Comprehensive Research on Projection of Climate Change Impacts and Evaluation of Adaptation

日本における洪水の適応策と緩和策の評価
Evaluation of adaptation and mitigation to flooding in Japan

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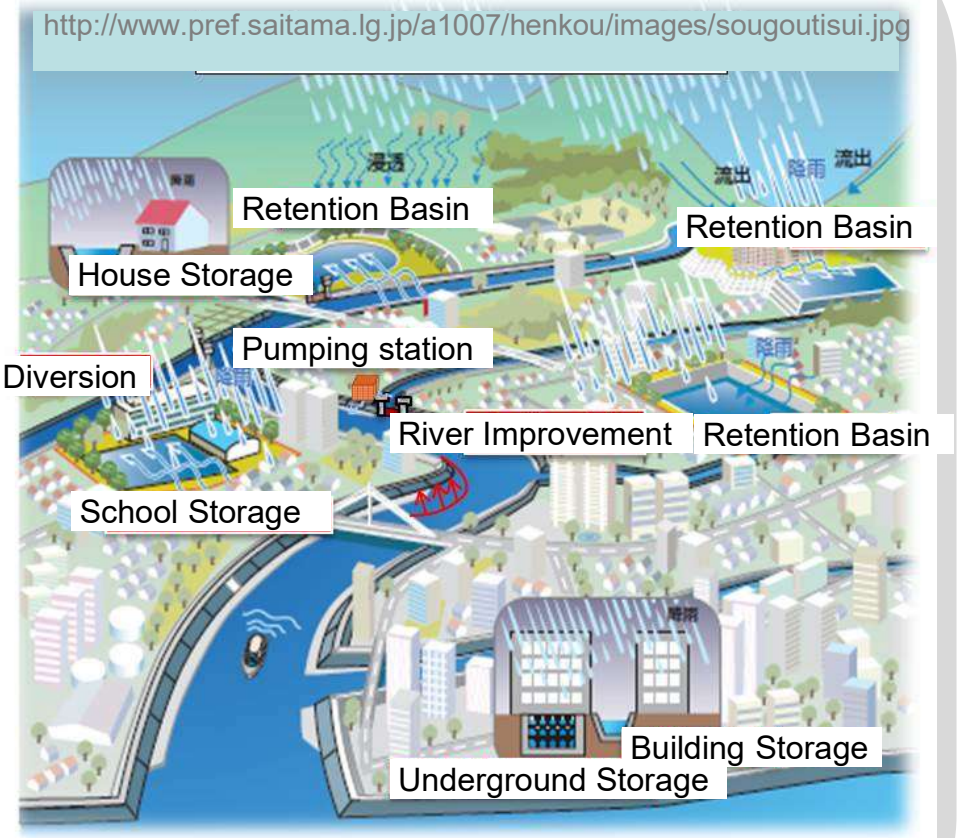
Responses to Climate Change and Future Society

1 Background 背景

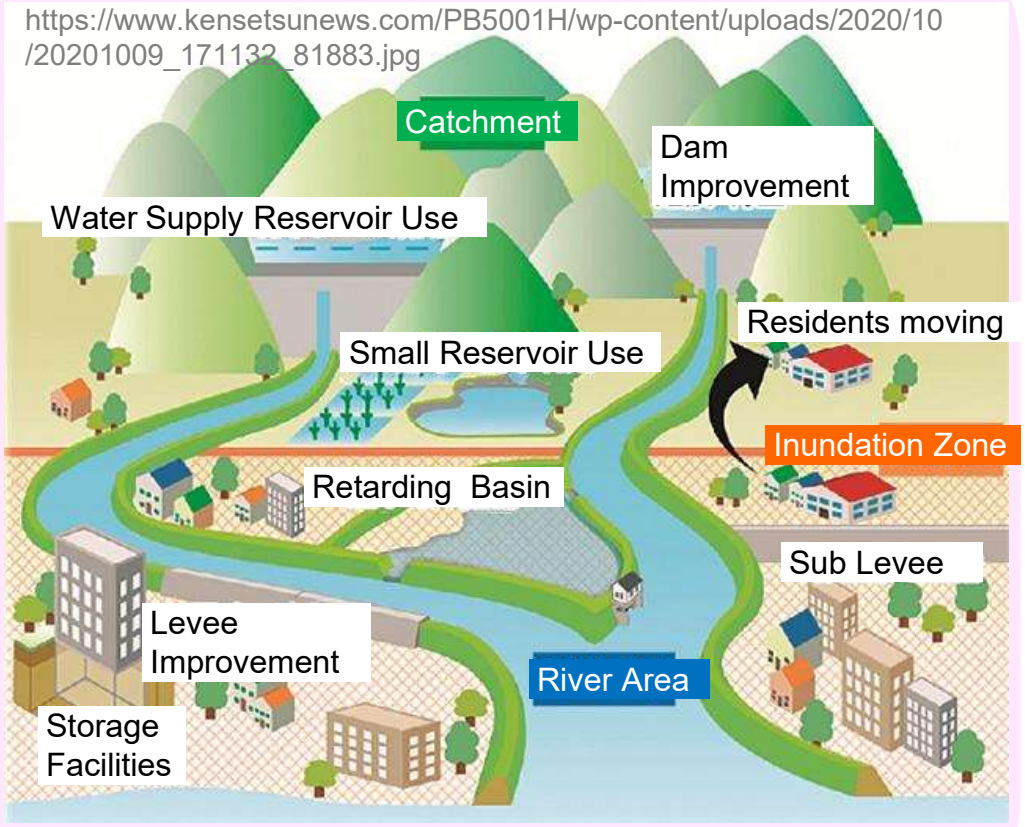
Japanese Government has shifted to a new Integrated Flood Management (IFM) 流域治水への変換

Water control 水の制御



Traditional IFM 総合治水

Life style control生活の変容



New IFM 流域治水

Since 2014, Japan has been greatly damaged by flood.

2 Background & Purpose: Evaluation of adaptations
背景と目的： 適応策の評価

Ex. Smit *et al.*,(1999)

Adaptation Options 適用策分類

PROTECT
防御

Levee堤防
Pumpポンプ

Traditional
IFM
旧治水

ACCOMMODATE
受容

https://pbs.twimg.com/media/EGqqWddUwAArYwT.jpg:small

Piloti house
高床
Paddy dam
田んぼダム

New
IFM
流域治水

RETREAT
撤退

https://www.vill.noda.iwate.jp/seikatukibannsaikenn/image/0000002133002.jpg

Landuse
Control
土地利用規制

3 2D Hydraulic Model Simulation for Damage evaluation 数値計算

5 GCMs for Distribution of Extreme Rainfall

5つのGCMの再現期間降雨

Probability Rainfall

2D Hydraulic Model 水深推定

Water Depth

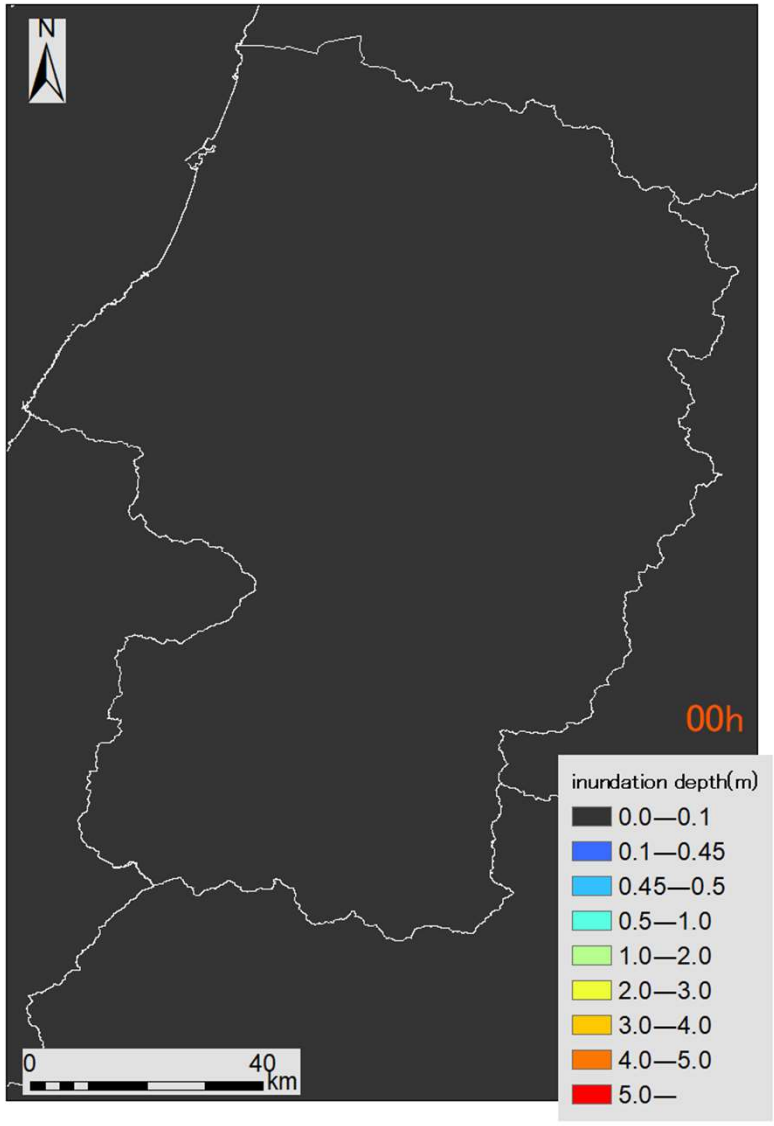
Economic Evaluation Manual

治水経済マニュアル
による被害額計算

Expected Annual
Damage Cost

山形の例

Example of Yamagata
100 years return period
Good agreement to the last year (2020) flood inundation

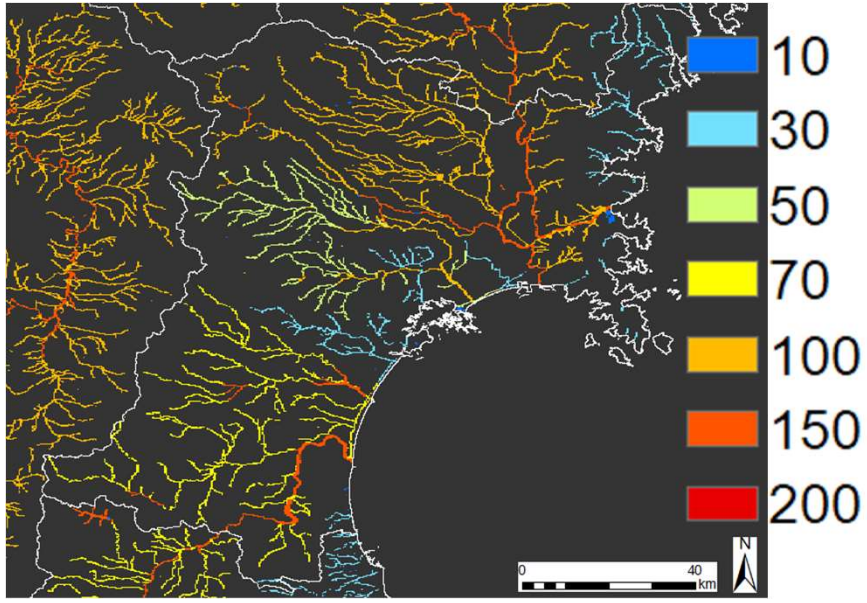


4 High levee Bed Excavation : higher Protection Level
治水レベルの向上 河道掘削=堤防建設

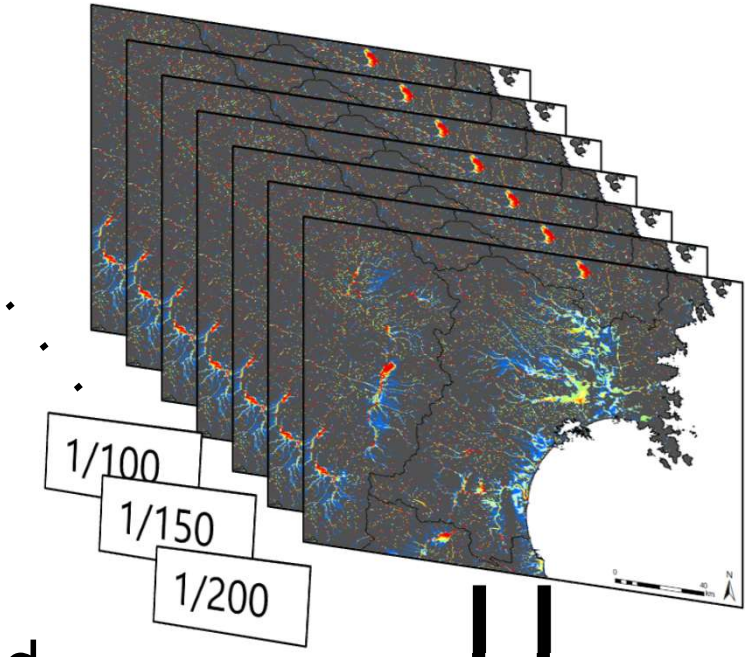
Tanaka et al.(2019) method

・Protection level for each river and each government zone 各河川整備方針を反映

Protection level 治水レベル

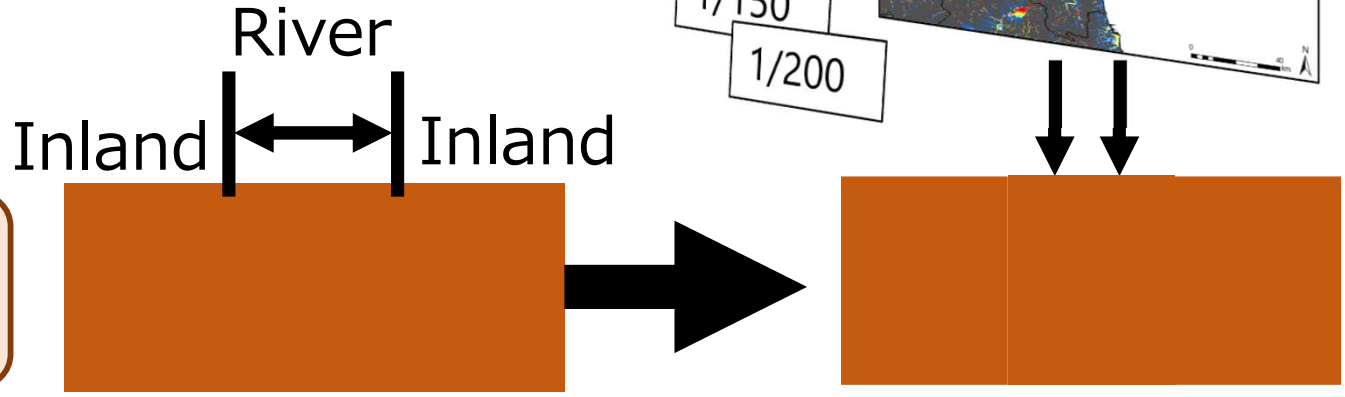


River bed excavation to protect flood with RP X years 再現期間毎



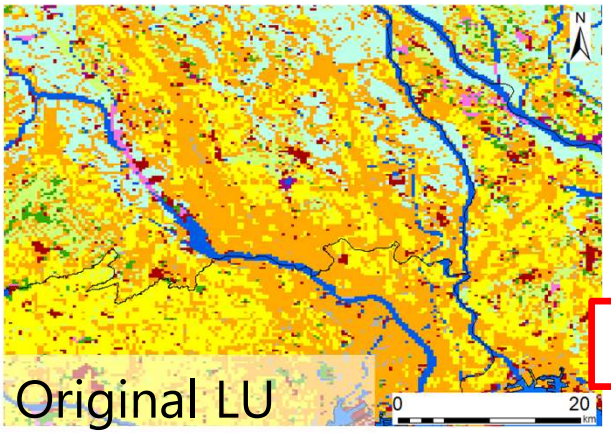
Dike 河道掘削

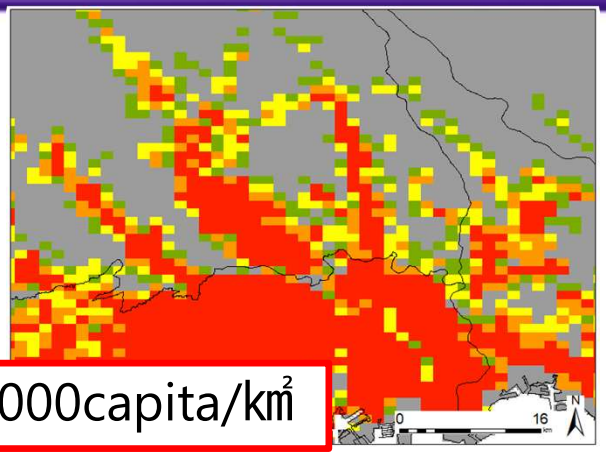
Expressed by lower elevation



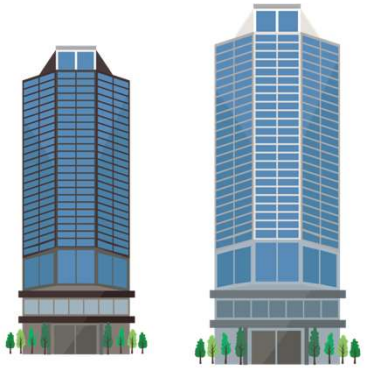
5 Piloti and Land use control
高床住宅と土地利用規制

paddy field
field
forest
barren land
road
others
water
coast
river
golf
business
residential area
pilotis business area
pilotis residential area
restricted business area
restricted residential area



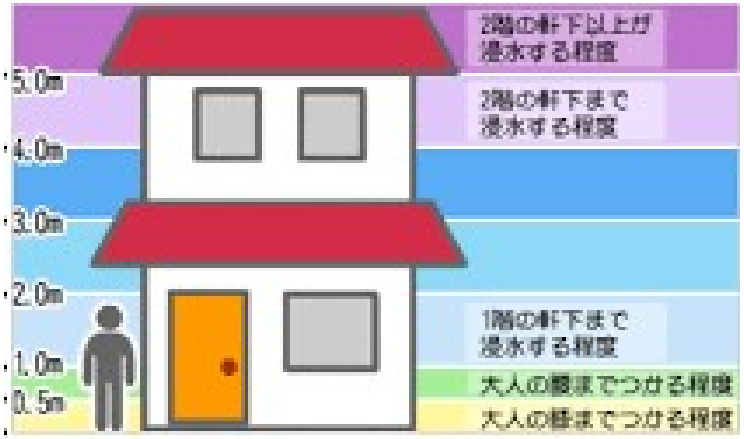


capita/km²
0 - 4,000
4,000 - 6,000
6,000 - 8,000
8,000 - 10,000
10,000 -



Piloti　高床住宅

3m below → No damage
in high dense area
with flood of 30 years return period
高人口密度地域　3m以下　被害無



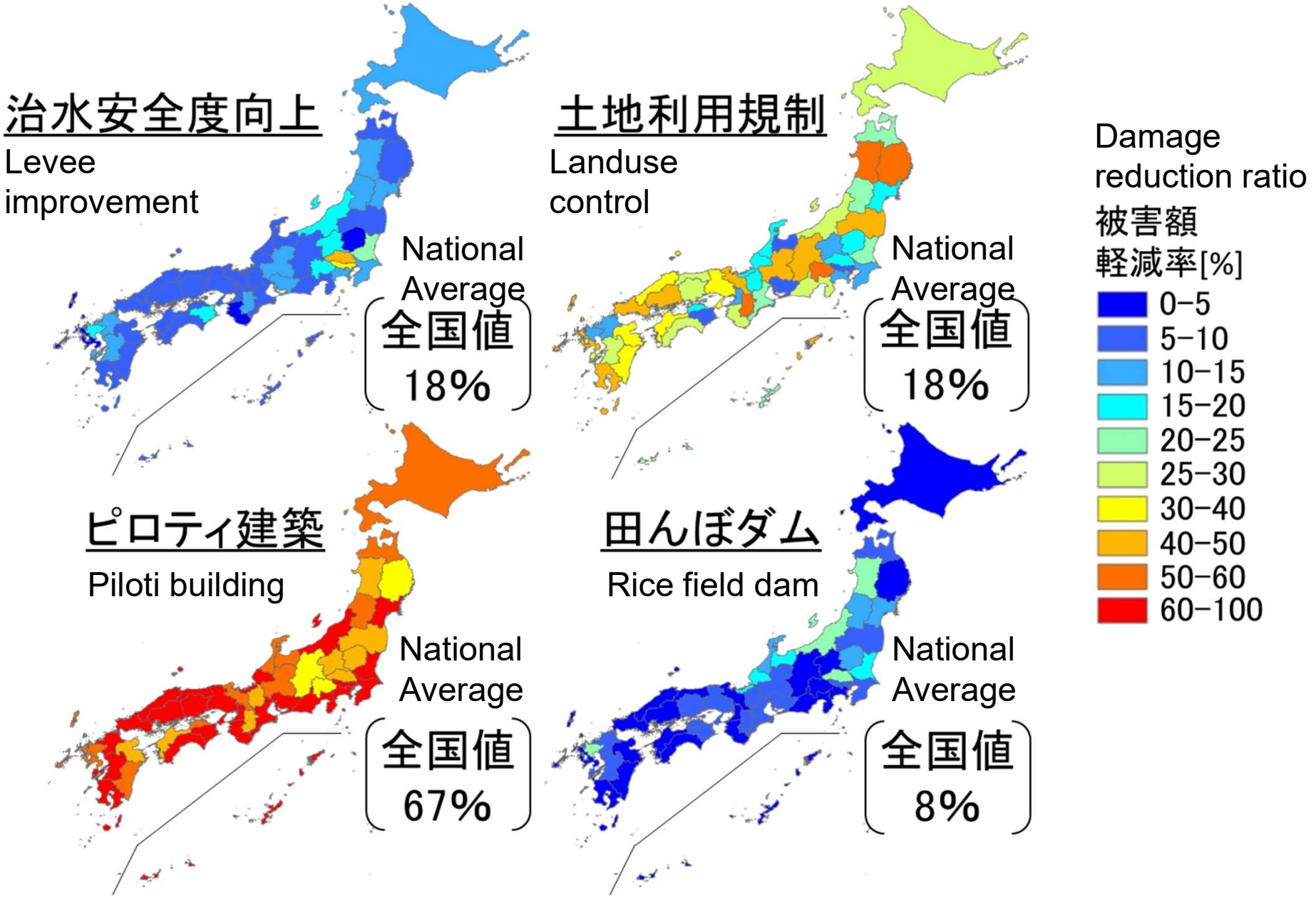
Hazard map of Hyogo Prefecture
ttps://lh3.googleusercontent.com/proxy/qsmiSXL-McWlc3fYQevrCYOx5IkLvRv2y4HsVVNdq_p044U9AF_Q4zPnPoub0vrcnUYk2iPRvzR256Mp4exm3-5EFSfW366MaROn0YuX-IT-ifBrdSHob7G01A

Landuse Control　土地利用規制

3m over → No damage
in low dense area
with rain of 200 years return period
低人口密度地域　3m以上被害無し

6 Adaptation effects in different areas
県別適応策の効果（20世紀条件）

Damage reduction ratio for fluvial flooding / 20century base



7 Adaptation effects on fluvial flood
外水洪水の適応策の効果　現状固定

20世紀末・適応策無しに対する被害額変化率
Change ratio for non-adaptation in the 20th century

		適応策無し No adaptation	治水安全度向上 Levee Improvement	土地利用規制 Landuse control
20世紀末　20C end		0	-18	-18
近未来 2050	RCP2.6	22	2	1
	RCP8.5	23	4	2
21世紀末 21C end	RCP2.6	16	-4	-5
	RCP8.5	38	18	16

		ピロティ建築 Piloti	田んぼダム Rice field dam	全ての適応策 All together
20世紀末　20C end		-67	-8	-85
近未来 2050	RCP2.6	-46	14	-74
	RCP8.5	-45	16	-74
21世紀末 21C end	RCP2.6	-51	8	-76
	RCP8.5	-30	31	-65

増加
increase

減少
decrease

8 Adaptation effects on pluvial flood
内水洪水の適応策の効果　現状固定

20世紀末・適応策無しに対する被害額変化率
Change ratio for non-adaptation in the 20th century

		適応策無し No adaptation	治水安全度向上 Levee Improvement	土地利用規制 Landuse control
20世紀末　20C end		0	-54	-31
近未来 2050	RCP2.6	50	-2	5
	RCP8.5	53	1	8
21世紀末 21C end	RCP2.6	35	-16	-7
	RCP8.5	85	36	30

		ピロティ建築 Piloti	田んぼダム Rice field dam	全ての適応策 All together
20世紀末　20C end		-86	-10	-90
近未来 2050	RCP2.6	-75	38	-91
	RCP8.5	-74	41	-90
21世紀末 21C end	RCP2.6	-78	23	-92
	RCP8.5	-66	71	-85

増加
increase

減少
decrease

9 Effect of Mitigation and Adaptation to flooding
両洪水の緩和策と適応策の効果

21世紀末　RCP8.5　適応無に対する被害軽減効果

Based on 21C end, comparing with non-adaptation with RCP8.5

※外水と内水の被害額を同程度として計算: Pluvial and fluvial floods are same damage.

政策 Policy option	被害額軽減率		
	現状固定	SSPシナリオ	
緩和策 Mitigation	22%↓	30%↓	
治水安全度向上 Levee Improvement	14%↓	17%↓	←内水含まず Only fluvial
排水能力向上 Pump	26%↓	26%↓	←外水含まず Only pluvial
土地利用規制 Landuse Control	24%↓	19%↓	
ピロティ建築 Piloti buildings	68%↓	68%↓	
田んぼダム Rice field dam	7%↓	5%↓	

Ex. Landuse Control=(116+130)/(138+185)=76%(24%↓)

10 Summary
まとめ

▸**Purposes**: Evaluation of Adaptation and Mitigation in Japan to **Flooding**　**適応策の定量評価**

▸Mitigation (Difference between RCPs)

22% decrese (late 21st century)

緩和策 22%被害減

▸Single adaptation Effects for current climate

7～68 % decrease

単適応策　最大68%被害額減

▸Integrated adaptation Effects for current climate

85 % decrease

組み合わせ適応策　最大85%被害額減

More detail: Tao Yamamoto et al., *Climatic Change*, 165:60, 2021.