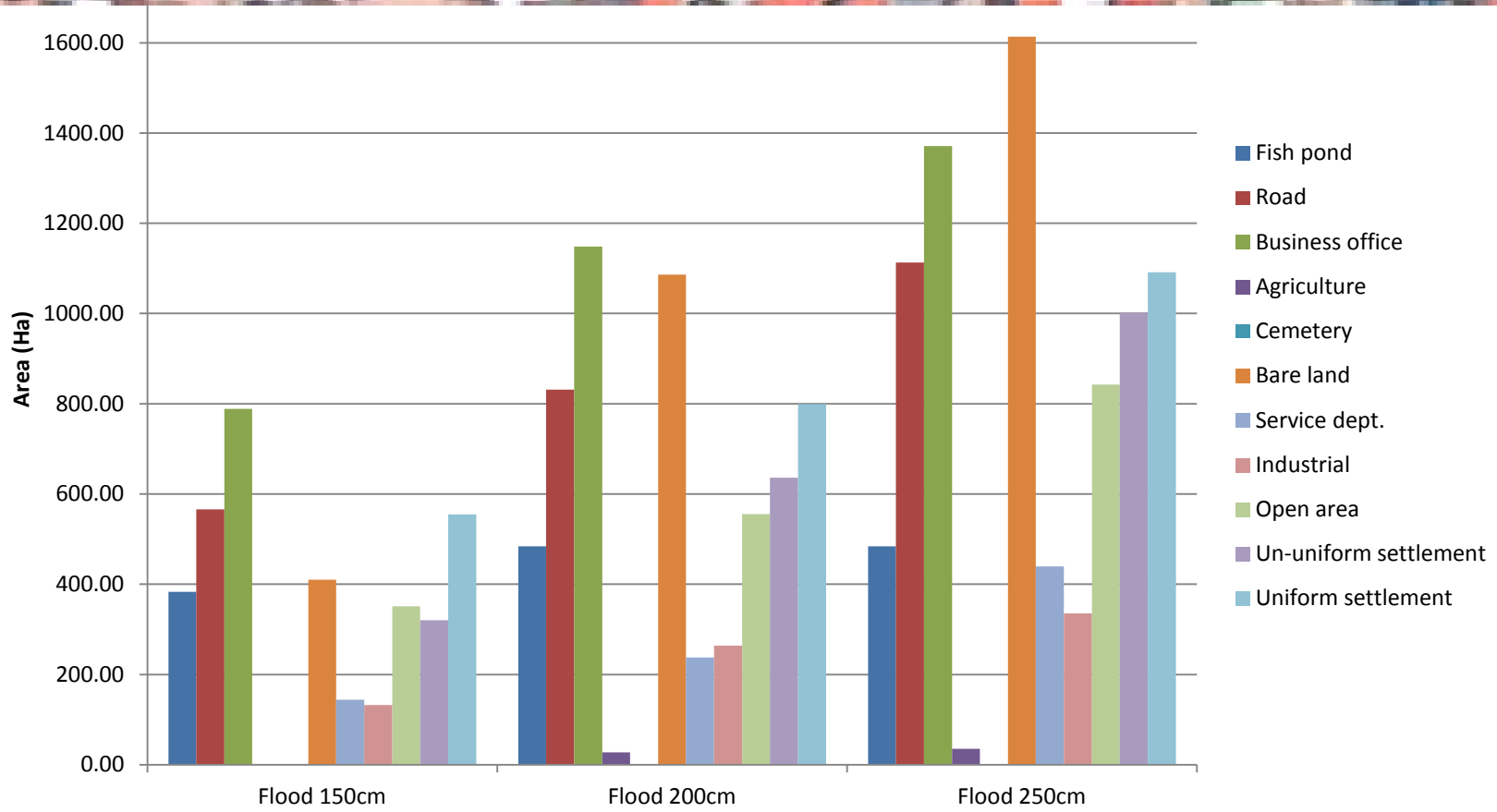
Coastal Ecosystems Affected by Sea Level Rise (in Hectares)

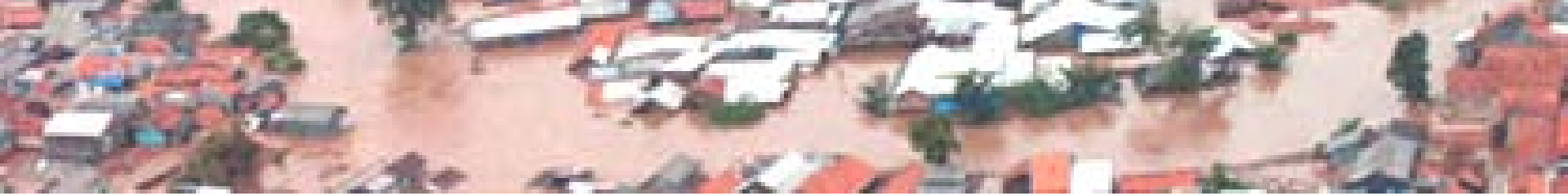
No	Type of land use	Scenario of inundation flood model				
		0.50 m	1.00 m	1.50 m	2.00 m	2.50 m
1	Industrial	44.38	120.22	149.44	230.67	643.77
2	Road	246.58	458.82	626.14	774.30	1462.58
3	Service dept.	24.81	113.19	155.65	208.91	674.19
4	Bare land	15.10	268.06	477.32	813.42	2293.70
5	Cemetery	0.00	0.00	0.00	0.13	1.39
6	Agriculture	0.00	0.00	0.00	26.20	260.87
7	Uniform settlement	128.39	459.67	602.40	727.48	1775.67
8	Un-uniform settlement	68.38	242.82	384.99	557.46	1515.59
9	Business office	349.68	673.66	850.59	1059.81	1829.27
10	Open area	126.41	292.65	380.03	463.17	1070.32
11	Fishpond	310.50	341.31	406.09	458.14	483.78

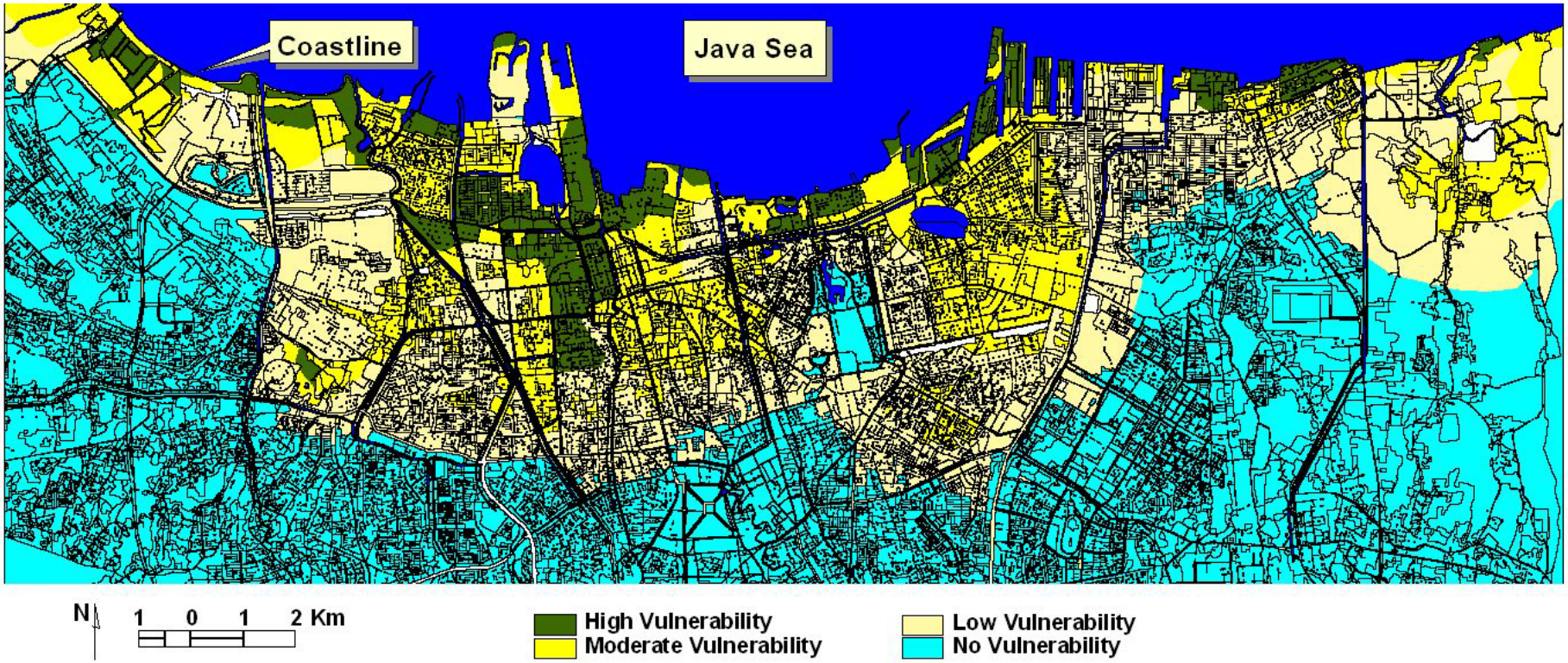


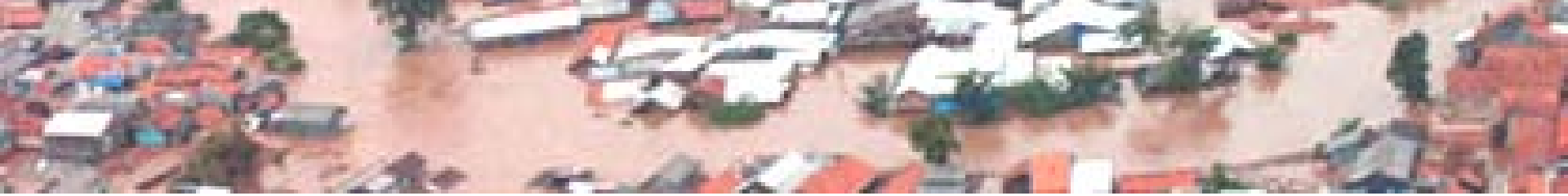
Risk

No	Type of land use	Cost estimation (in rupiah *(1 million))					
		S1 108,2 cm	S10 132,9 cm	S100 159,6 cm	S1000 188,0 cm	WL I 350,56 cm	WL II 400,56 cm
1	Build up area						
	* uniform settlement	306,531.13	1,097,462.13	1,438,230.00	1,736,858.50	4,239,412.13	4,583,068.88
	* Un-uniform settlement	162,744.40	577,911.60	916,276.20	1,326,754.80	3,607,104.20	4,019,248.80
2	Business area	16,754.80	36,282.80	46,227.20	59,975.60	125,889.20	134,298.40
3	Agriculture area	0.00	0.00	0.00	681.20	6,782.62	8,640.84
4	Bare land, beach, and yard area	7,783.05	30,839.05	47,154.25	70,219.60	185,097.55	190,705.90
5	Fishpond area	13,972.50	15,358.95	18,274.05	20,616.30	21,770.10	21,770.10
	Total Cost Estimation	507,785.88	1,757,854.53	2,466,161.70	3,215,106.00	8,186,055.80	8,957,732.92

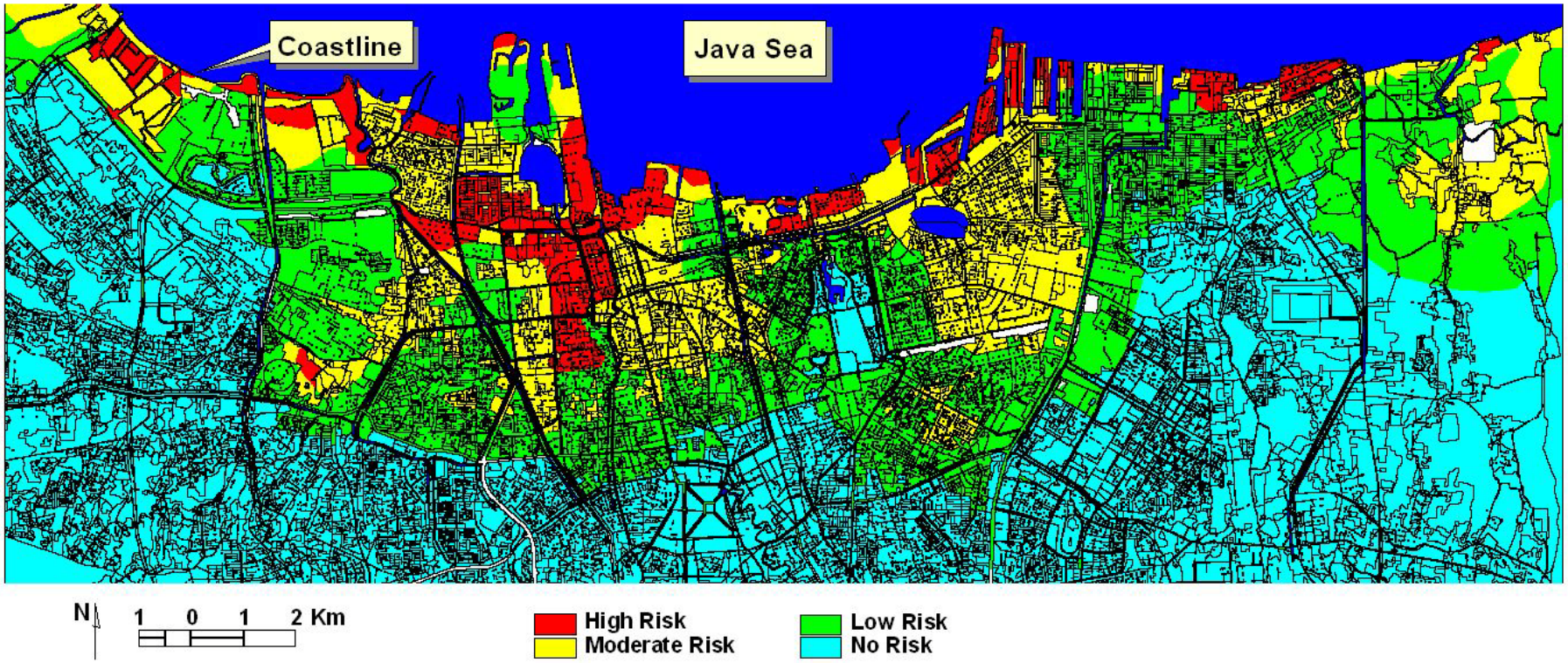

1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
Area (Ha)
Flood 150cm
Flood 200cm
Flood 250cm
Fish pond
Road
Business office
Agriculture
Cemetery
Bare land
Service dept.
Industrial
Open area
Un-uniform settlement
Uniform settlement

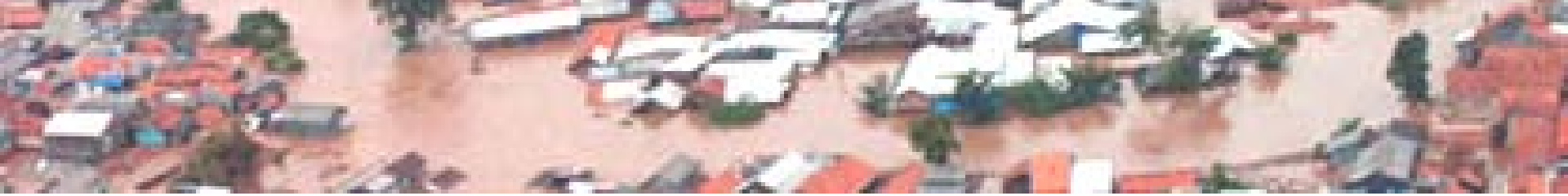



Coastline
Java Sea
N
1 0 1 2 Km
High Vulnerability
Moderate Vulnerability
Low Vulnerability
No Vulnerability



Risk


Coastline
Java Sea
N
1 0 1 2 Km
High Risk
Moderate Risk
Low Risk
No Risk

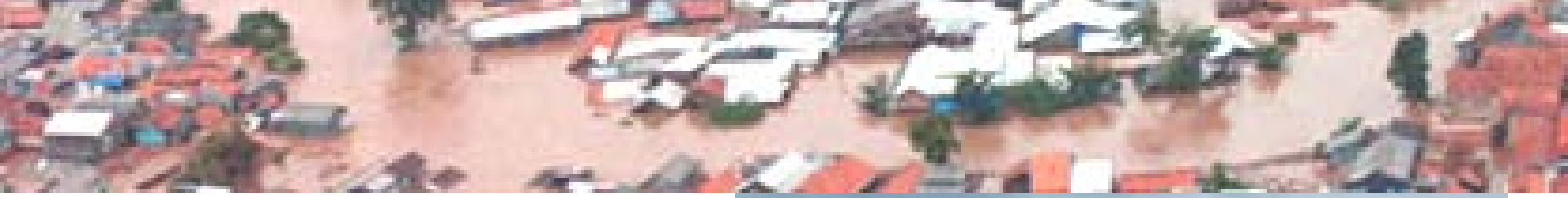


(additional information impact of flood in jakarta)

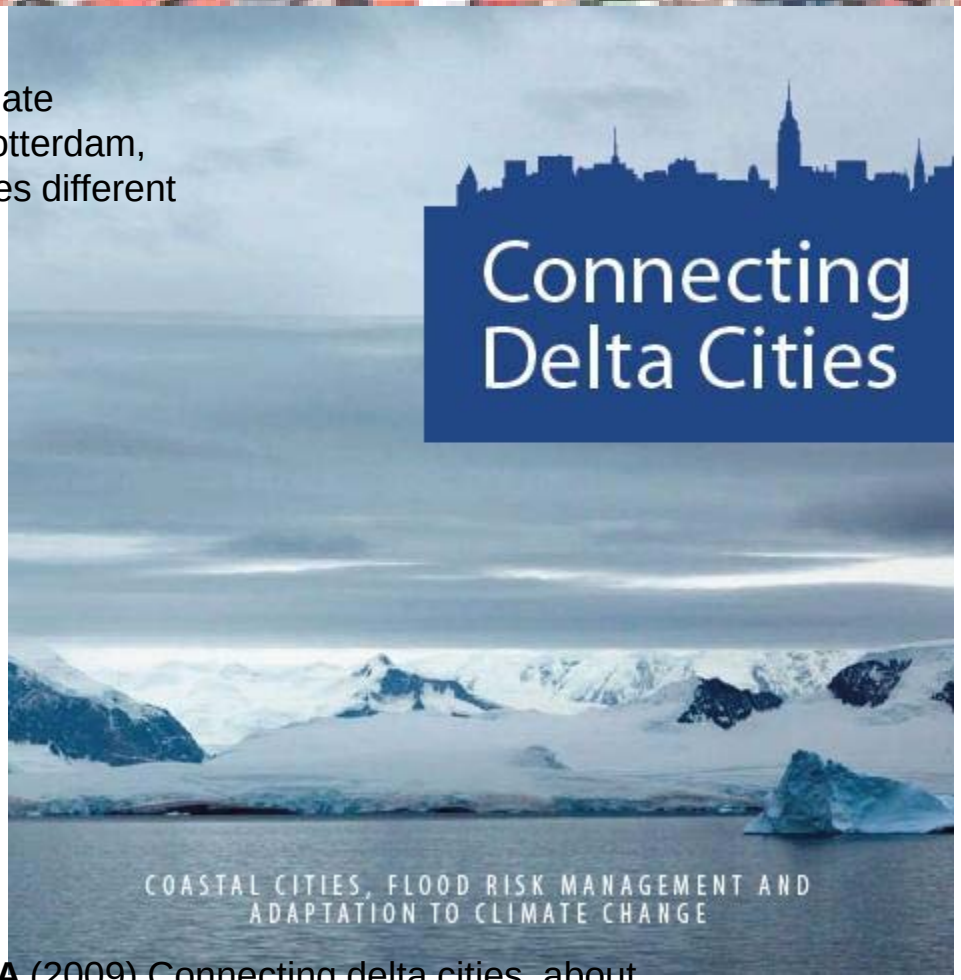
Projected Losses due to increasing coastal flooding in Jakarta

Inundation Scenario	Damaged Road (Km)	Losses (Billion Rupiah)
0.50 m	4.93	9.863
1.00 m	9.18	18.353
1.50 m	12.52	25.046
2.00 m	15.49	30.972
2.50 m	29.25	58.503

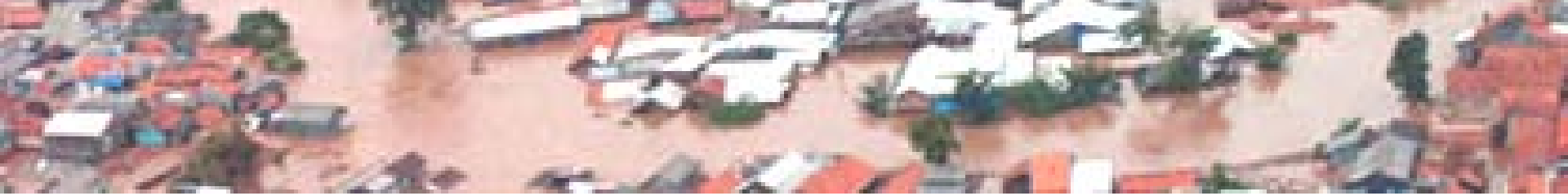
*assumption: width of the road = 5 m, Cost to build new road = 2 billion rupiah/km
http://www.yehu.or.id/new/Bisnis-dan-Teknologi/jalur-lintas-sulawesi-rusak-parah.html



"…….This book shows the different aspects of climate adaptation and is a joint initiative of the Cities of Rotterdam, New York and Jakarta. In this regard, each city faces different challenges;…….

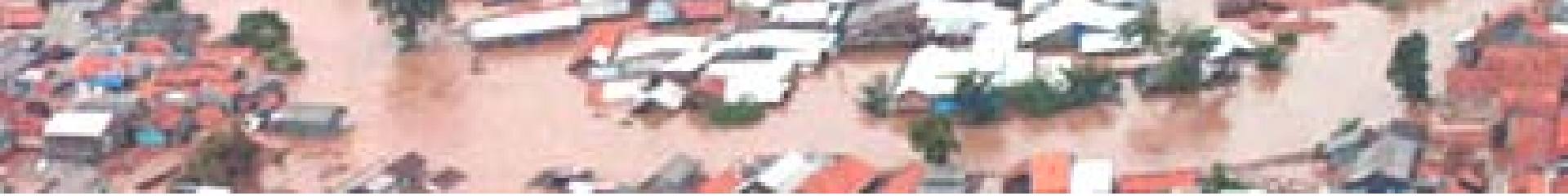


Aerts J, Bowman M, Dircke P, Major D, and **Marfai MA** (2009) Connecting delta cities, about global coastal cities and future chalanges. VU University Press, Amsterdam, The Netherlands



Reference:

Ward PJ, Marfai, MA, Yulianto F, Hizbaron DR, Aerts JCJH, 2010. Coastal inundation and damage exposure estimation: a case study for Jakarta. Natural Hazards, Springer 56: 899-916. http://www.springerlink.com/content/h33284l688800282/



DeltAlliance

Knowledge for Climate

END OF PRESENTATION

THANK YOU…