ESTIMATING DEMAND FOR FLOOD CONTROL INFRASTRUCTURE

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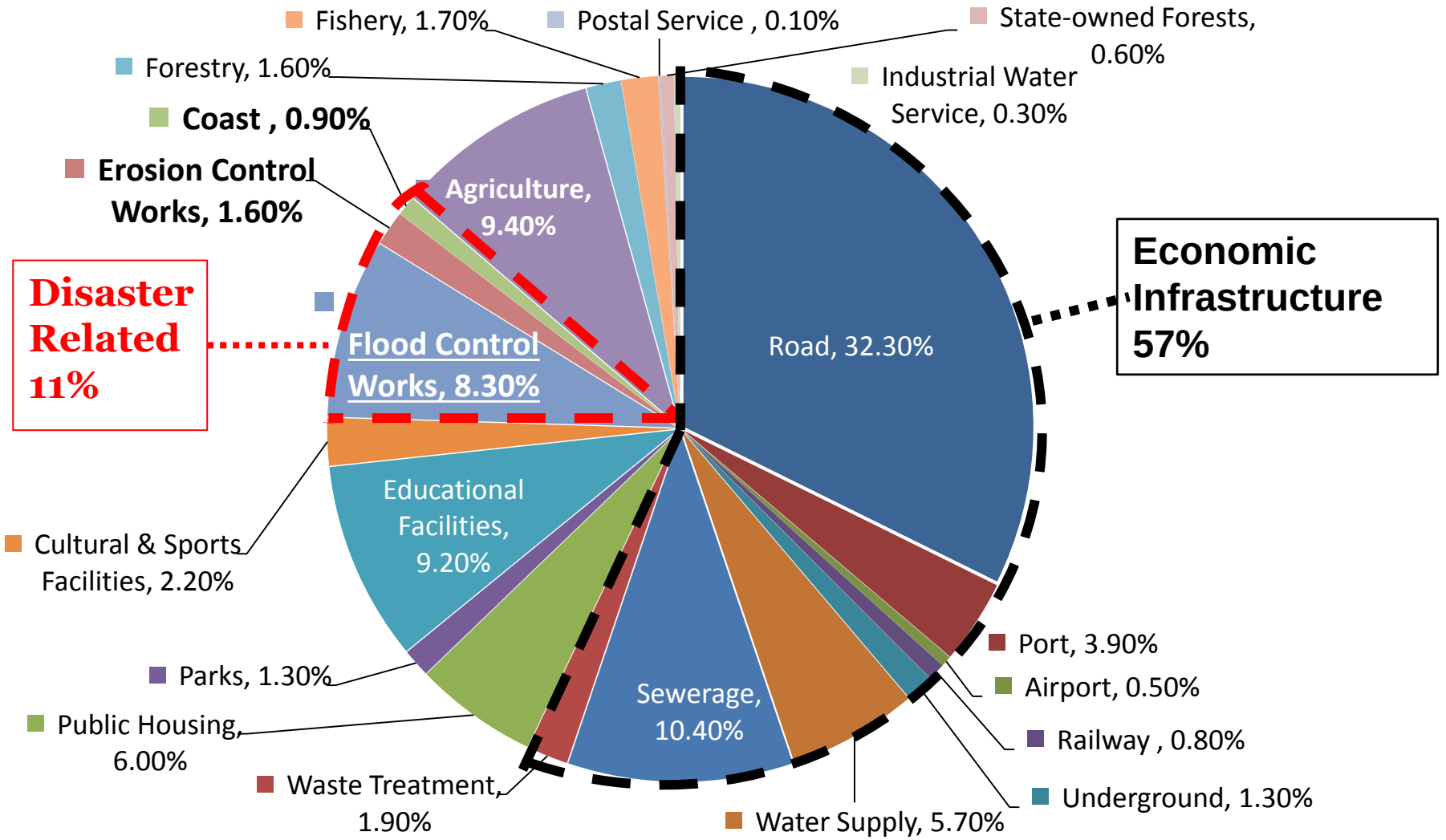
1. Introduction:

Large capital stock for disaster-related



Yet its demand estimate not available

- Many estimates for economic infrastructure investment only.
  - ✓ ADB(2017), *Meeting Asia's Infrastructure Needs*
  - ✓ Mckinsey Global Institute(2013), *Infrastructure Productivity*
- No studies for demand estimate on disaster related and social infrastructure, despite its large magnitude.

No established methodology for estimate

- Stylized model for economic infrastructure demand is **not applicable** for disaster-related.

✓ Economic infrastructure demand = (1) household consumption + (2) production sector

(1) Household demand = f (Y, qI)

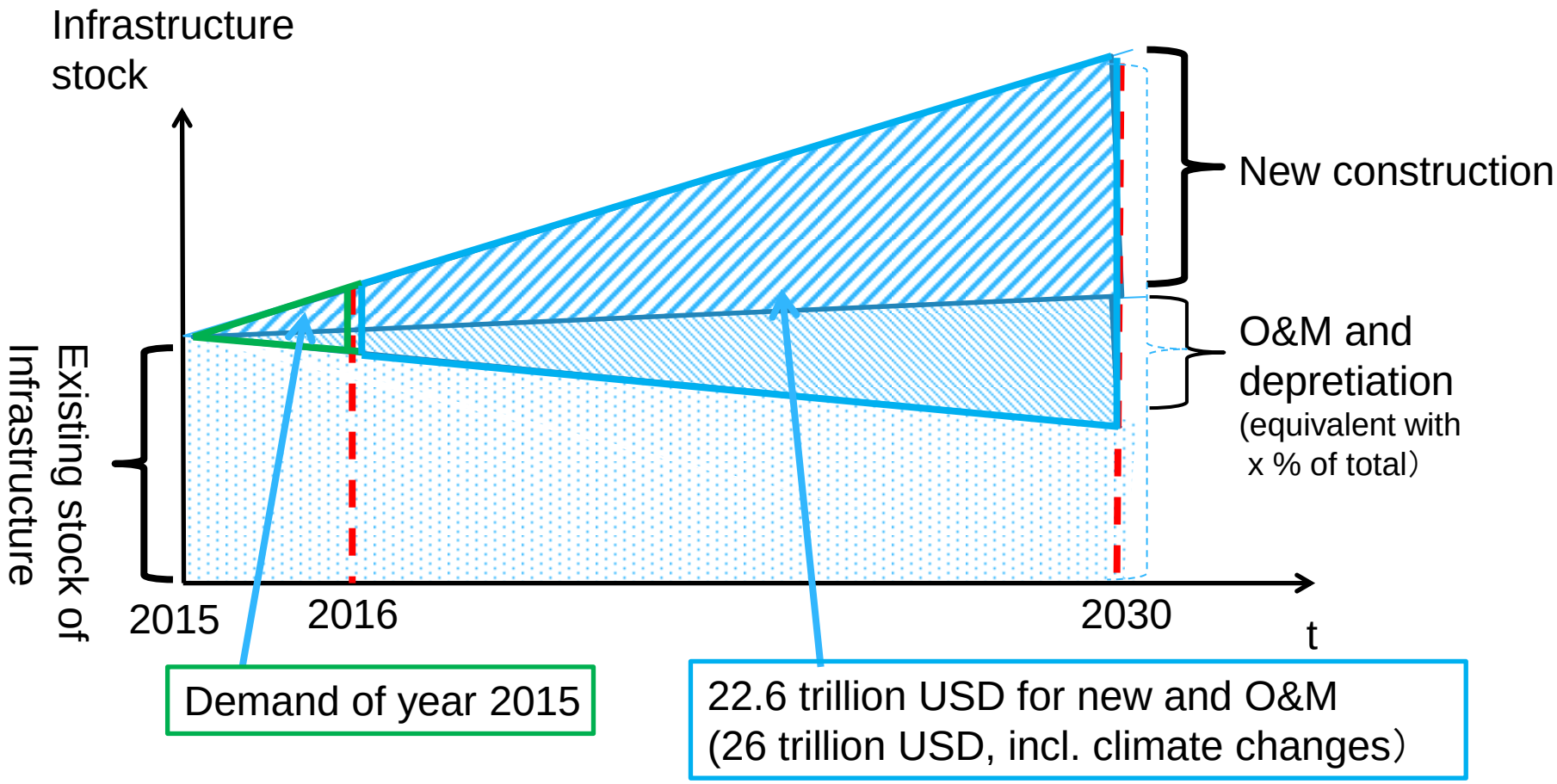
(2) Production sector demand= f (Y, qI, Yagr, Yind, A) /Cob-Douglas production function

*Y: income, qI: infrastructure service price, Yagr: Agriculture per GDP, Yind: Industry per GDP, A: technology

$$I_{i,t} = \alpha_0 + \alpha_1 I_{i,t-1} + \alpha_2 y_{i,t} + \alpha_3 A_{i,t} + \alpha_4 M_{i,t} + \alpha_5 D_i + \alpha_6 D_t + \epsilon_{i,t}$$

IJ (i,t) = demand for infrastructure stock of type j-th in country i-th at time t;
IJ(I,t-1)= the lagged value of the infrastructure stock,
y (i,t) =income per capita of country i-th;
A(i,t) = share of agriculture value added in GDP of country i-th;
M(i,t)= the share of manufacturing value added in GDP of country i-th,
D(i) = a country fixed effect,
D(t) = a time dummy;
e(i,t) = error term.

(Ref) Economic infrastructure demand is universally the simple increasing function development



Difficulty of estimate on disaster related

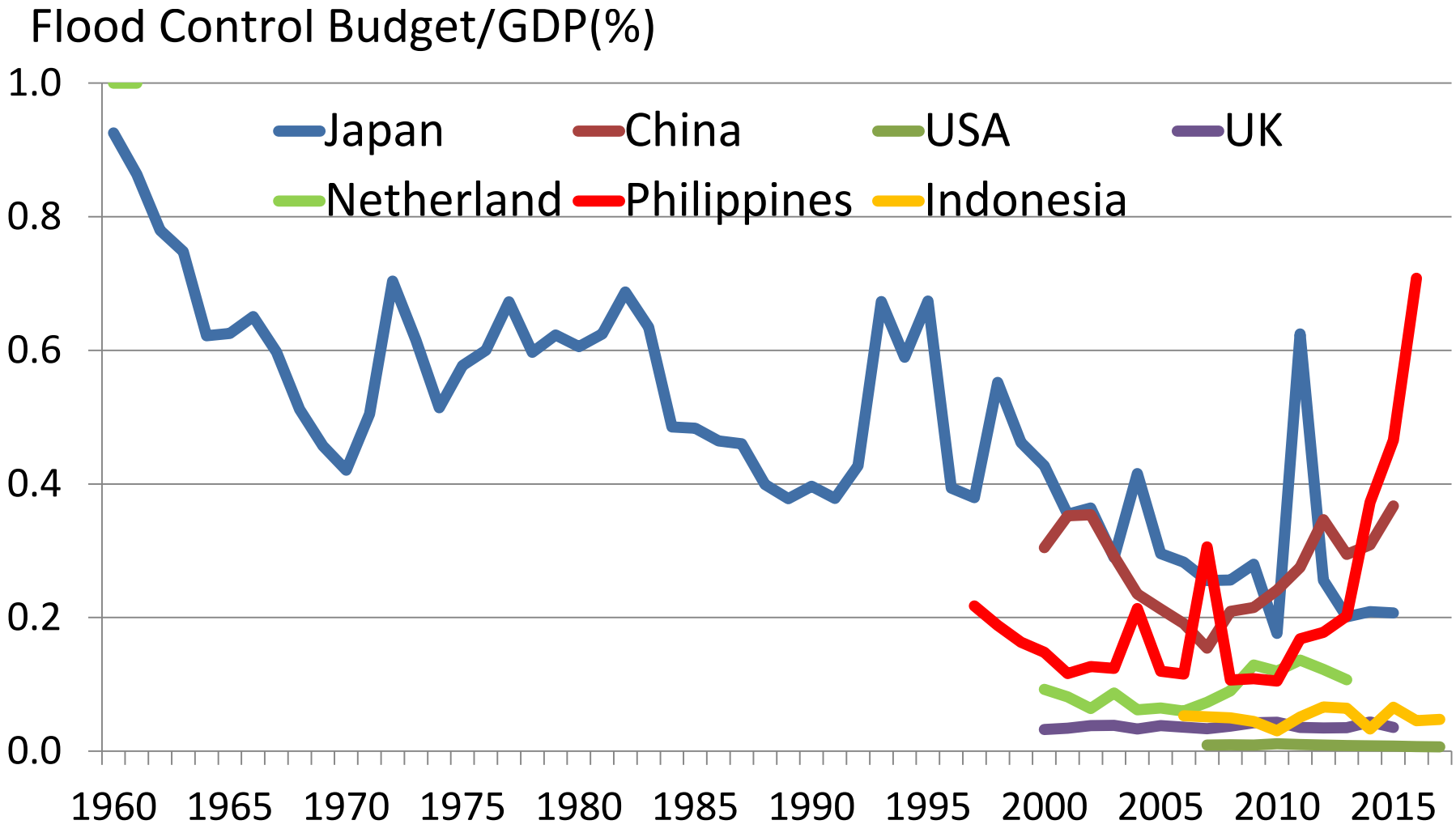
- Large differences of disaster risk by country due to its climate, geological and topographical conditions.
- Difficulty to identify the area to be invested by using macro estimate model.
- Difficulty to standardize the required target setting for disaster prevention.
- Difficulty to collect information on disaster damage and budget

Our approach for estimate

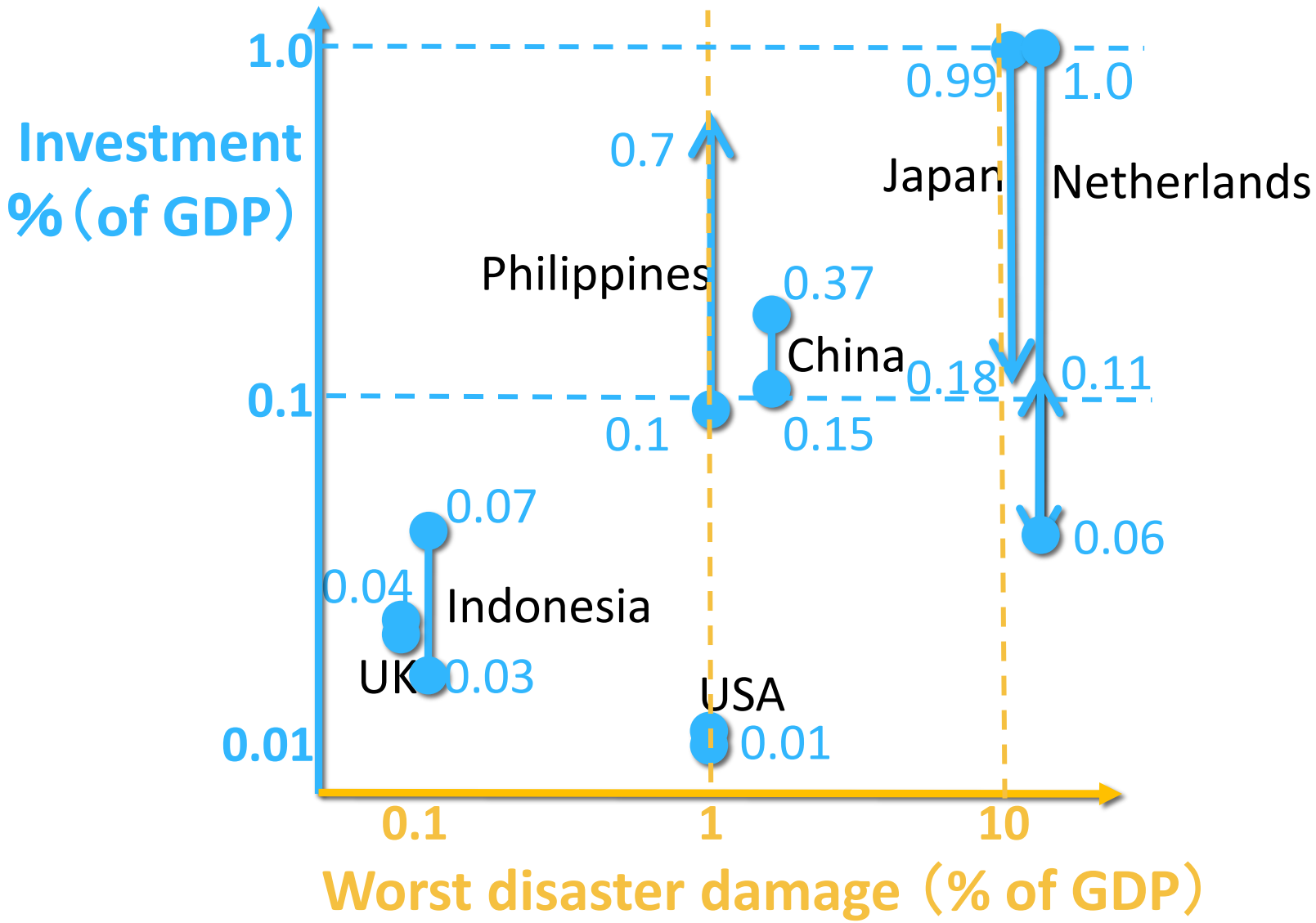
- Macro-model is not applicable. Bottom-up approach(aggregation of all projects) is not practical.
- Budget record must reflect differences of climate, geological and topographical conditions. The common historical trend may be identified by studying budget record.

⇒ JICA focuses on budget record.

2. Relationship between flood control investment & damage: from global experiences



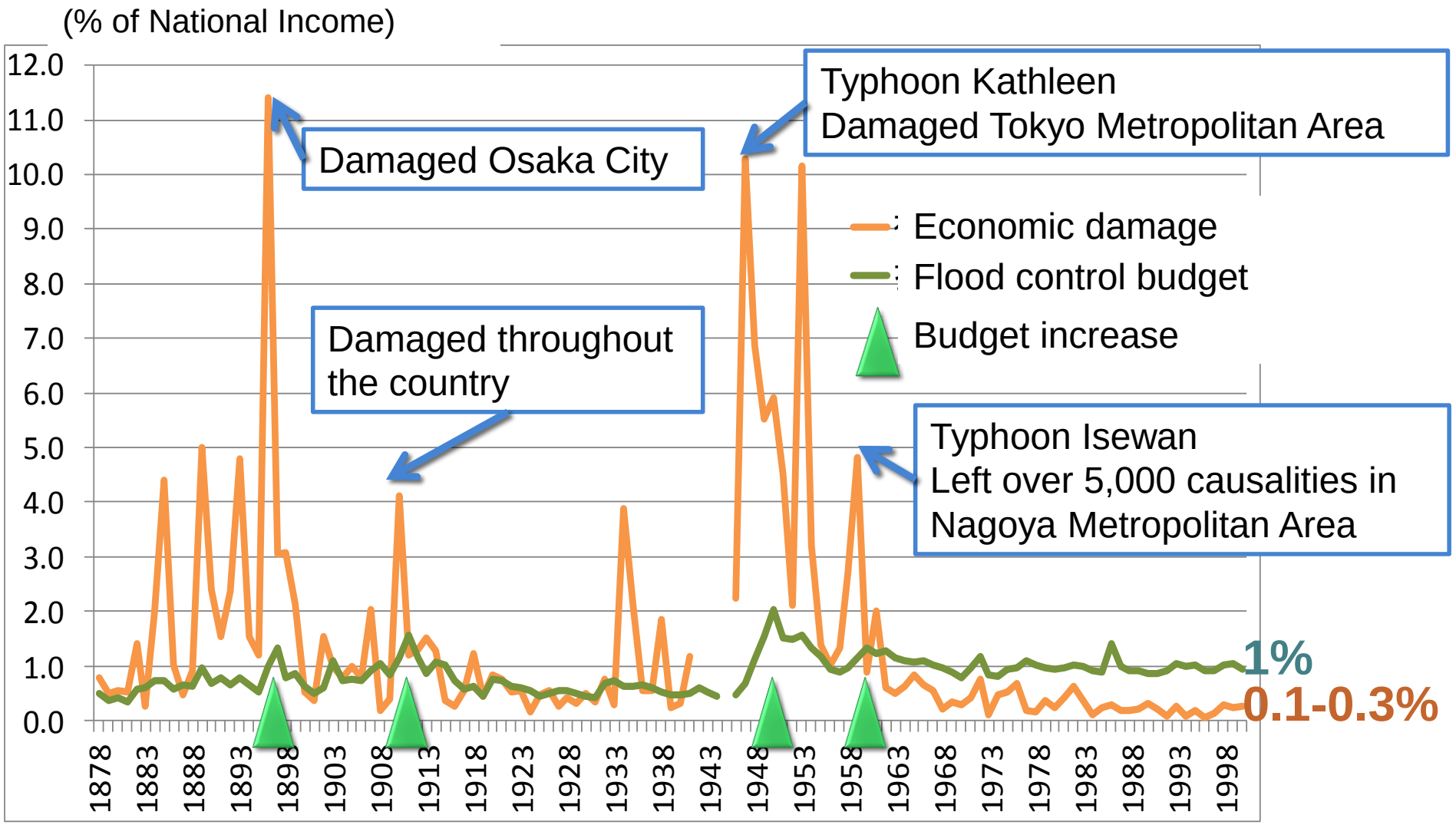
Flood control investment depends on historical records of most severe disaster on national economy



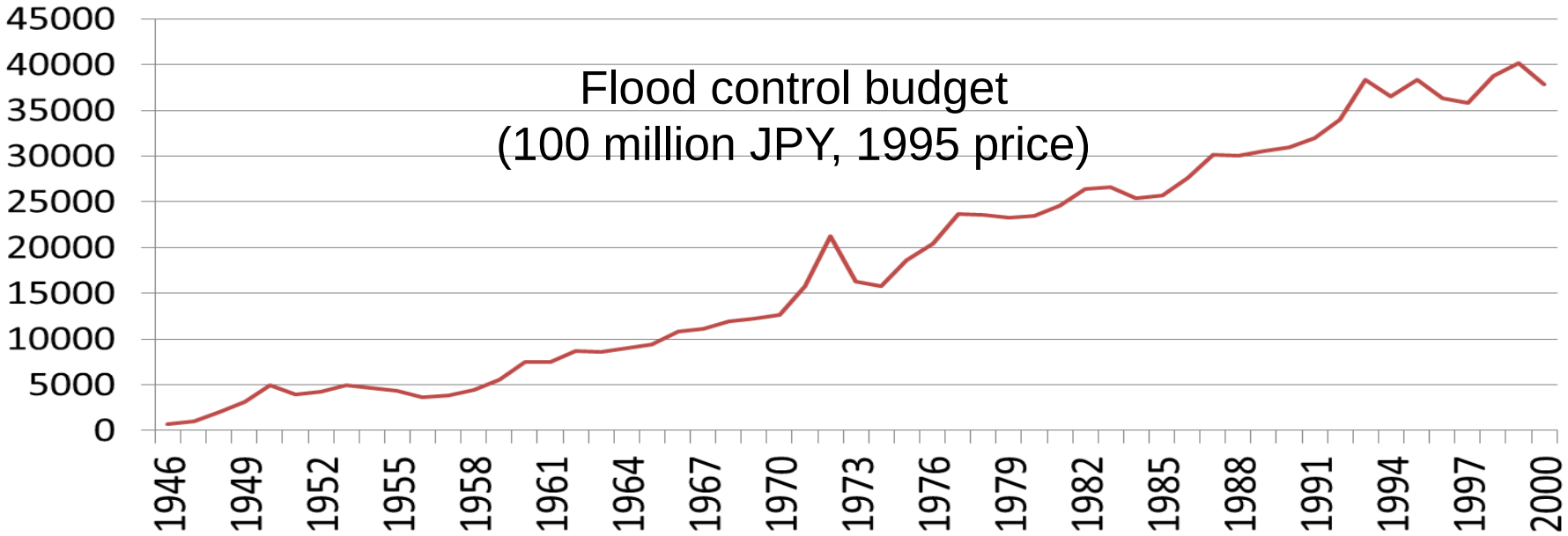
3. Investment in Japan

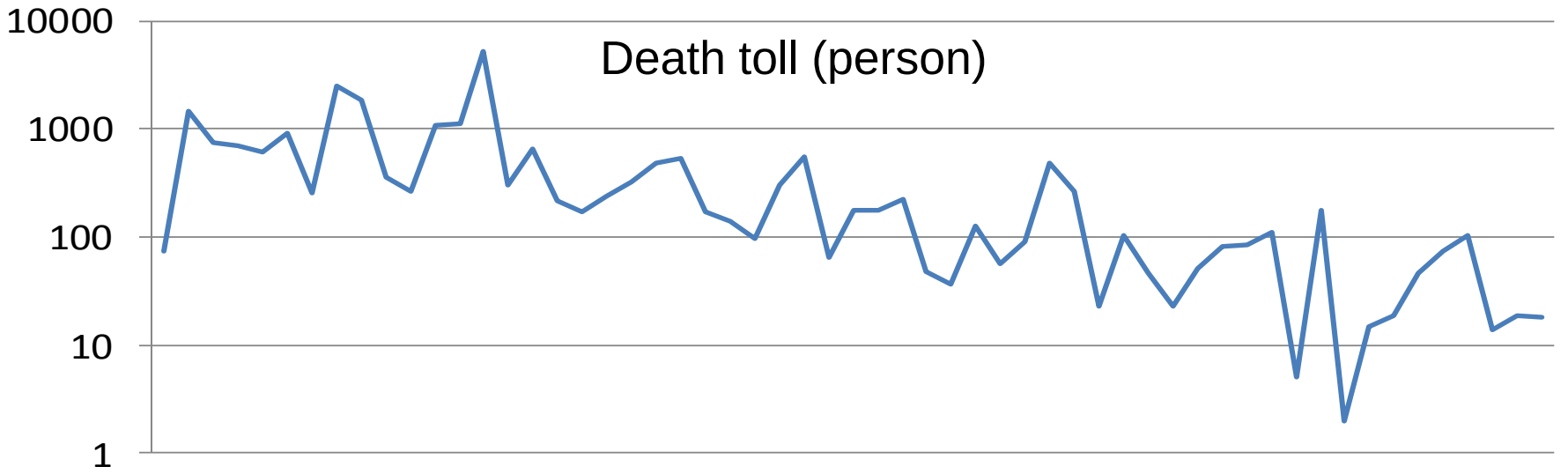
(a) Damage mitigation by accumulating investment

- Historically disasters were the investment trigger

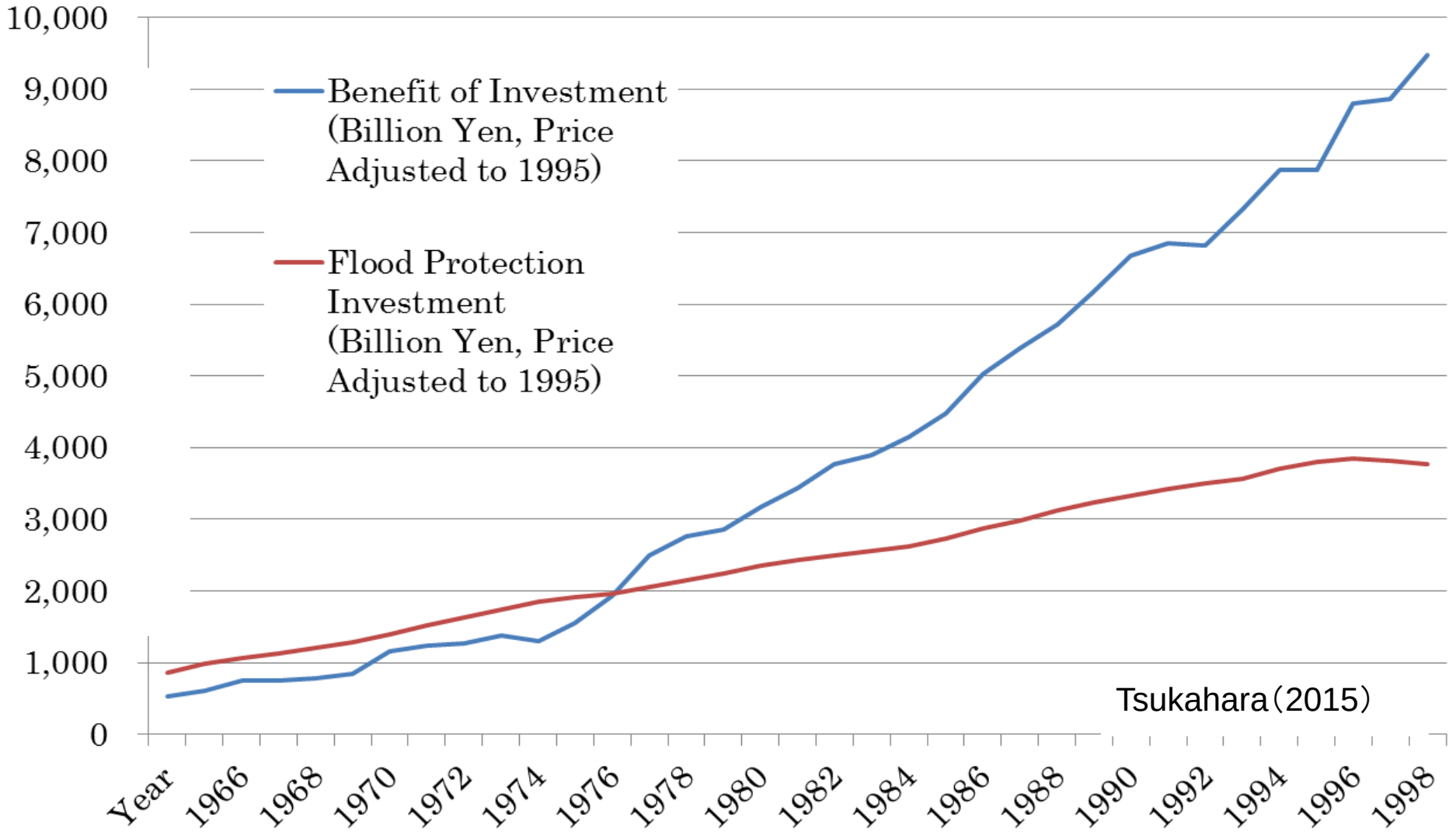


FC investment could drastically decrease casualty due to disaster

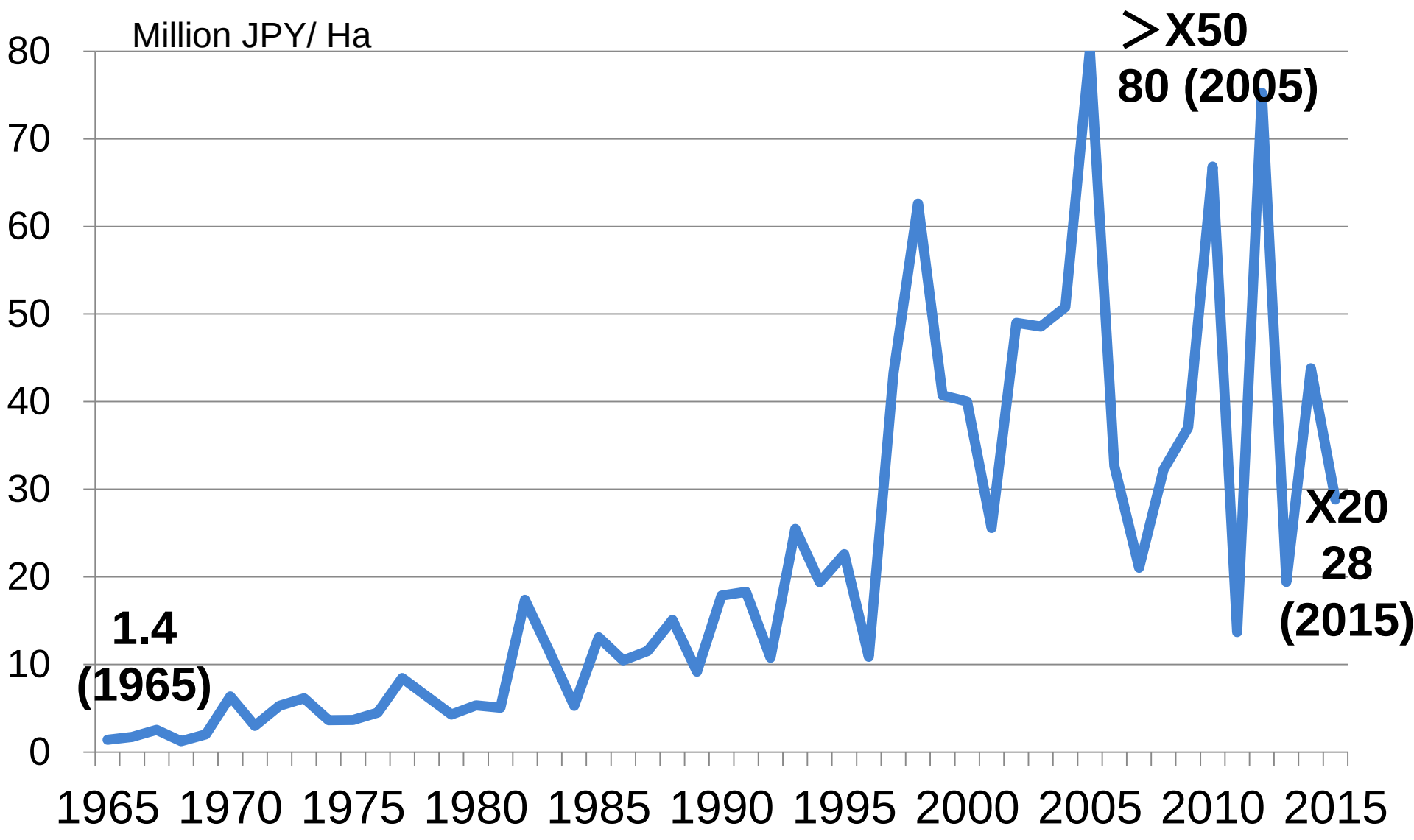




(b) **Flood control investment created asset value in risk areas, as the economic grew**



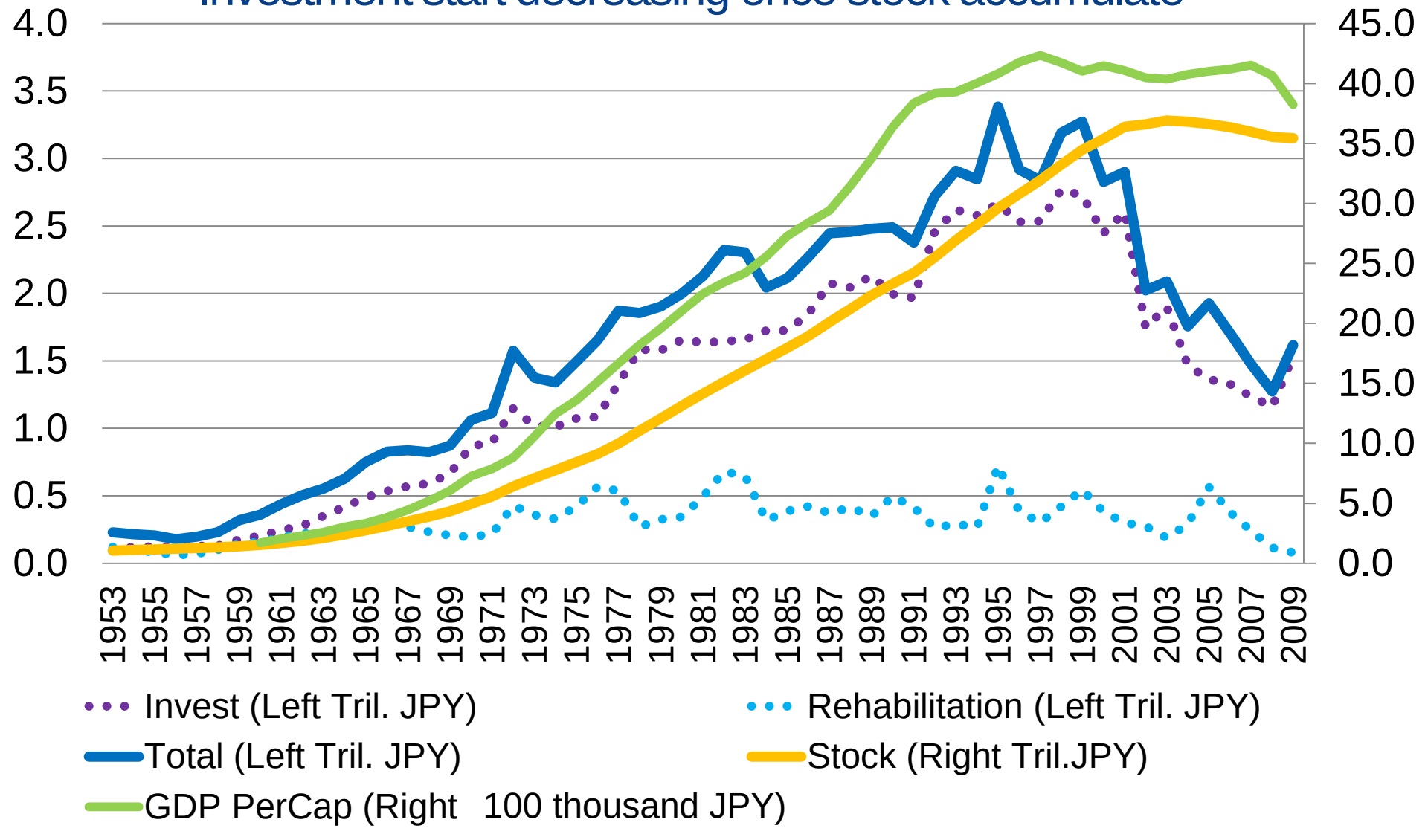
Urbanization and economic growth brought damage density (damage/ area) to rapidly increase



(c) How can we use JPN's experiences for global estimate?

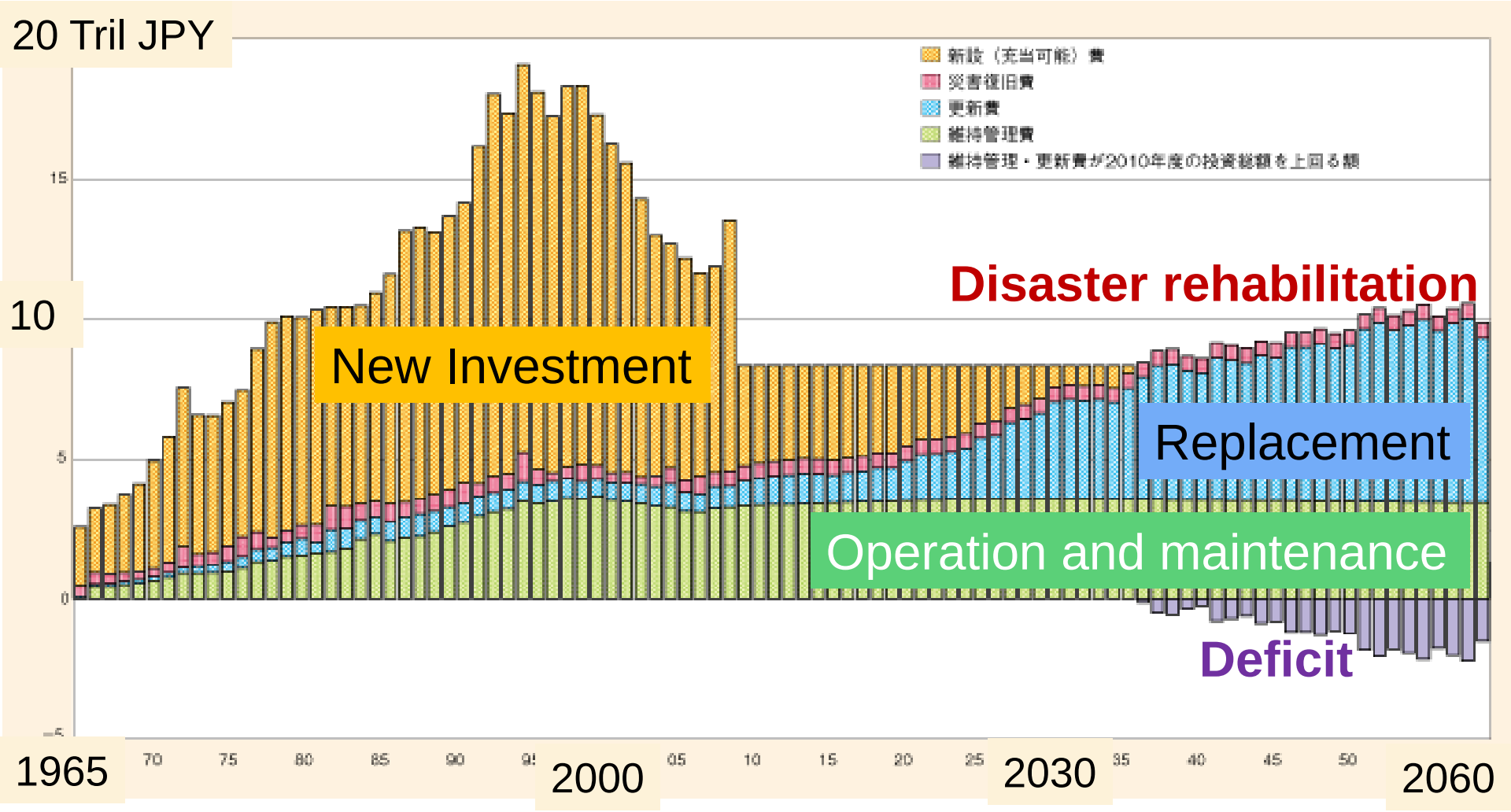
As economy develop, investment increase

Investment start decreasing once stock accumulate



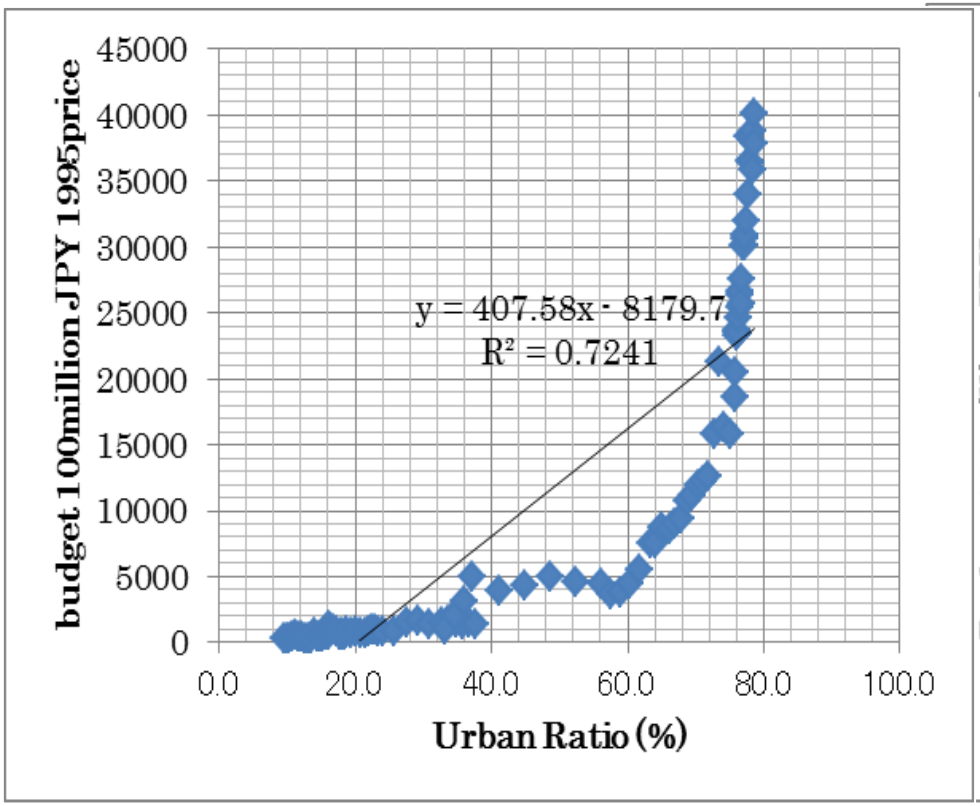
Infrastructure investment by MLIT

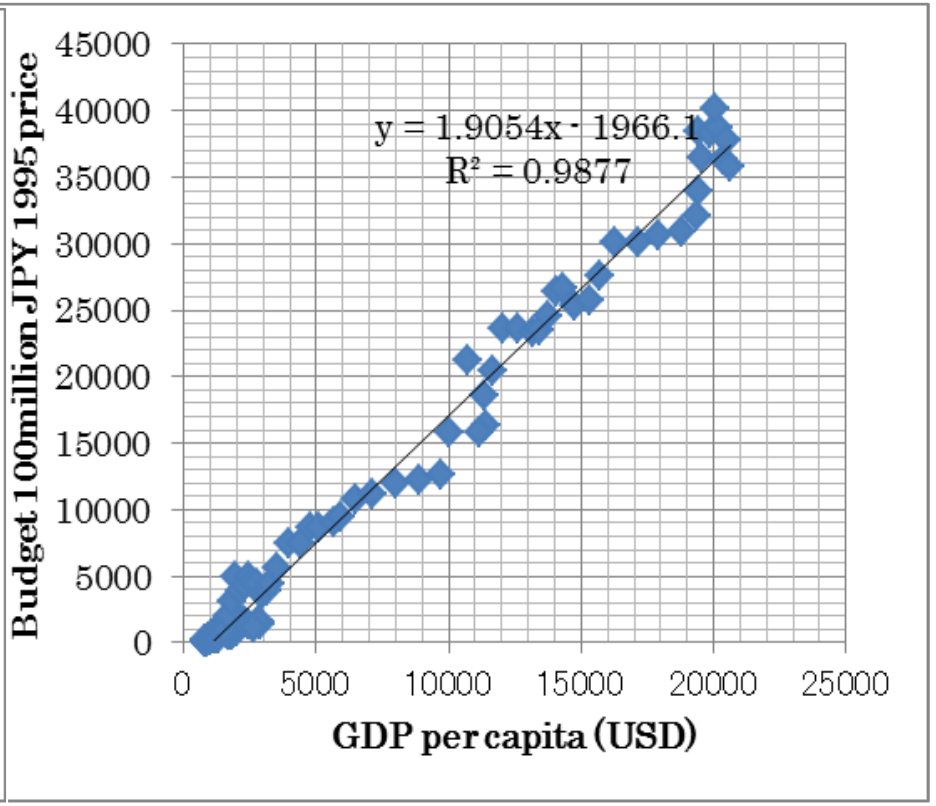
Replacement cost increase, new investment decrease



Estimate for flood control investment

Relationship between budget for flood control and
(a) urban ratio (1893-2000) (b) per capita GDP (1875-2000)



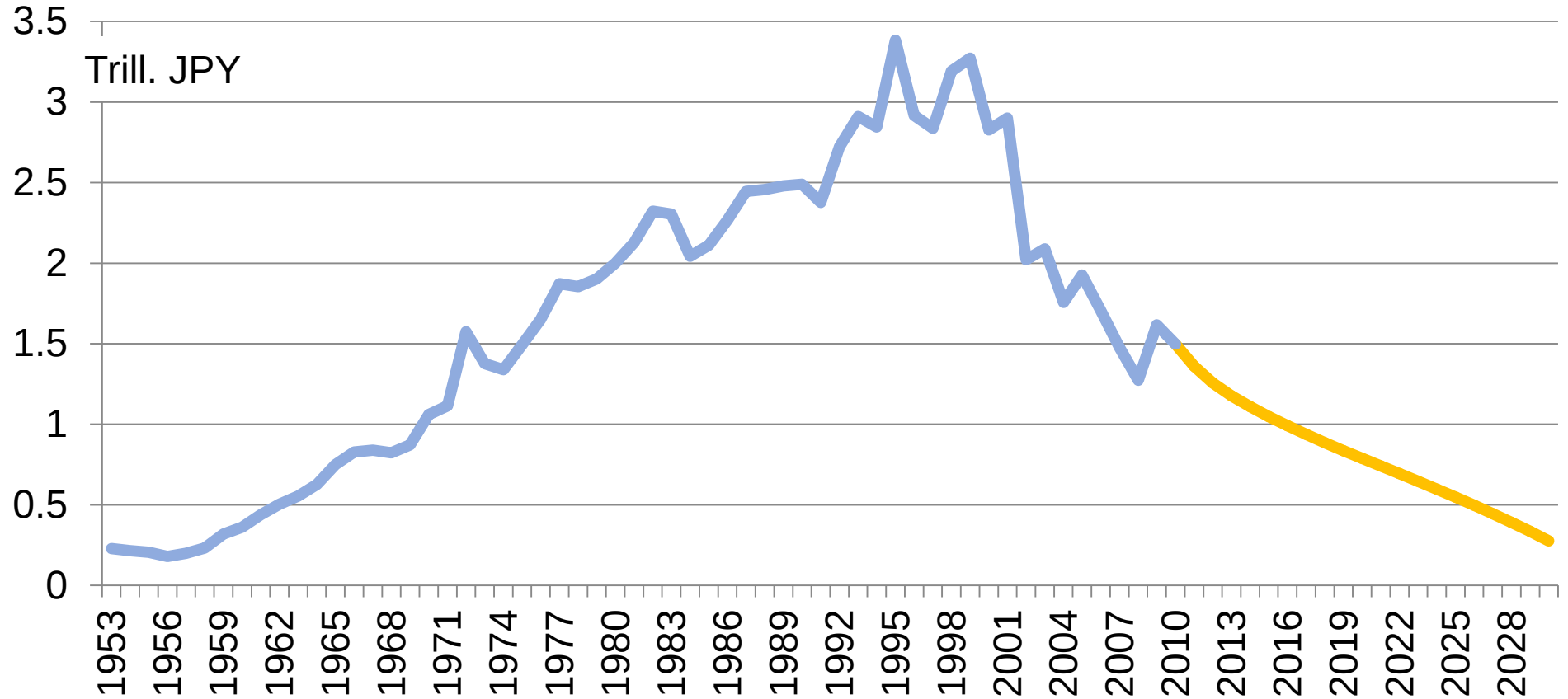


Demand estimate of investment Multiple regression model

$$I_t = \alpha_1 I_{t-1} + \alpha_2 A_t + \alpha_3 U_t + \alpha_4 G_t + \beta$$

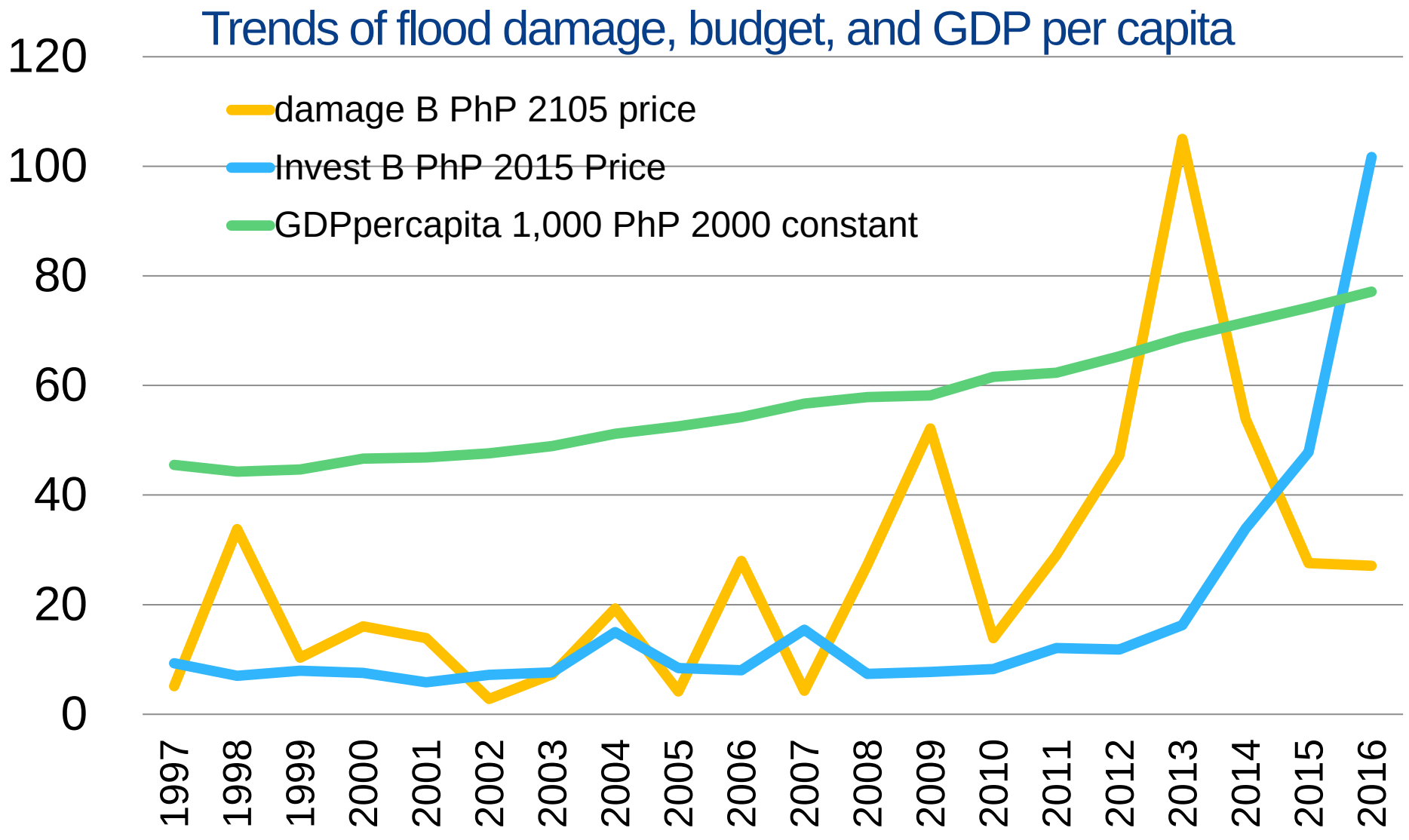
I: investment, **A**: protected area, **U**: urbanization, **G**: Per cap GDP, t: year

- I_{t-1} previous year's budget: scale of damage & inflexibility of budgeting
- A: protected area: As protected area increase, investment decrease
- U, & G: urbanization & per capita GDP: assets to be protected



Variables	coefficients			
Intercept	2107.754 (0.479)	2120.001 (0.483)	6643.074 (1.600)	1031.108*** (3.542)
Previous yr investment	0.651569*** (5.155)	0.644085*** (5.098)	0.772967*** (6.372)	0.661148*** (5.574)
Protected area	-35.0033** (-2.290)	-33.6786** (2.201)	—	-36.8883*** (-2.830)
Urbanization	-20.8187 (-0.2453)	-22.9561 (-0.2709)	-118.554 (-1.528)	—
GDP per capita	0.000486* (1.828)	0.000489* (1.844)	0.000399 (-1.528)	0.000435*** (2.608)
Damage	—	0.009139 (1.065)	—	—
Adjusted R^2	0.844254	0.844851	0.639535	0.848319

4. Philippines rapidly increasing investment after recent serious typhoons



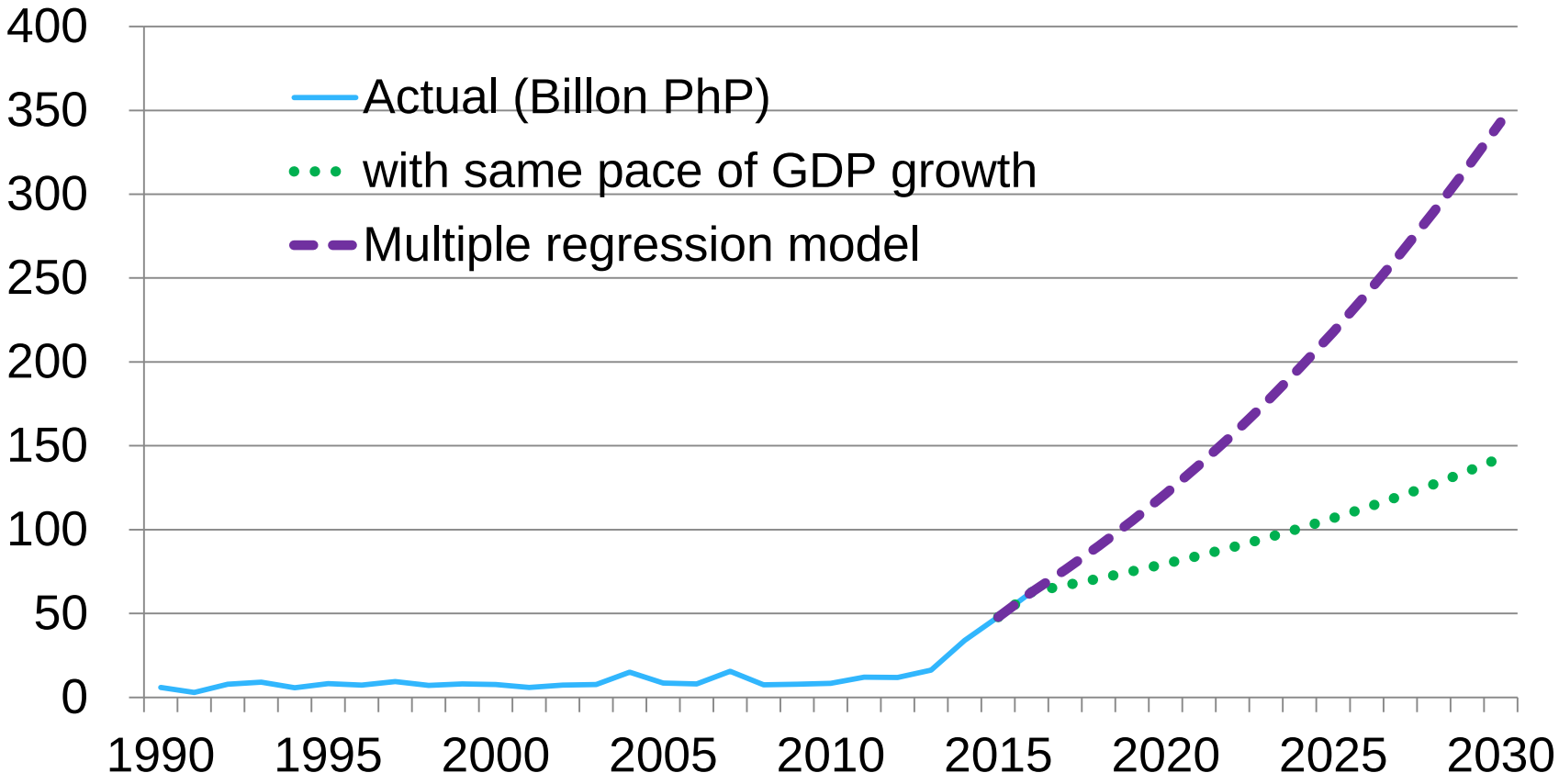
Investment estimate on flood control in Philippines 2016-30

USD 32.3 – 61.4 billion (PhP 1.47-2.79 Tri.)

Urbanization, per capita GDP, & previous year budget as explanatory variables

$$I_t = \alpha I_{t-1} + \beta U_t + \gamma G_t + \delta$$

I: investment, U: urban ratio, G: Percap GDP, t: year



R^2 value: 0.909, adjusted R^2 value: 0.896.

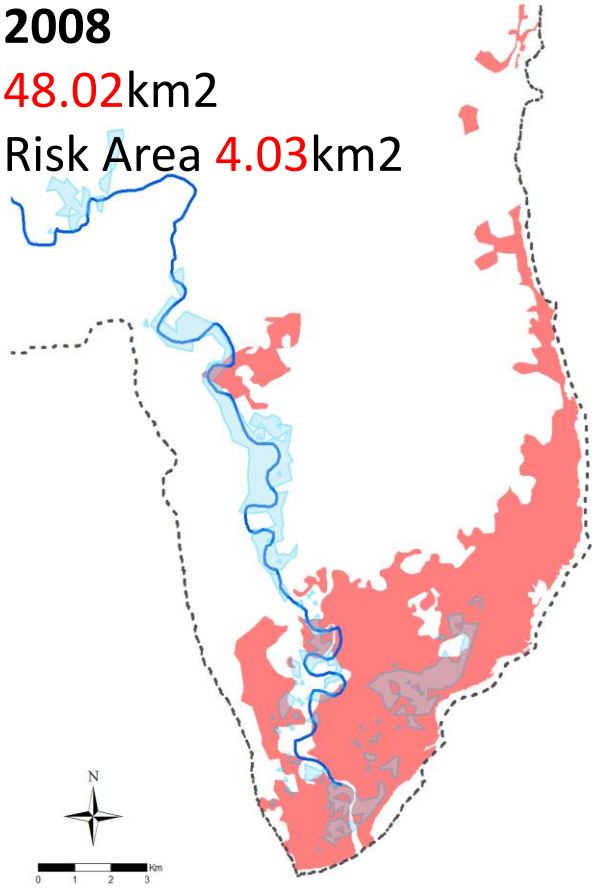
Change of risk area in Davao

Asset value in risk areas increase because of urbanization & economic growth

2008

48.02km2

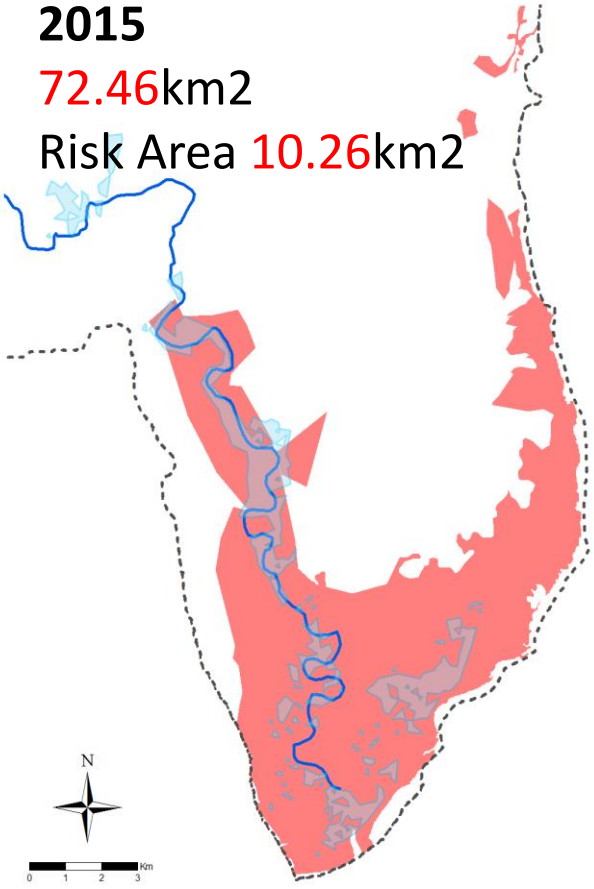
Risk Area 4.03km2



2015

72.46km2

Risk Area 10.26km2

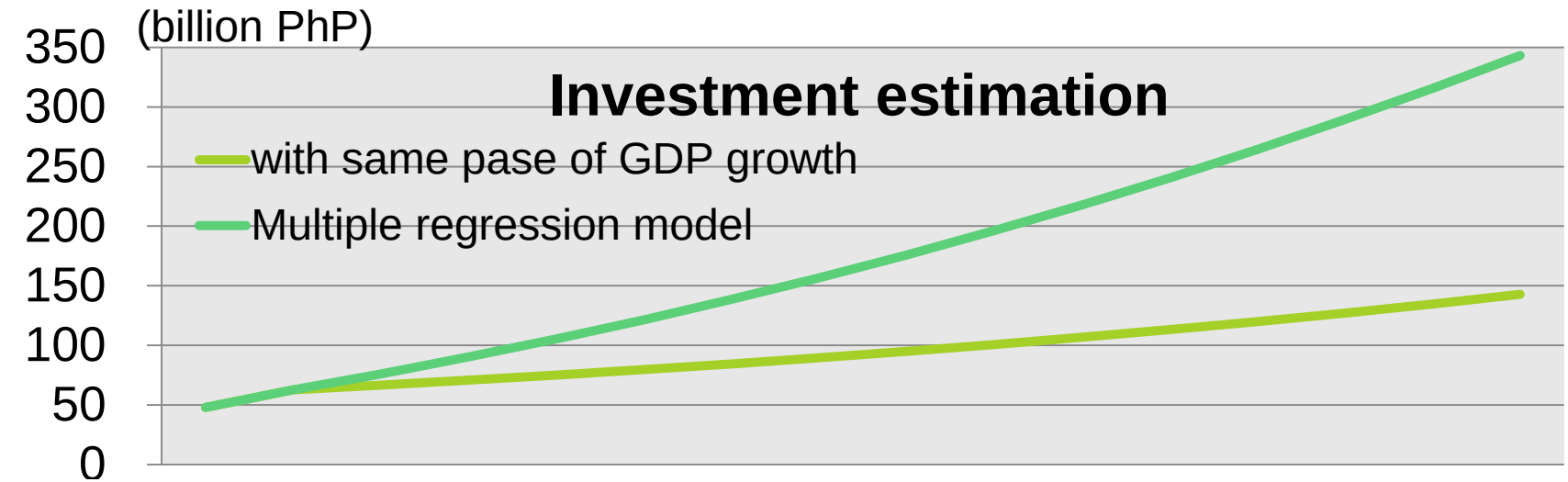


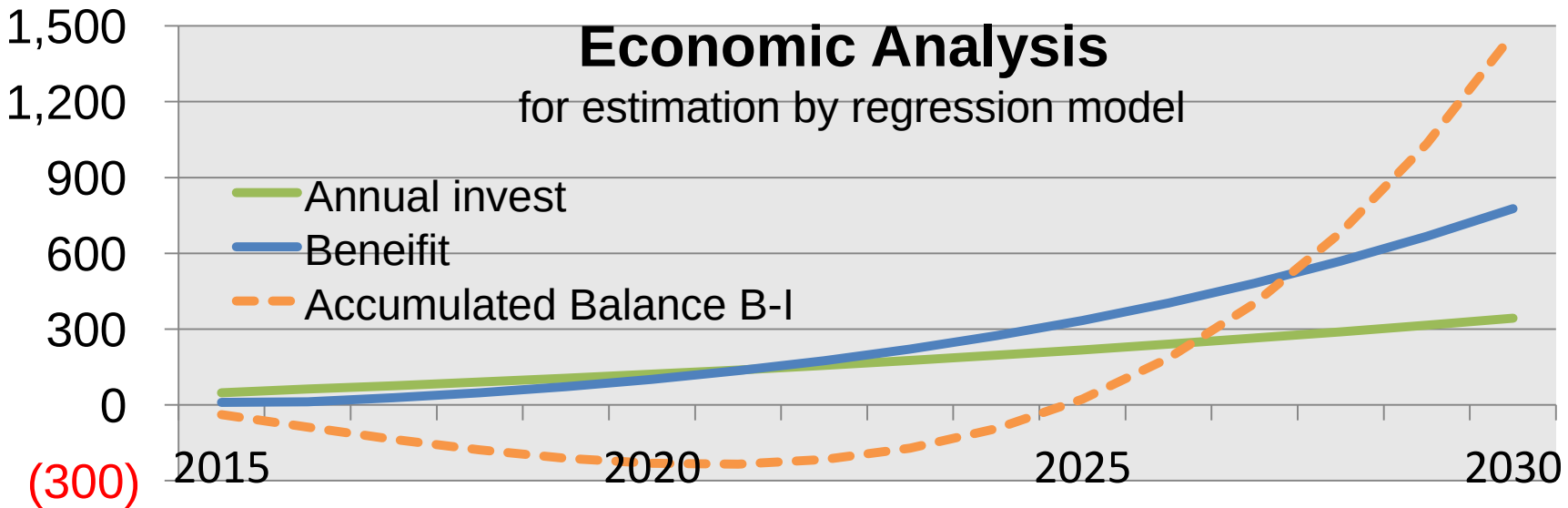
Legend

Basin Boundary | Inundation Area | Main Stream | BUA

Source: JICA (2008), Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

Investment estimation on flood control in Philippines 2016-2030
USD 32.3 – 61.4 billion (PhP 1.47-2.79 Tri.)
Balance (benefit-cost) accumulation becomes positive in 2025



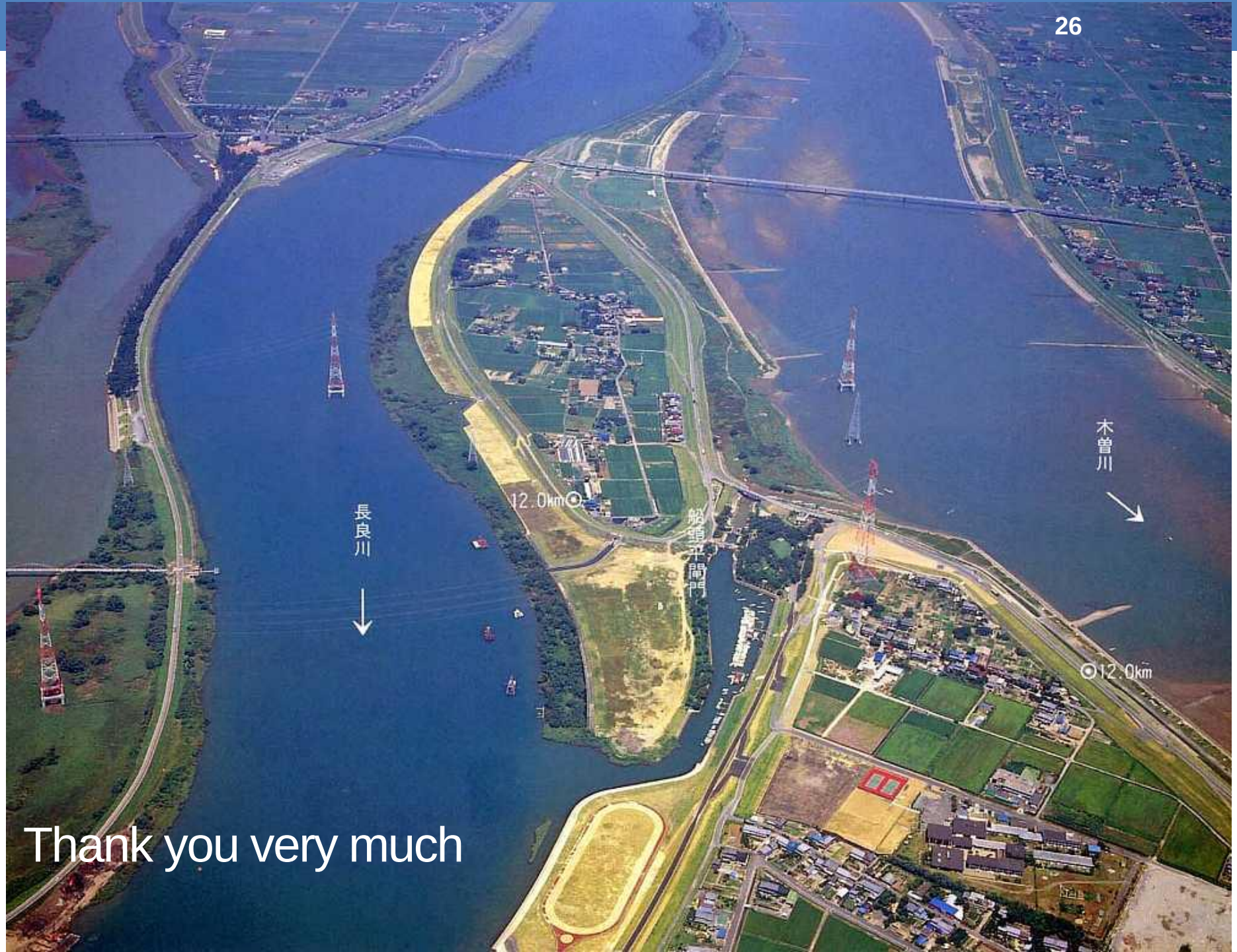


5. Tentative conclusion

- For some countries, JPN, UK, Netherlands, PHI, CHI, disasters were the trigger for investment
- Japanese experience shows,
  - Investment was fully paid off
  - securing flood control budget of central government needs political intervention: legislation, institution, commitment (long-term plan), budget sharing with local government
- Philippines is rapidly increasing investment for flood control, estimated from 0.45% in 2015 to 1.08% of GDP in 2030

Way forward

1. Collecting budget information of other flood prone countries: IND, IDN, BAN, CHI, VET, THI, CHI TAIPEI, Malaysia…..
2. Develop common regression model in Monsoon Asia, if possible
3. Estimate demand in all developing Asia

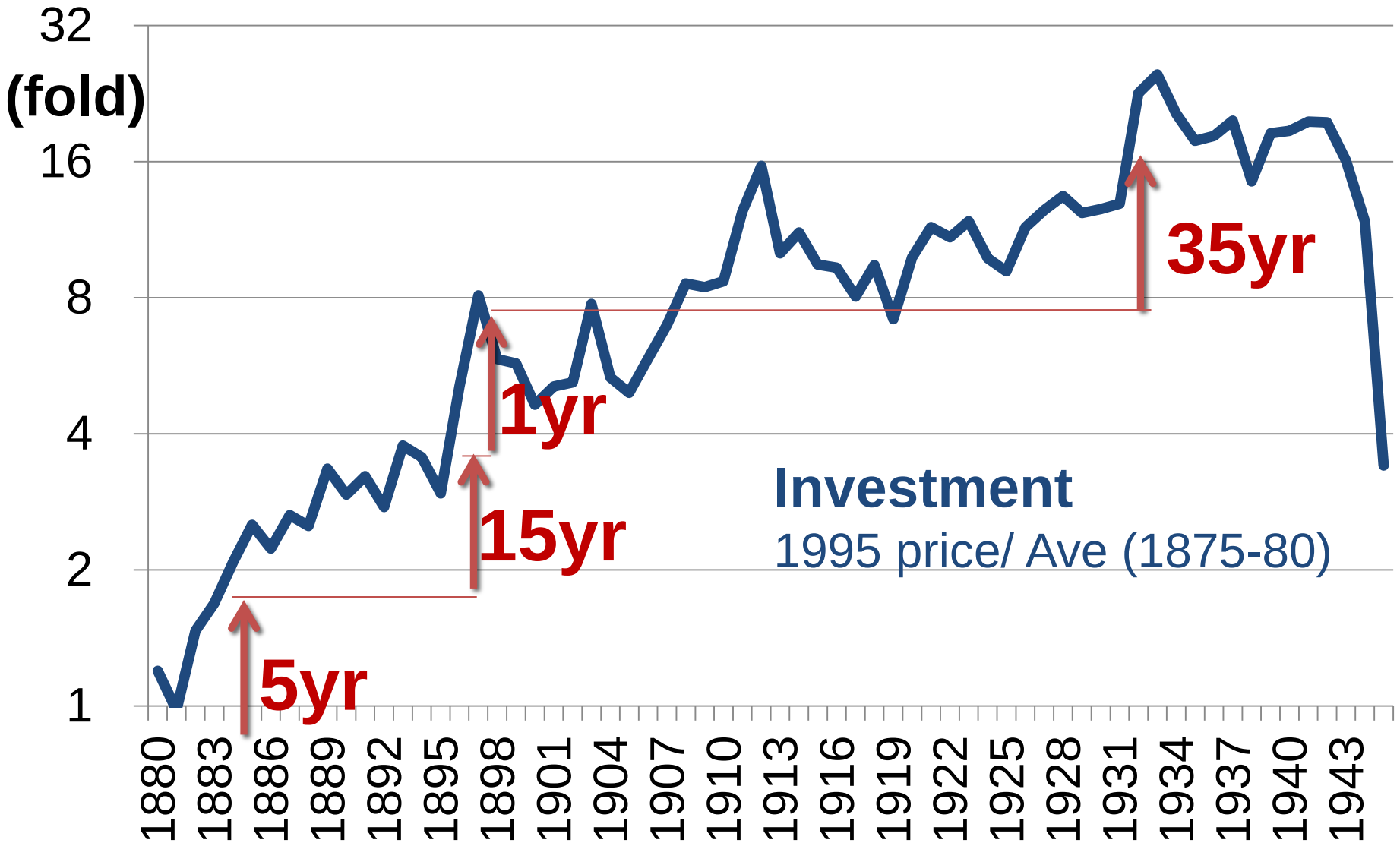


Thank you very much

ANNEX 1
HOW LONG DOES IT TAKE TO DOUBLE INVESTMENT?

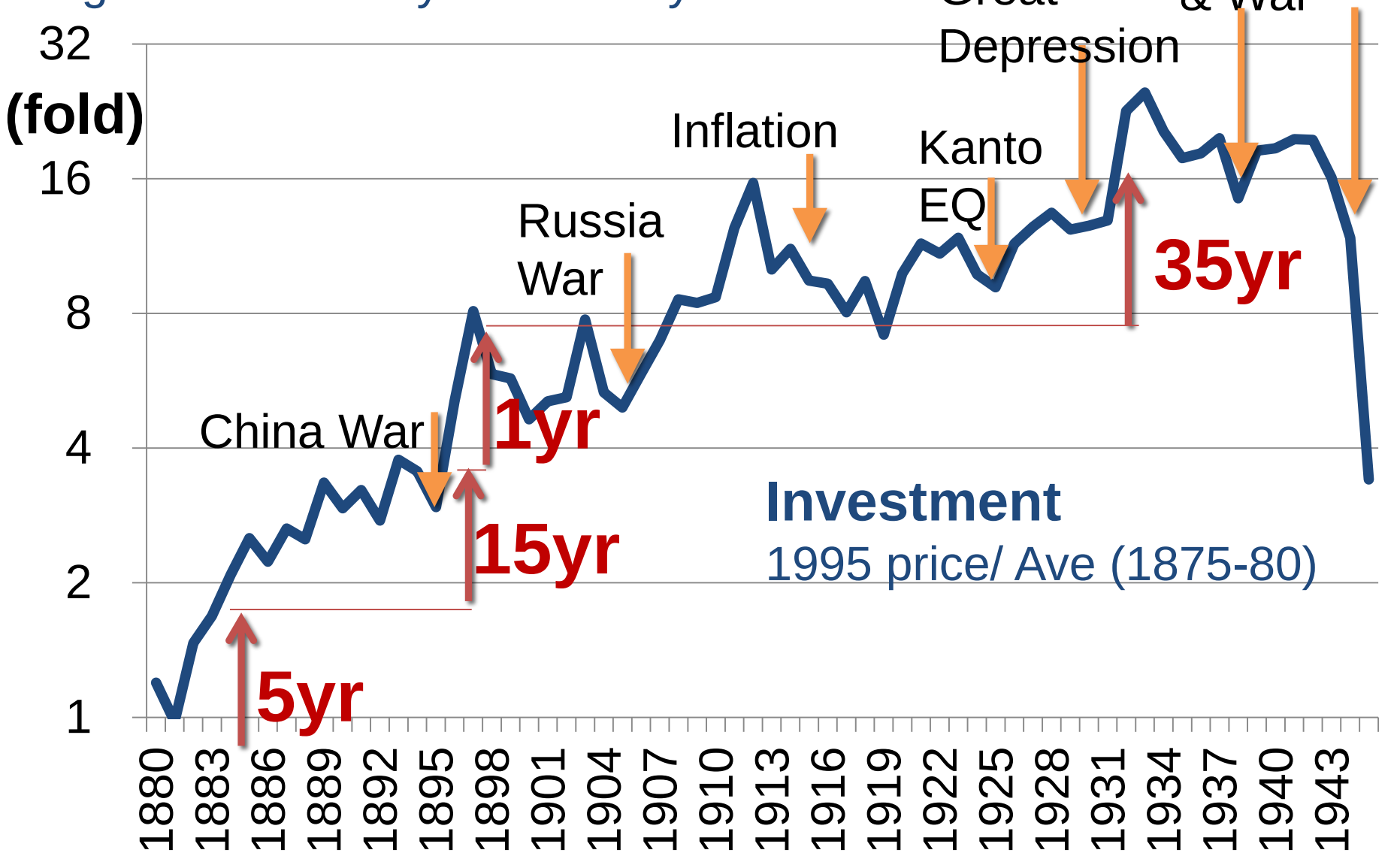
Japan modernization era before WW2

increasing steadily in the late 19th Century

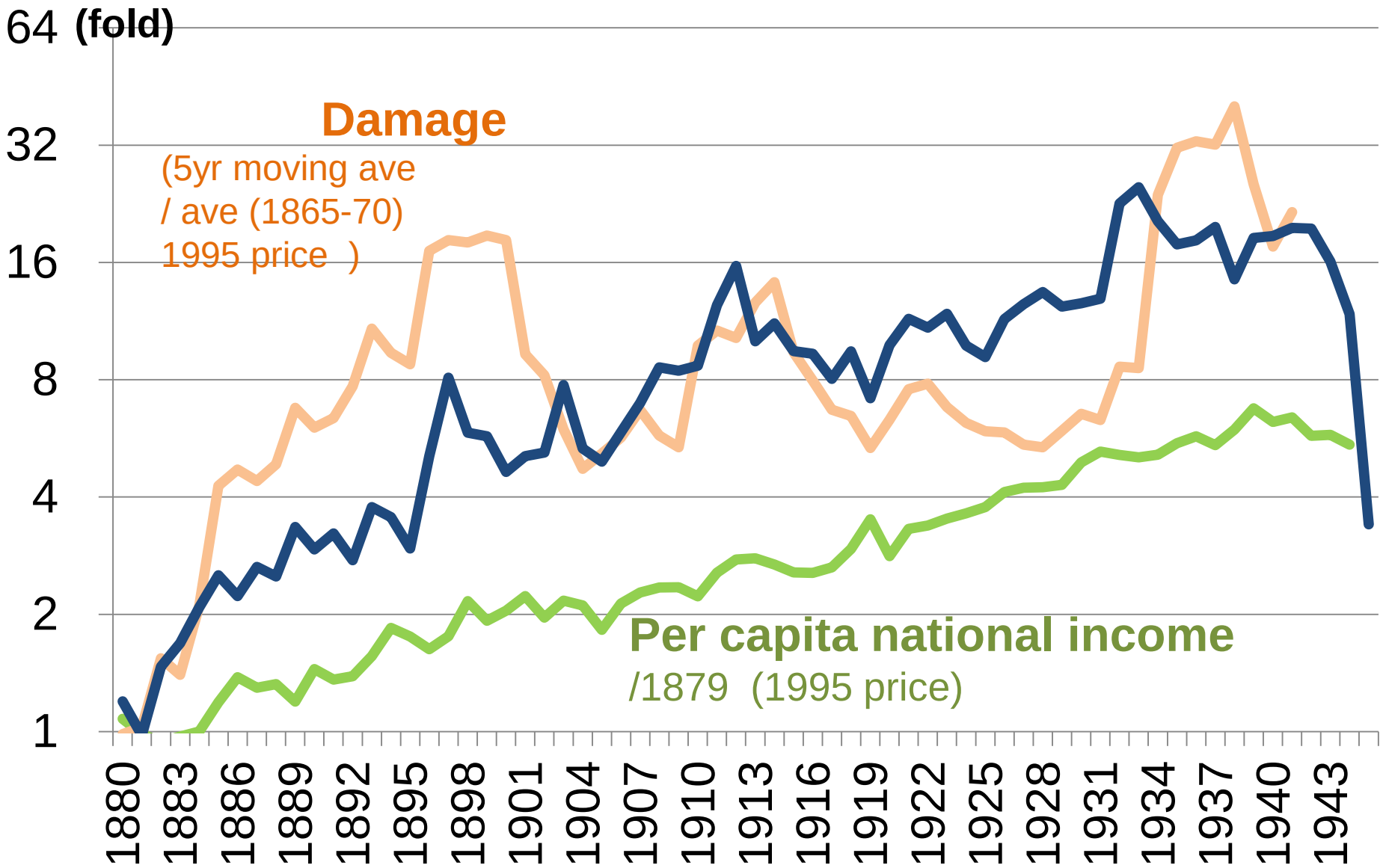


Japan modernization era before WW2

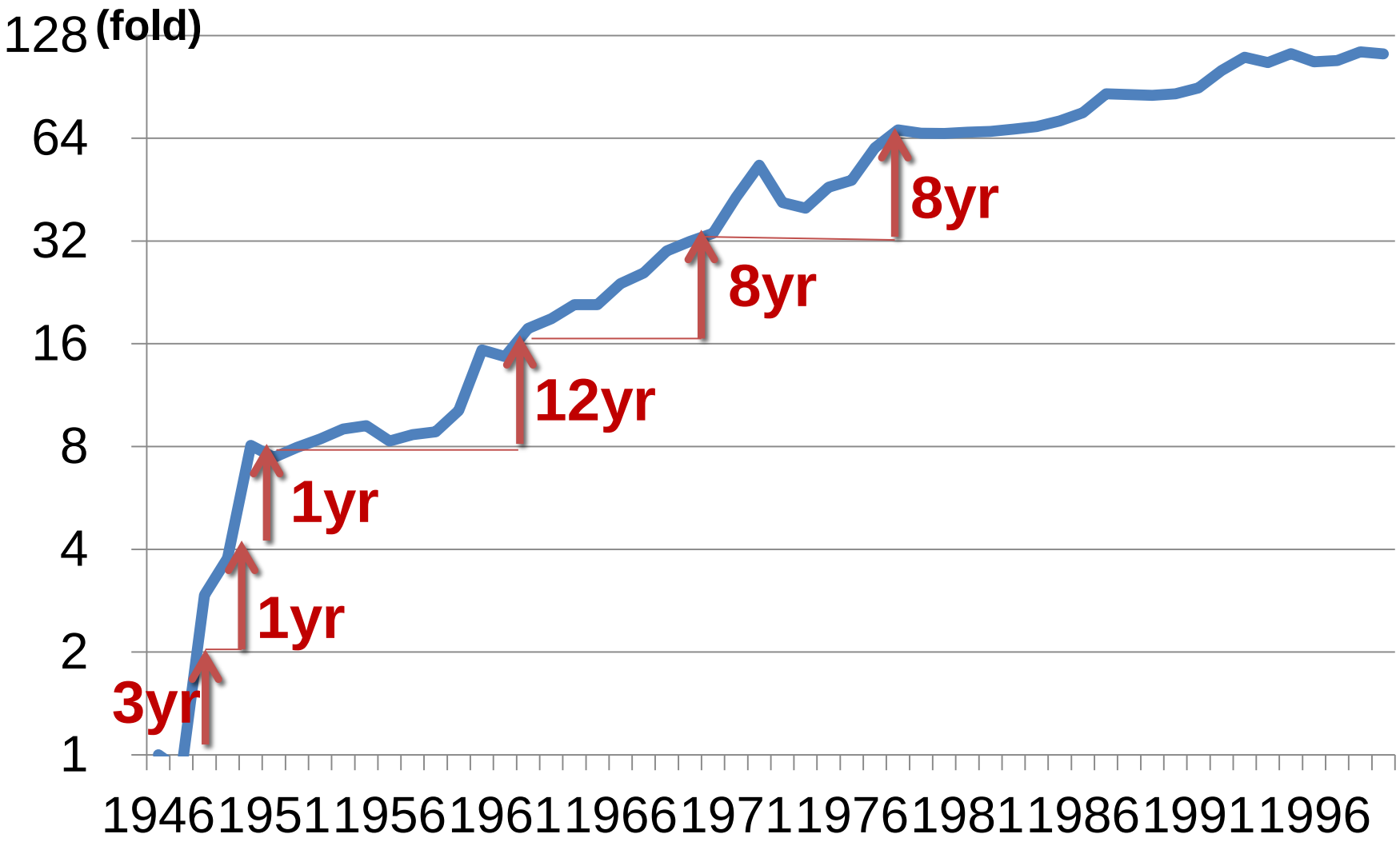
stagnated in the early 20th Century



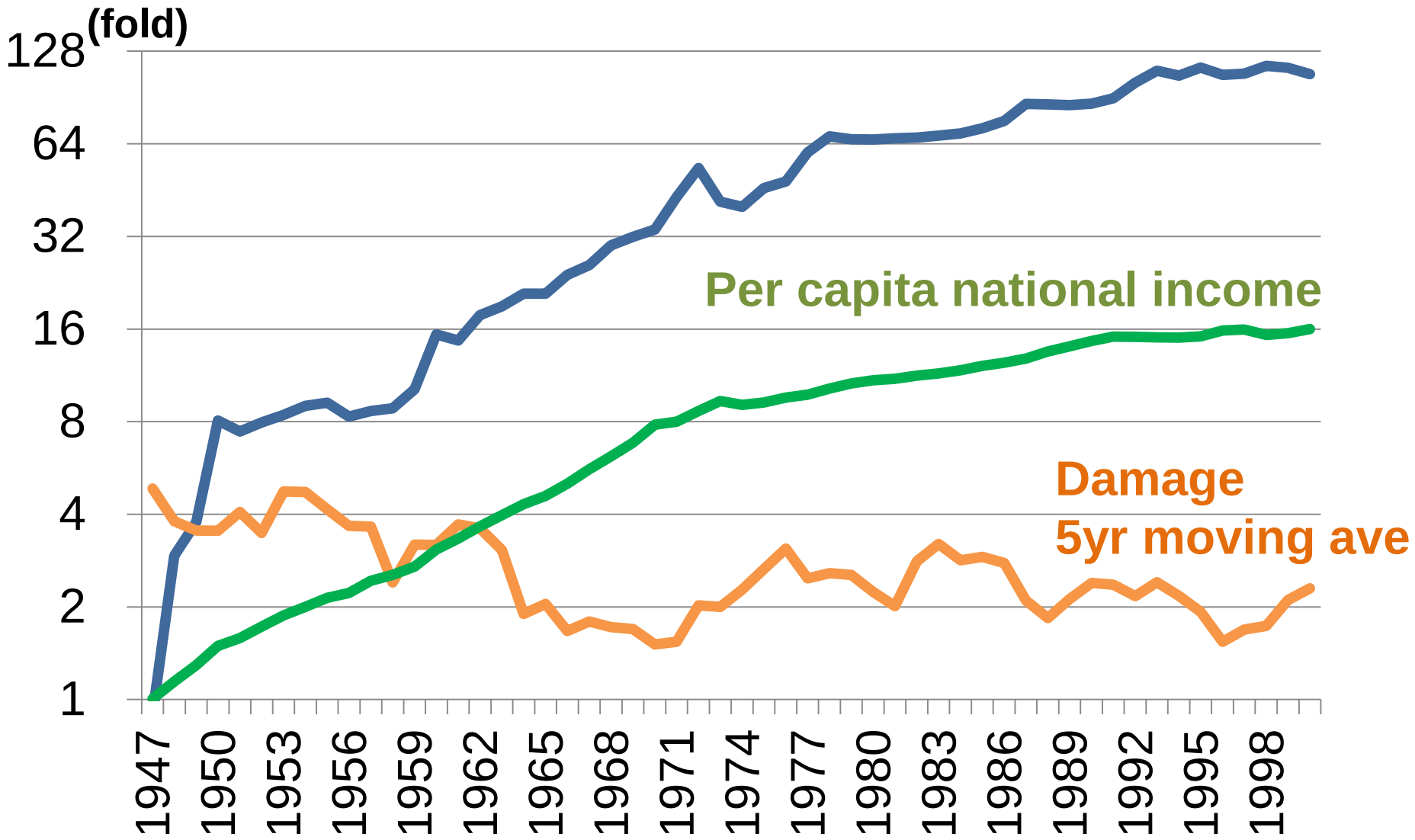
Correlation with damage and national income



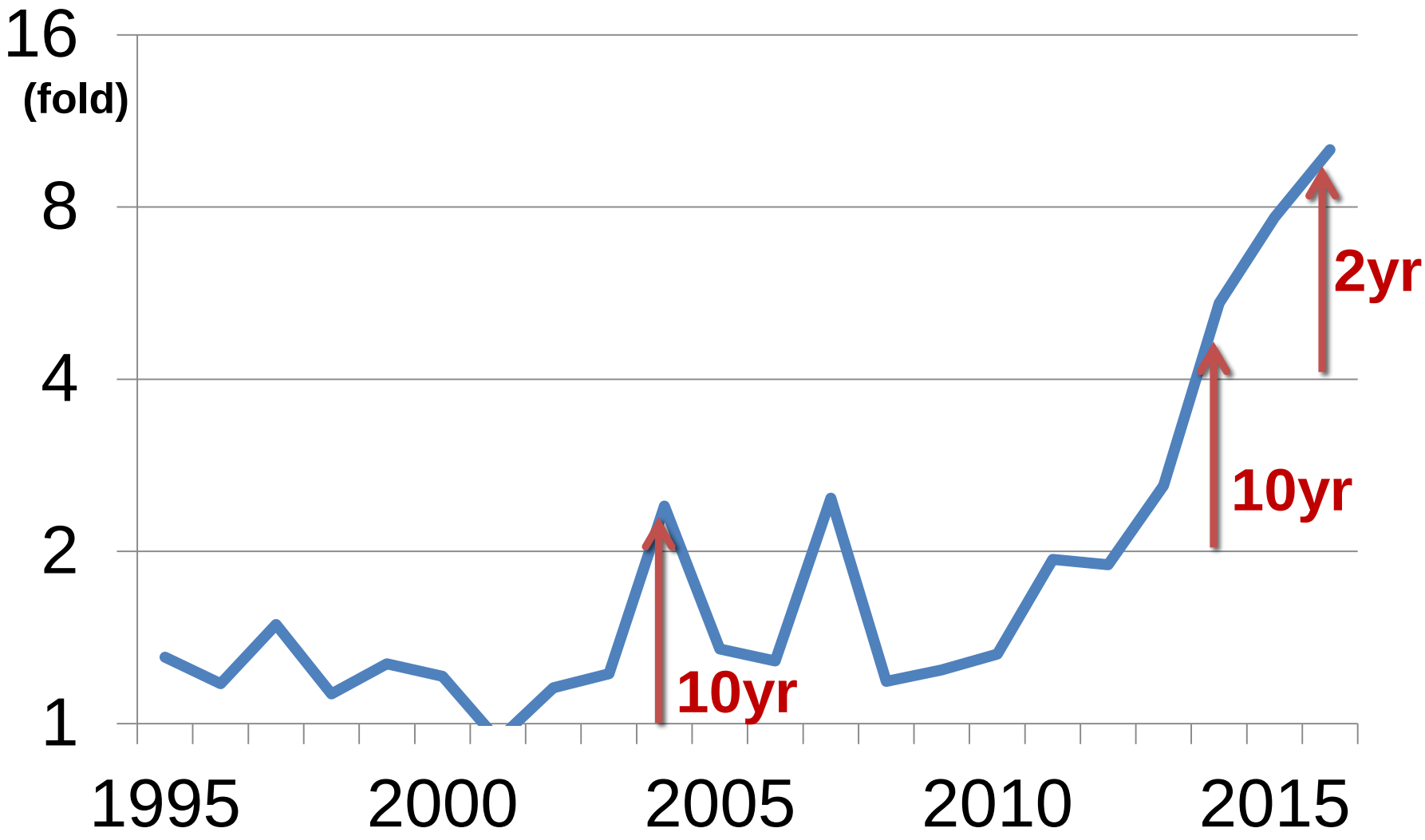
After WW2, Constantly doubling until 1980



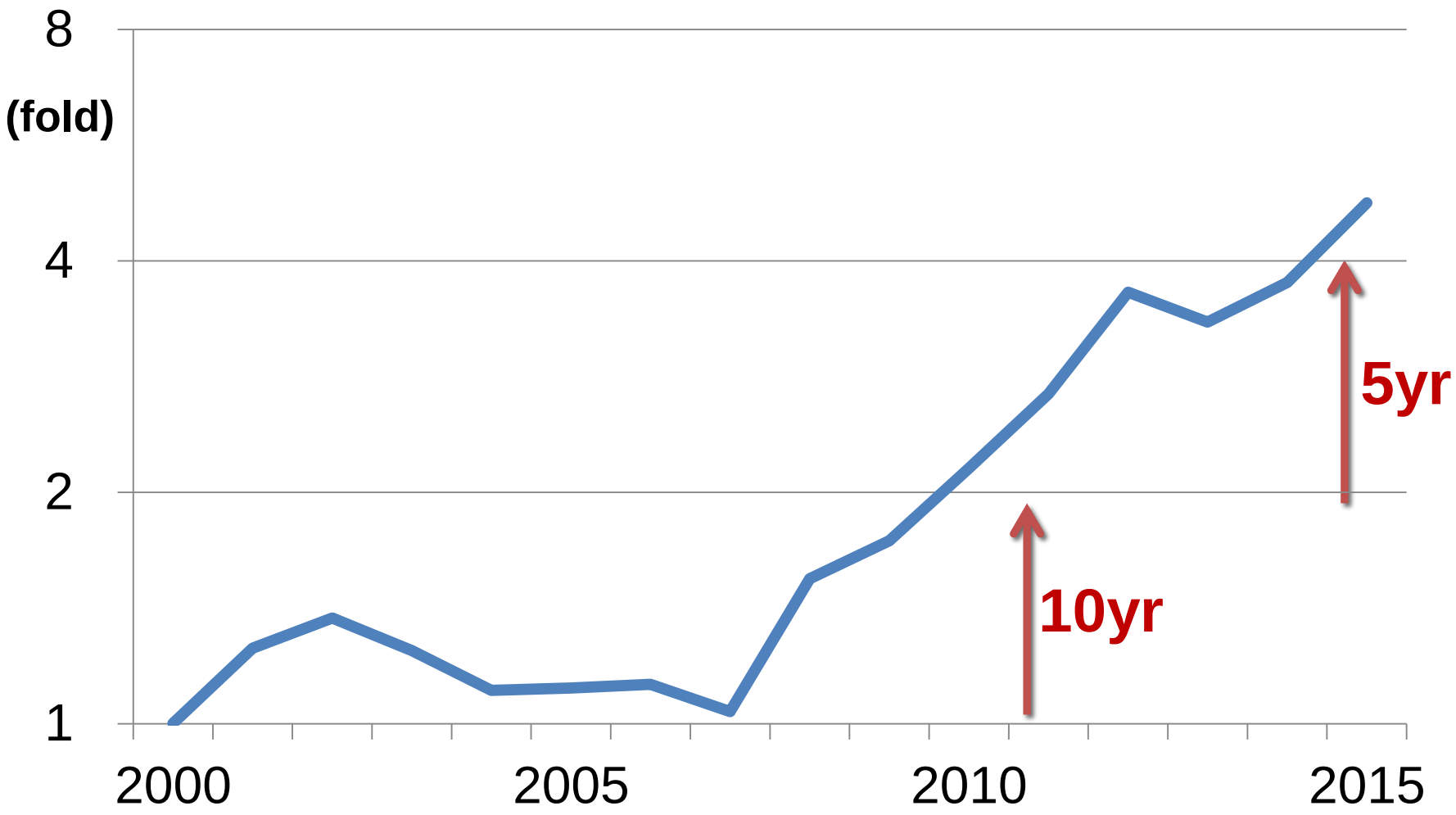
Correlation with national income opposite correlation with damage



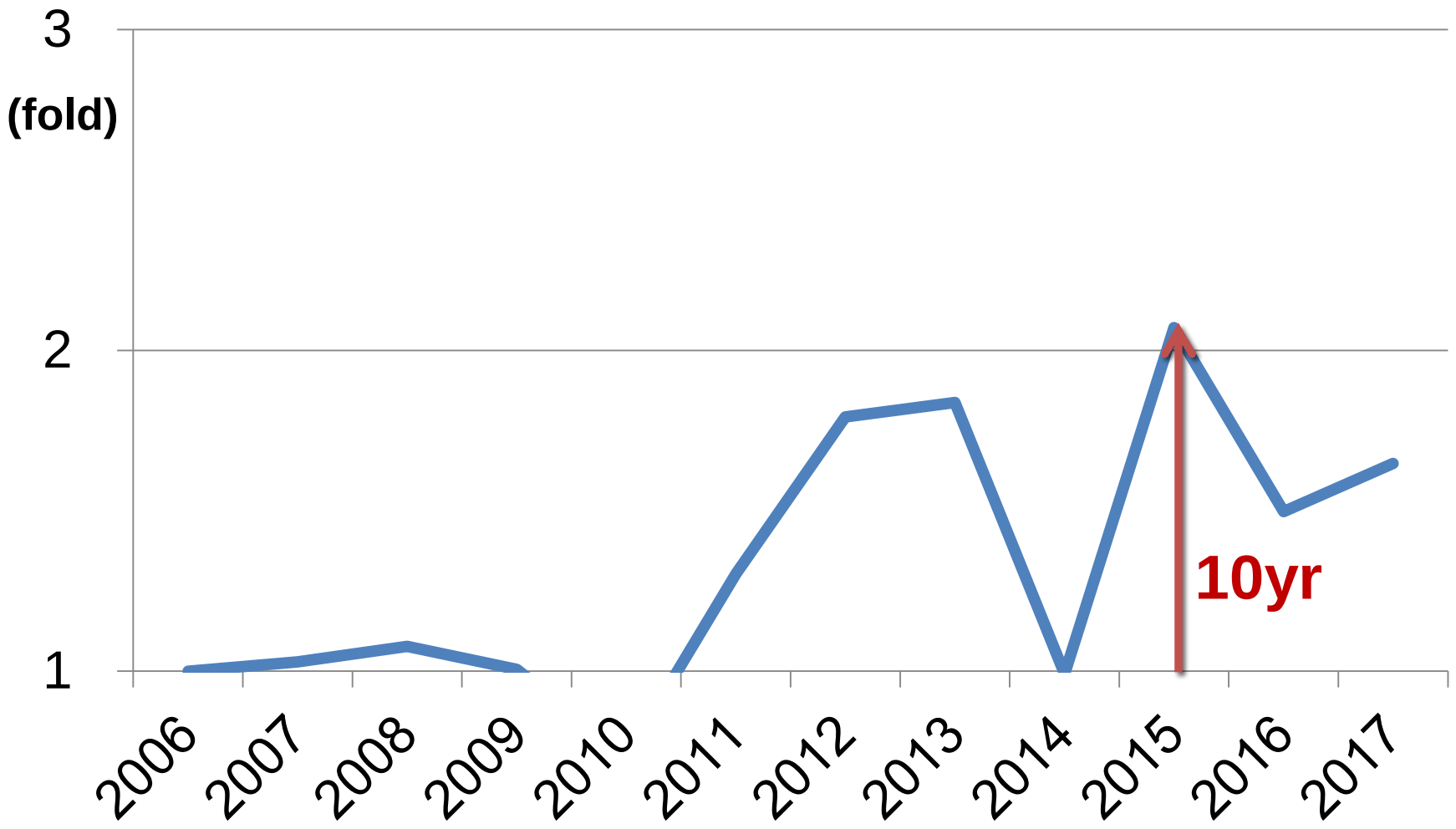
Philippines: rapidly increasing recently



China: rapidly increasing recently

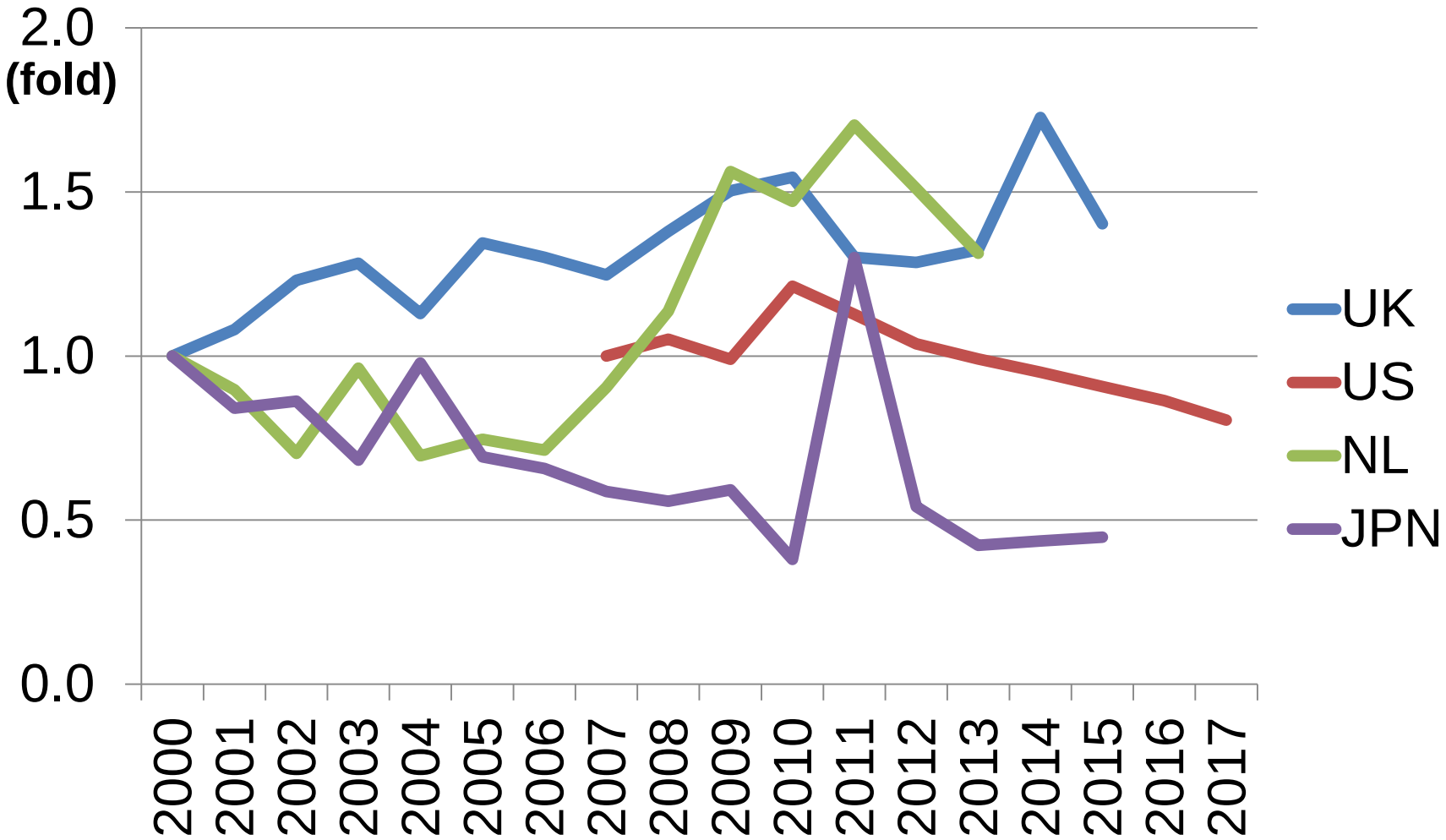


Indonesia


3
(fold)
2
1
10yr
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

Industrialized countries

UK & NL increasing budget some

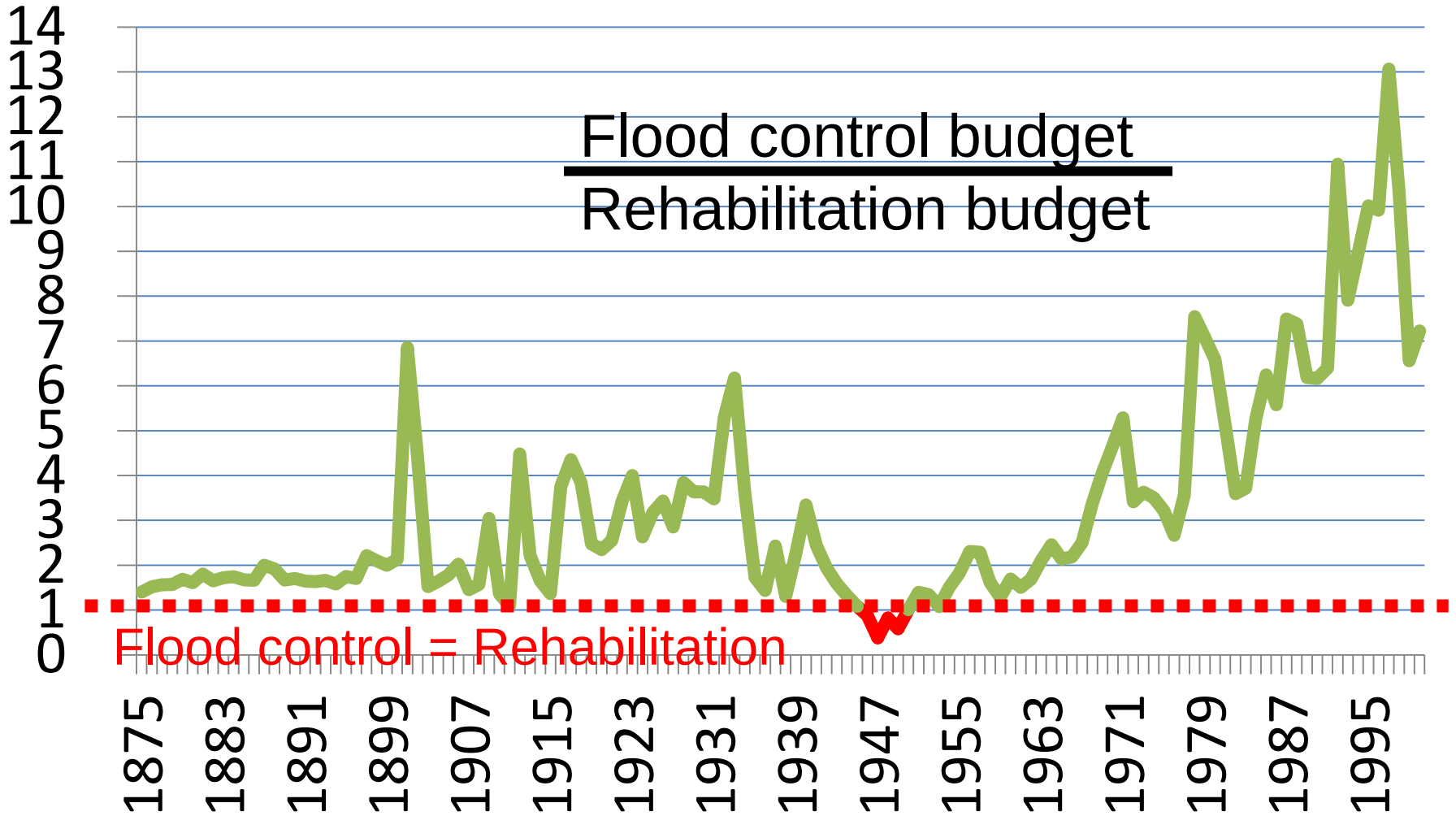


ANNEX 2
INVEST/ REHABILITATION HOW CHANGING

Japan: ratio of (flood control/rehabilitation)

by increasing investment

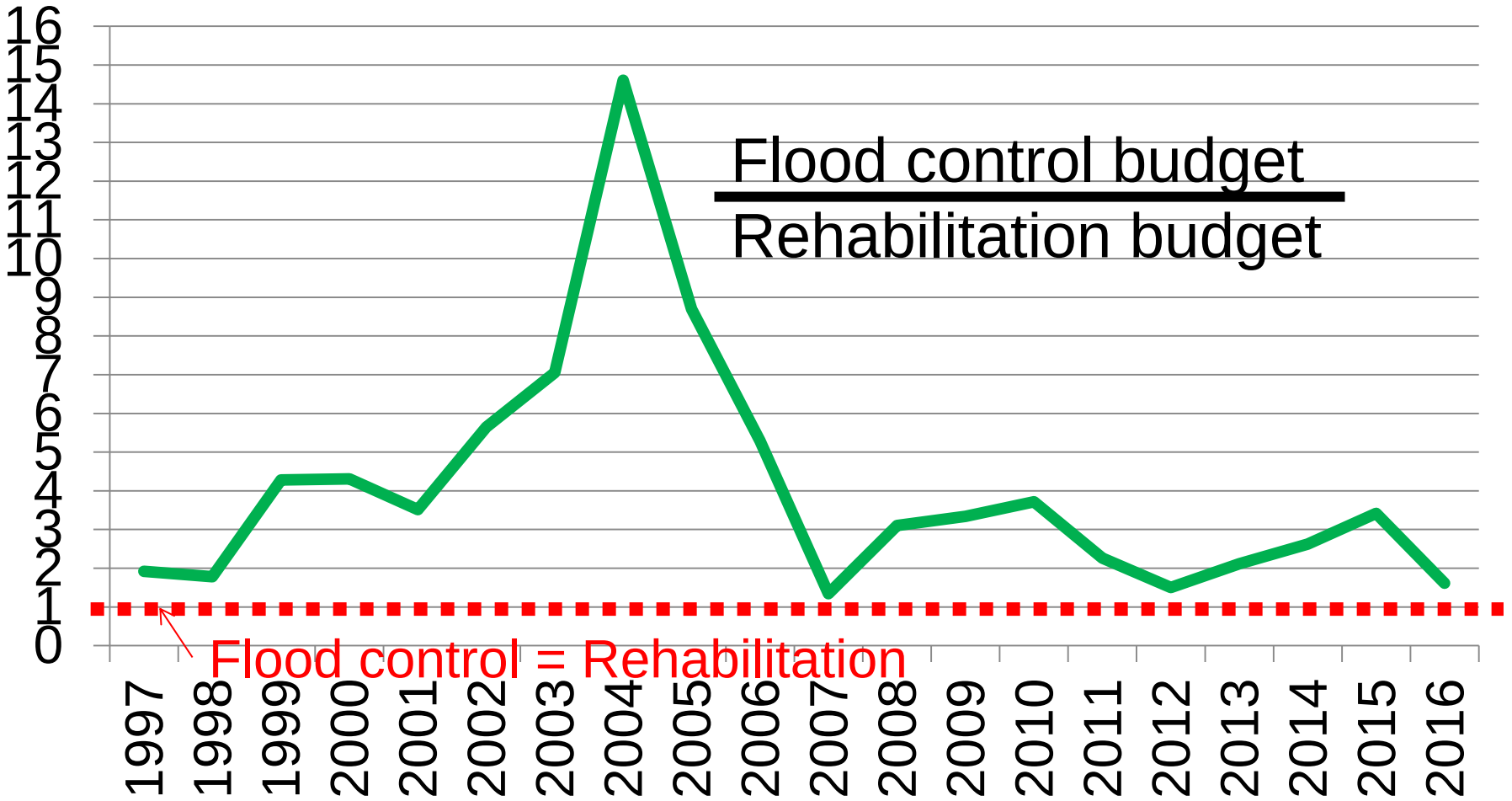
ratio is increasing = damage decreasing



The Philippines: flood control/ rehabilitation

the ration is not increasing

= Still needs investment increase



ANNEX 3
INVESTMENT TREND IN JAPAN

1896 flood triggered central government intervention

Legislation: river law enacted
from local efforts to central government initiative

- Damage: 11.36% of national income
- Death toll 1250

Shinanogawa River,

Source: MLIT

1910 floods: government commitment

formulated long-term budget plan and special account

- Damage: 3.6% of national income
- 2500 people died
    - Saitama Pref,

not always secured budgets

- 1894-95: Sino-Japanese war
- 1904-05: Russo-Japanese war
- 1910s: inflation
- 1923: rehabilitation following the Great Kanto Earthquake
- 1929: the Great Depression
- 1930s: allocated major portion for military expansion

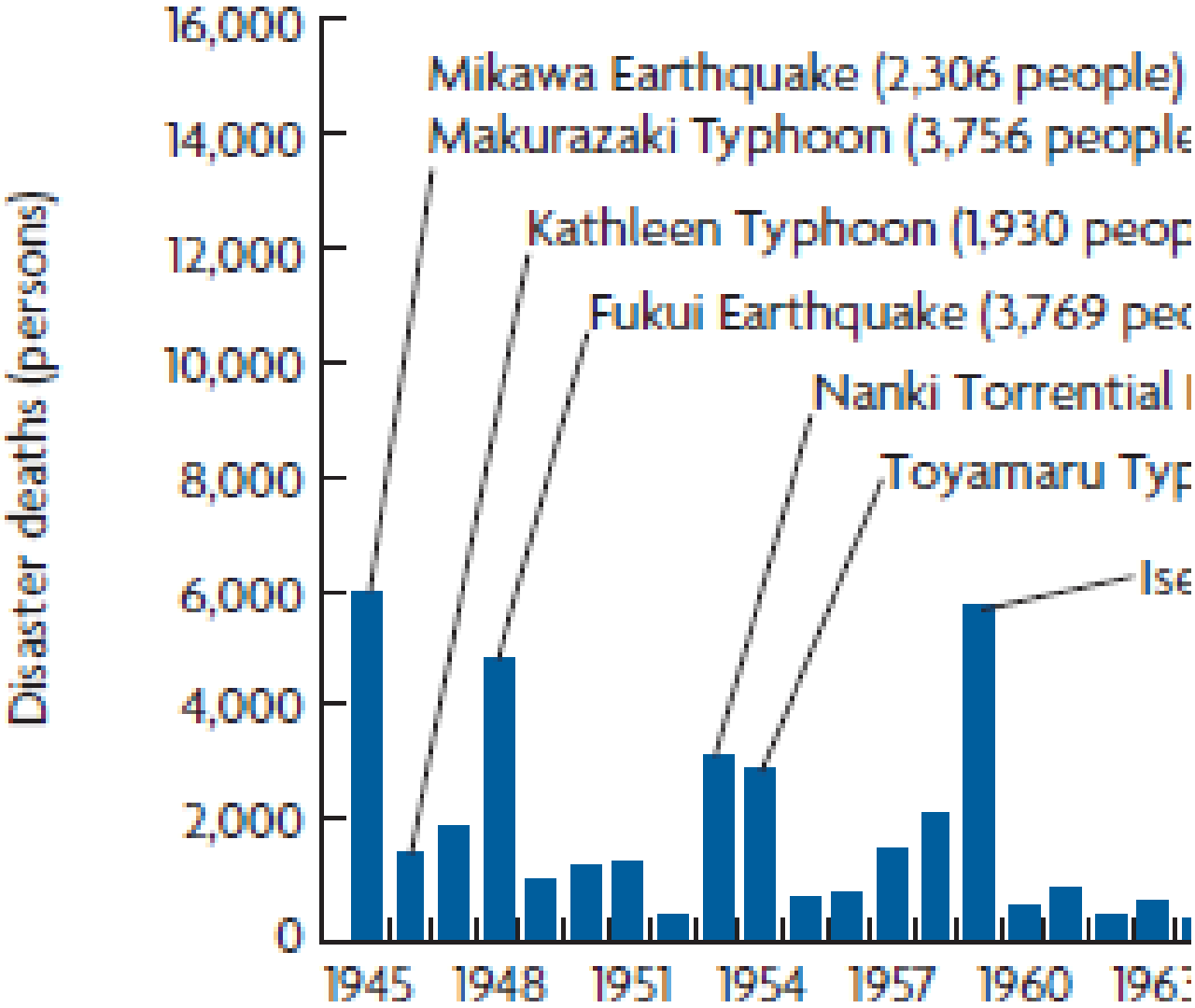
- from 1946 until 1959

the country suffered from serious floods

Annual economic damage 1-10 % of National Income

Isewan Typhoon in 1959
killed 5,098, flooded 1.2 million houses in Nagoya

Mega disasters happened almost every year after WWII



Budget share (%)

Flood control & Disaster rehabilitation / public works over 50%, recovery > prevention in the 1950s