

# NO LONGER THE BLACK SWAN : IMPACTS OF RISING NATURAL DISASTERS AND ENVIRONMENTAL ISSUES ON AGRICULTURE AND ECONOMY

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Columbia University

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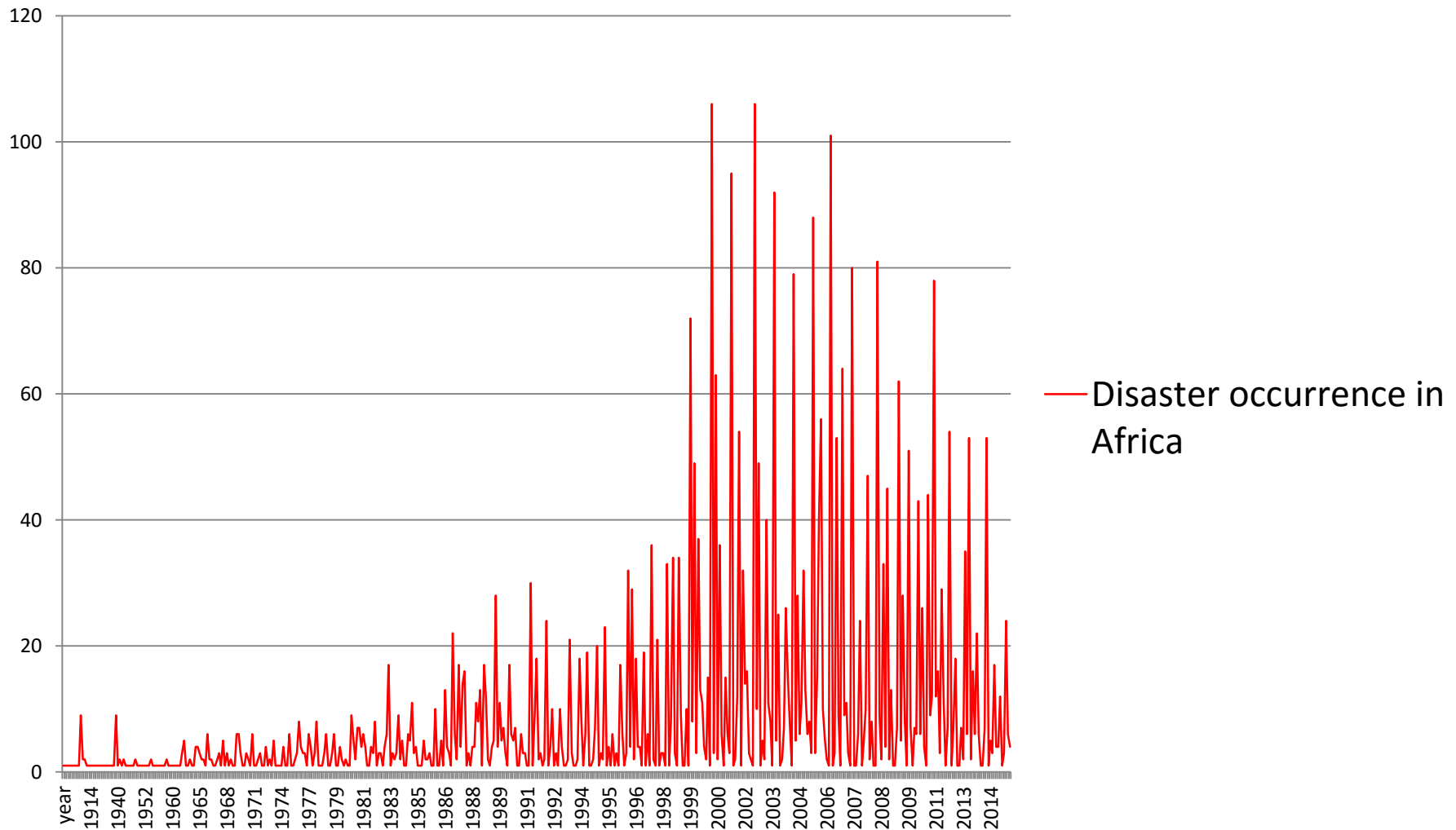
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Institute; Adjunct Researcher, Waseda University

## Section 1

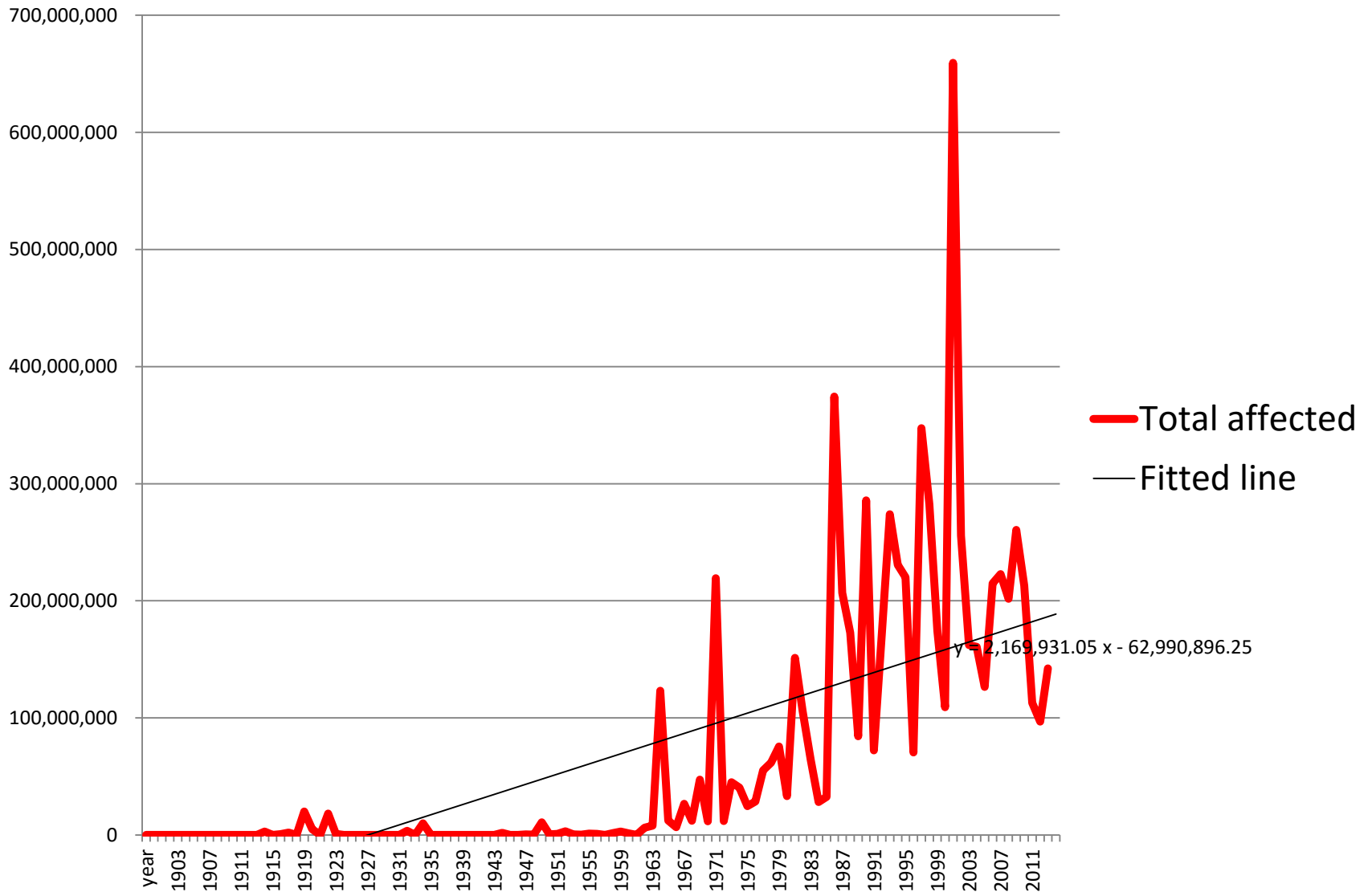
# ARE NATURAL DISASTERS STILL BLACK SWANS IN AFRICA?

# Natural disasters are not black swans anymore in Africa. The number of natural disasters has been increasing rapidly.



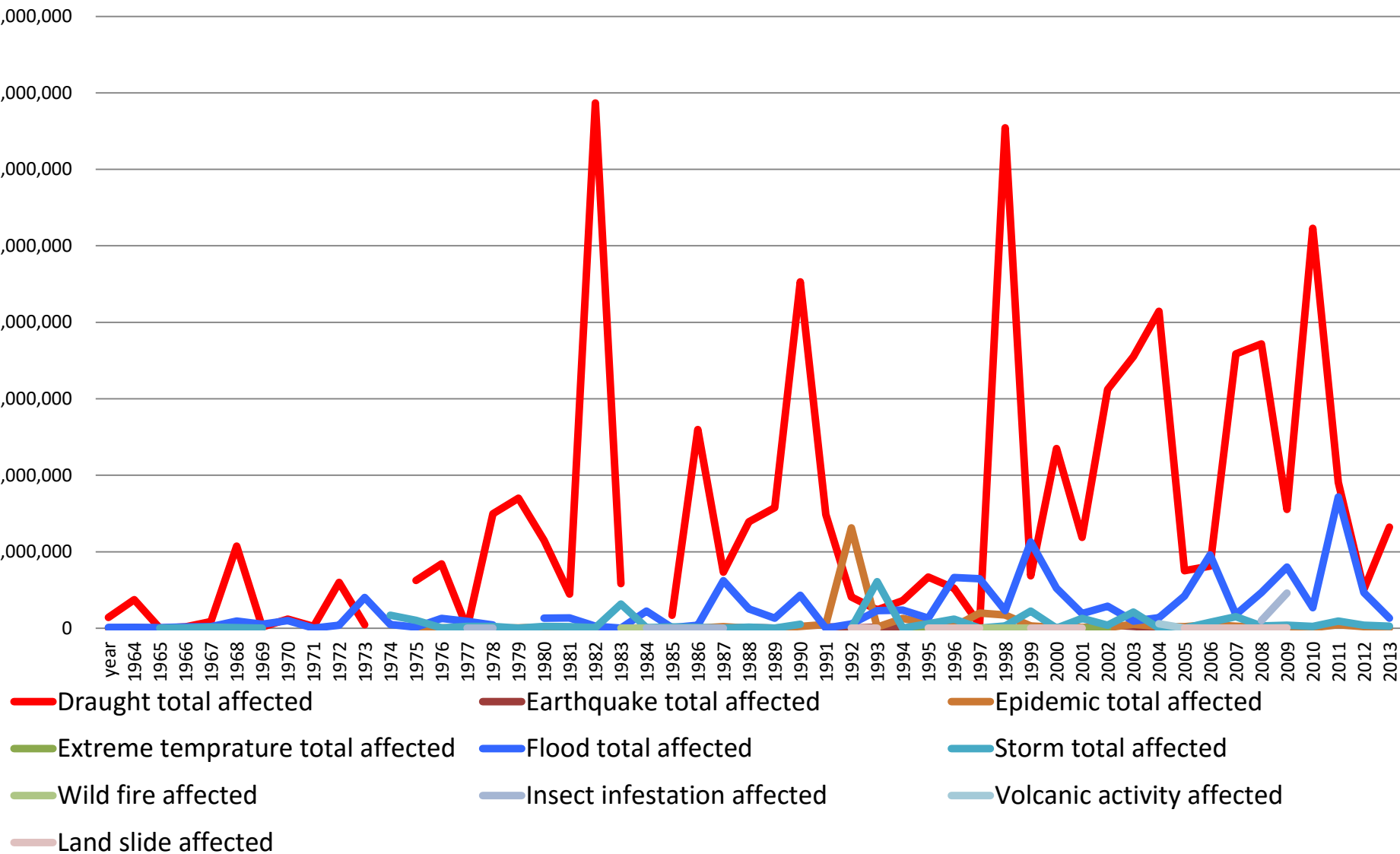
(Source: Author based on EM-DAT date base)

# Total persons affected by natural disasters in Africa



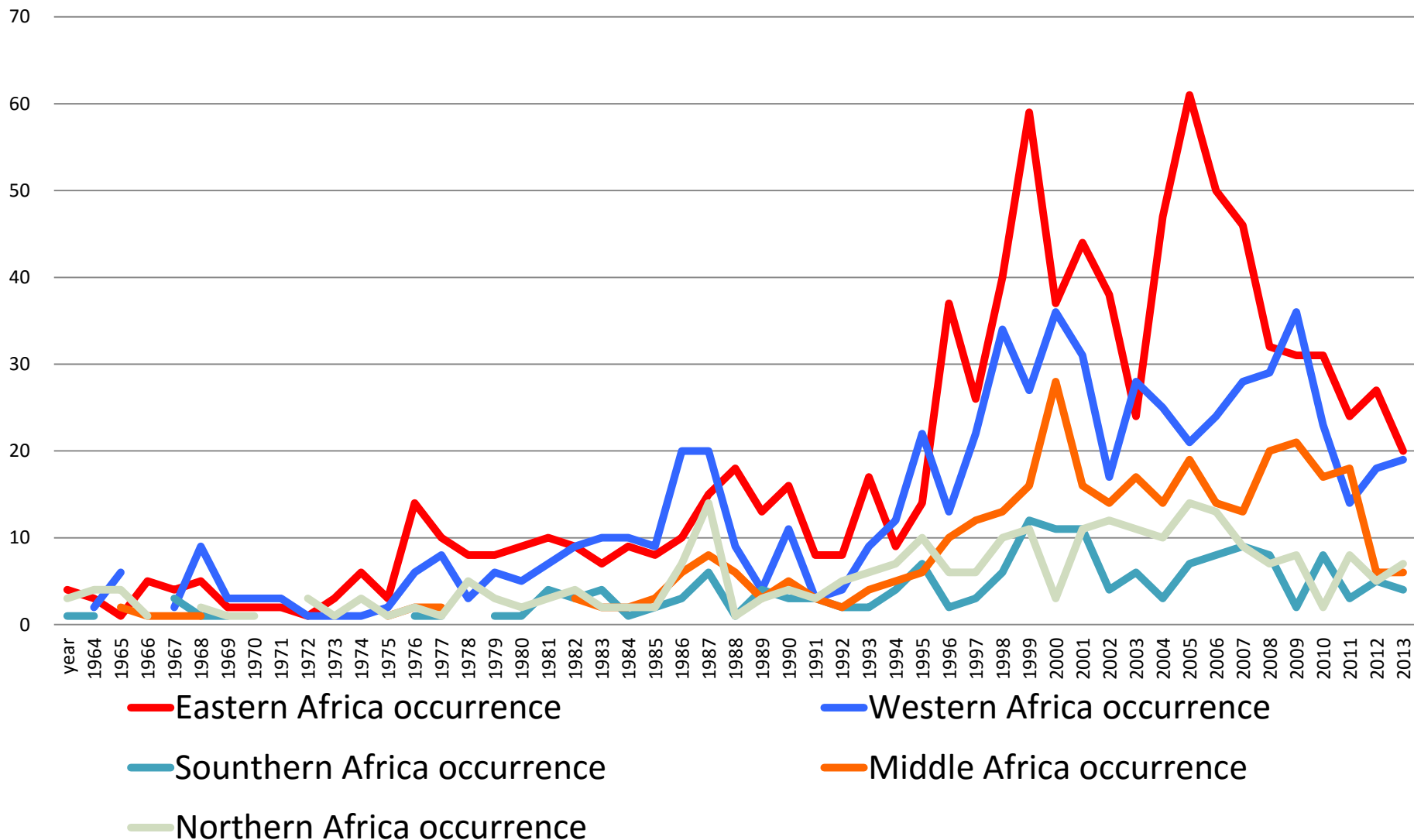
(Source: Author based on EM-DAT date base)

# What type of natural disasters? (Total affected persons by natural disasters in Africa)



(Source: Author based on EM-DAT date base)

# Eastern Africa suffers most from natural disasters (number of disasters by region)



(Source: Author based on EM-DAT date base)

SECTION 2: There is comparatively little literature on the impacts of natural disasters on agriculture

## WHAT IS THE IMPACT OF NATURAL DISASTERS IN AFRICA?

# Influence of extreme weather disasters on global crop production

- Lesk, Rowhani and Ramankutty (2016). *Nature* 529, 519–522
- Findings:
  1. National cereal production reduced by 9-10% globally due to extreme weather (drought and extreme heat) between 1964-2007.
  2. No impacts were found from floods and extreme cold.
  3. Drought: reduces both harvested area and yields.
  4. Extreme heat: decreased cereal yields.
  5. Greater damage in developing countries than developed countries.
- However, this is global analysis not regional. Long-term trends need to be analyzed.



# Economic analysis framework

$$\Delta \log y_{i,t} = a_0 + b_1 \log y_{i,t-1} + b_2 DIS_{i,t} + e_{i,t}$$

$Y_{i,t}$ : Outcome variables (Consumption, GDP/capita, Agricultural Production Index)

$i$ : Country,  $t$ : time

$DIS$ : Disaster variable

Autoregressive model (Beck and Katz 2009)

## Descriptive statistics: Panel data of Africa (57 Countries, 1963-2015):

Variable	Obs	Mean	Std. Dev.	Min	Max
Household final consumption expenditure per capita growth (annual %)	1196	1.822	12.228	-45.36324	219.142
GDP per capita growth (annual %)	2,164	1.384	6.671	-50.29035	92.586
Agriculture production index (2004-2006 = 100)	2,536	71.881	28.410	14.23	192.72
Disaster Occurrence	2,824	0.867	1.403	0	12
Agricultural land (% of land area)	2,616	22,400,000	27,100,000	3000	137,000,000
Forest area (% of land area)	1,185	28.0	24	0.0442011	88
Land under cereal production (hectares)	2,499	1,777,457	2,863,765	2	19,400,000
Land under maize production (hectares)	2,401	482,613	820,222.60	2	6,008,470

Data Souce:

Macro-economic data: African Development Indicators, World Bank

Agricultural Production Index: FAO statistics

Disaster Data: EM-DAT, CRED

# Disasters increased agricultural production: No impact on GDP/capita and consumption

	model 1	model 2	model 3	model 4	model 5	model 6	model 7	model 8	model 9
	Pooling	RE	FE	Pooling	RE	FE	Pooling	RE	FE
Dependent Variables	GDP per capita growth (log)			Household final consumption expenditure per capita growth (log)			Agricultural Production Index (log)		
GDP per capita growth (log) (lagged)	0.27 [8.91]***	0.27 [8.91]***	0.1631 [5.05]***						
Consumption (log) (lagged)				0.3208 [7.09]***	0.3208 [7.09]***	0.1335 [2.66]***			
Agricultural Production Index (log) (lagged)							0.9644 [210.59]***	0.9644 [210.59]***	0.9632 [167.00]***
Disaster occurrence	-0.0123 [-0.58]	-0.0123 [-0.58]	-0.0057 [-0.22]	-0.0396 [-1.37]	-0.0396 [-1.37]	-0.033 [-0.94]	0.0063 [4.58]***	0.0063 [4.58]***	0.0074 [4.50]***
_cons	0.7618 [14.30]***	0.7618 [14.30]***	0.8684 [15.36]***	0.9036 [10.64]***	0.9036 [10.64]***	1.1476 [12.72]***	1.67E-01 [8.80]***	1.67E-01 [8.80]***	1.70E-01 [7.22]***
N	983	983	983	493	493	493	2483	2483	2483
R-squared			0.0269			0.0172			0.9346
Adj-R-squared			-0.0286			-0.0581			0.9331

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

t-value in parentheses

Fixed effect is the best estimator, according to F-test, Hausman test, and Breusch and Pagan test.

# After one year, disasters decreased household consumption and increased agricultural production: No impact on GDP/capita

	model 10	model 11	model 12	model 13	model 14	model 15	model 16	model 17	model 18
	Pooling	RE	FE	Pooling	RE	FE	Pooling	RE	FE
Dependent Variables	GDP per capita growth (log)			Household final consumption expenditure per capita growth (log)			Agricultural Production Index (log)		
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Disaster occurrence (lagged)	-0.0006 [-0.03]	-0.0006 [-0.03]	0.0053 [0.21]	-0.0559 [-2.07]**	-0.0559 [-2.07]**	-0.067 [-2.01]**	0.0068 [4.81]***	0.0068 [4.81]***	0.0078 [4.73]***
_cons	7.48E-01 [14.18]***	7.48E-01 [14.18]***	8.56E-01 [15.37]***	9.26E-01 [10.99]***	9.26E-01 [10.99]***	1.19E+00 [13.24]***	1.69E-01 [8.89]***	1.69E-01 [8.89]***	1.74E-01 [7.33]***
N	983	983	983	493	493	493	2483	2483	2483
R-squared			0.0269			0.0239			0.9347
Adj-R-squared			-0.0286			-0.0509			0.9332

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

t-value in parentheses

# Disasters expanded agricultural land:

	model 19	model 20	model 21	model 22	model 23	model 24
	Pooling	RE	FE	Pooling	RE	FE
Dependent Variables	Agricultural land (% of land area)					
Disaster occurrence (log)	0.0267 [5.33]***	0.0267 [5.33]***	0.0266 [5.32]***			
Disaster occurrence (log lagged)				0.0286 [5.63]***	0.0286 [5.63]***	0.0285 [5.61]***
_cons	3.6248 [36.78]***	3.6248 [36.78]***	3.6975 [1023.74]***	3.6256 [36.67]***	3.6256 [36.67]***	3.6984 [1014.11]***
N	1093	1093	1093	1060	1060	1060
R-squared			0.0265			0.0303
Adj-R-squared			-0.0222			-0.0197

# Disasters decreased forest area:

	model 25	model 26	model 27	model 28	model 29	model 30
	Pooling	RE	FE	Pooling	RE	FE
Dependent Variables	Forest area (% of land area)					
Disaster occurrence (log)	-0.0336 [-4.98]***	-0.0336 [-4.98]***	-0.0337 [-4.98]***			
Disaster occurrence (log, lagged)				-0.039 [-5.35]***	-0.039 [-5.35]***	-0.0391 [-5.36]***
_cons	2.6169 [11.03]***	2.6169 [11.03]***	2.6662 [478.83]***	2.6204 [11.06]***	2.6204 [11.06]***	2.6628 [448.31]***
N	720	720	720	713	713	713
R-squared			0.0359			0.0416
Adj-R-squared			-0.0393			-0.0339

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

t-value in parentheses

# Disasters expanded land for cereal production:

	model 31	model 32	model 33	model 34	model 35	model 36
	Pooling	RE	FE	Pooling	RE	FE
Dependent Variables	Land under cereal production (hectares)					
Disaster occurrence (log)	0.1478 [7.85]***	0.1478 [7.85]***	0.1462 [7.87]***			
Disaster occurrence (lagged, log)				0.1412 [7.25]***	0.1412 [7.25]***	0.1395 [7.26]***
_cons	12.8903 [42.66]***	12.8903 [42.66]***	13.4563 [996.18]***	12.8995 [42.87]***	12.8995 [42.87]***	13.4435 [968.93]***
N	1084	1084	1084	1052	1052	1052
R-squared			0.0565			0.05
Adj-R-squared			0.0108			0.0025

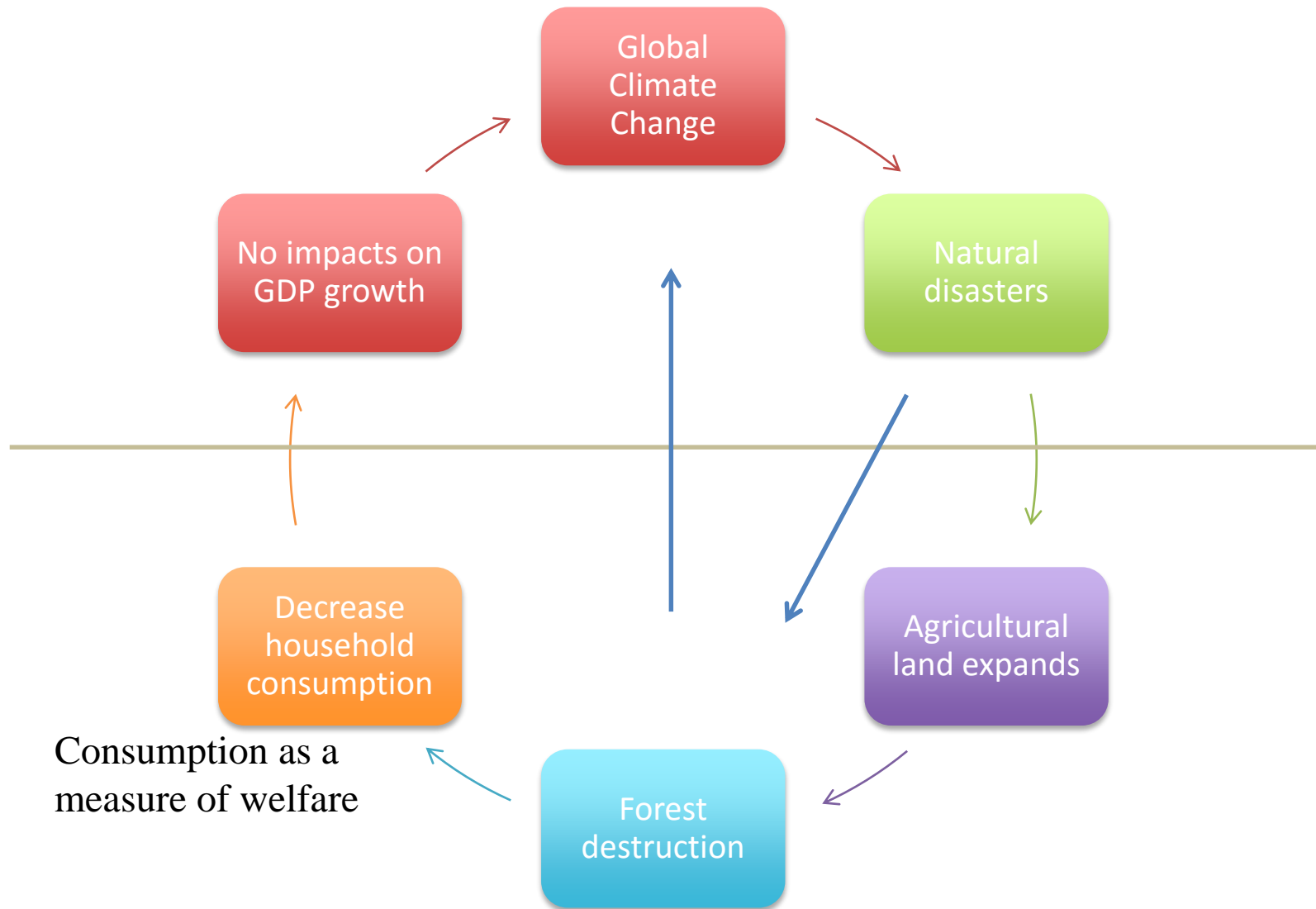
# The same as land for maize production:

	model 37	model 38	model 39	model 40	model 41	model 42
	Pooling	RE	FE	Pooling	RE	FE
Dependent Variables	Land under maize production (hectares)					
Disaster occurrence (log)	0.1599 [5.27]***	0.1599 [5.27]***	0.1558 [5.20]***			
Disaster occurrence (log, lagged)				0.1623 [5.19]***	0.1623 [5.19]***	0.1582 [5.13]***
_cons	11.2622 [35.75]***	11.2622 [35.75]***	11.745 [534.67]***	11.2763 [35.60]***	11.2763 [35.60]***	11.7329 [522.16]***
N	1056	1056	1056	1024	1024	1024
R-squared			0.0262			0.0263
Adj-R-squared			-0.0203			-0.0217

\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

t-value in parentheses

# Since there is no impact on GDP, the vicious cycle does not stop automatically

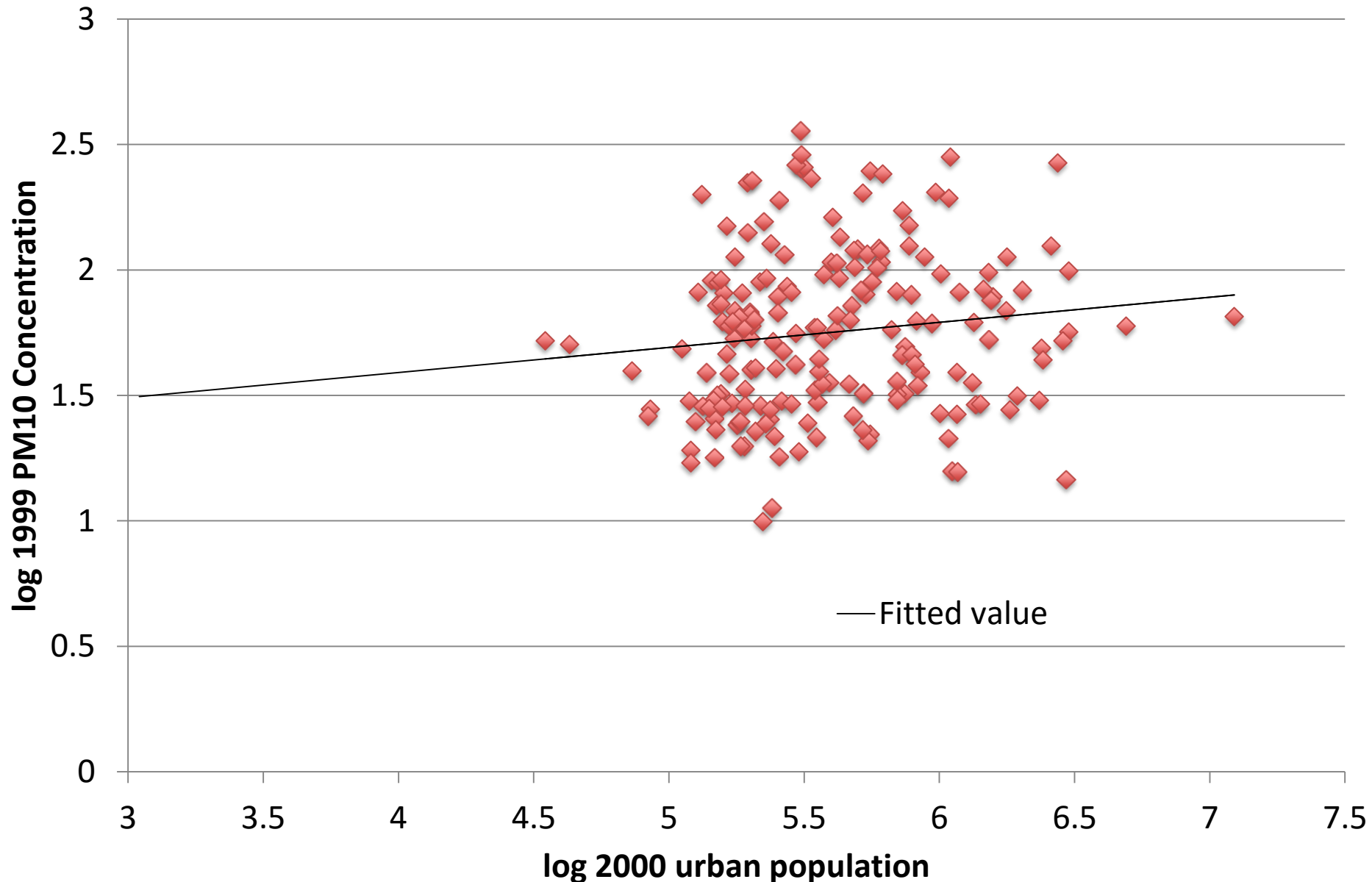


### Section 3

# HOW GREEN (OR BROWN) ARE AFRICAN CITIES?



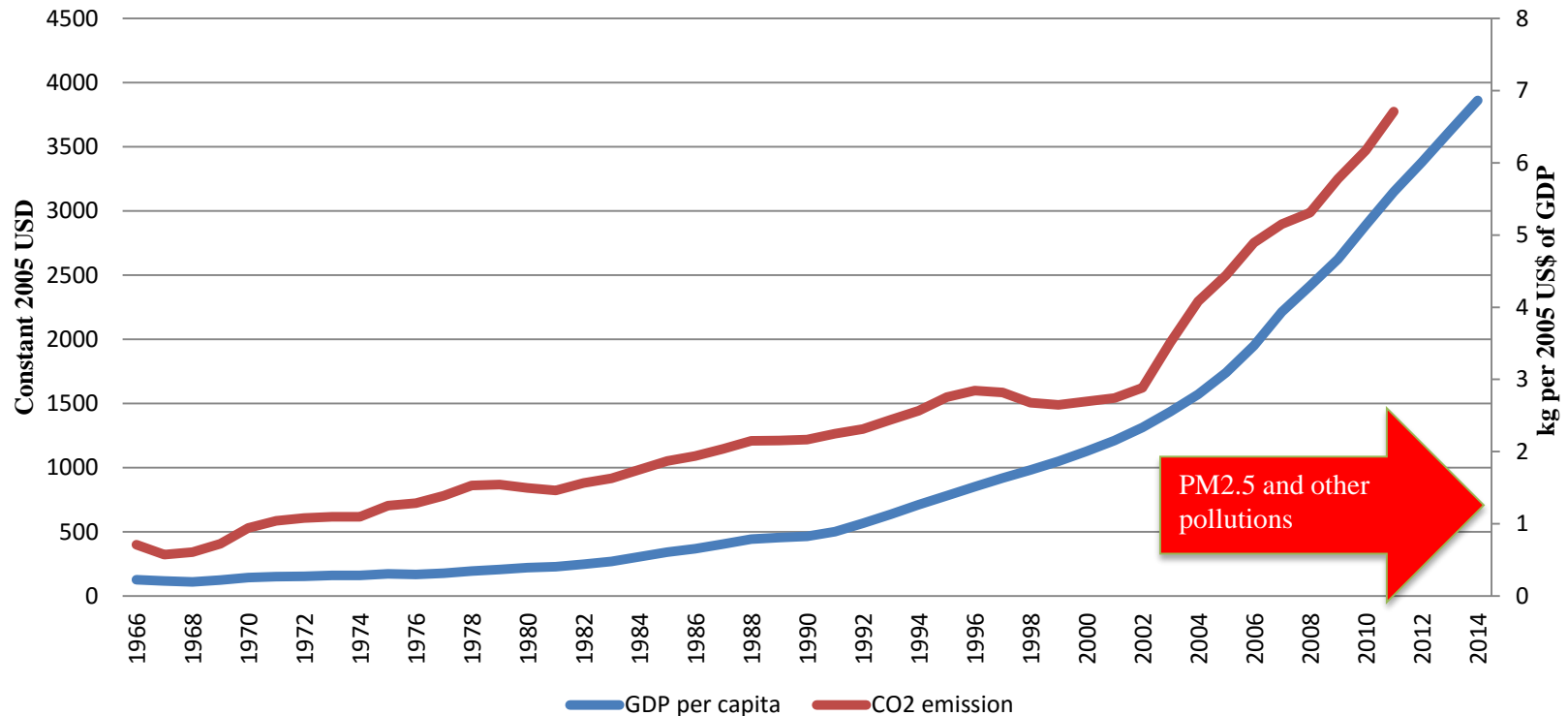
# Urbanization and PM10 ( 190 African Cities)



(Source: Author based on Air Pollution in World Cities 2000, PM10 Concentrations Data by Development Economic Research Group, World Bank(1999) [http://microdata.worldbank.org/index.php/catalog/424/get\\_microdata](http://microdata.worldbank.org/index.php/catalog/424/get_microdata))

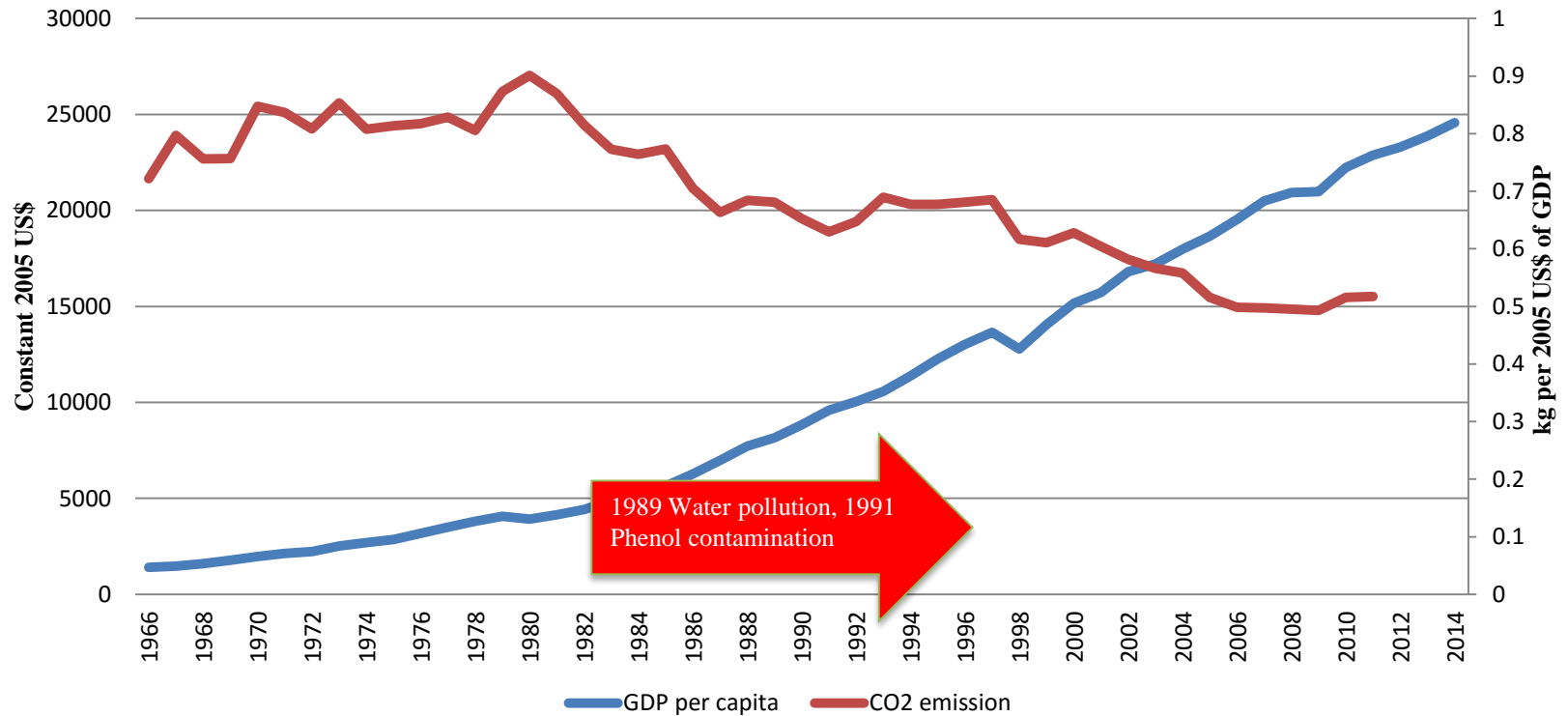
# If environmental Kuznets curve exists, then air pollution could become a challenge for Africa

**CO2 emissions and GDP per capita (China)**



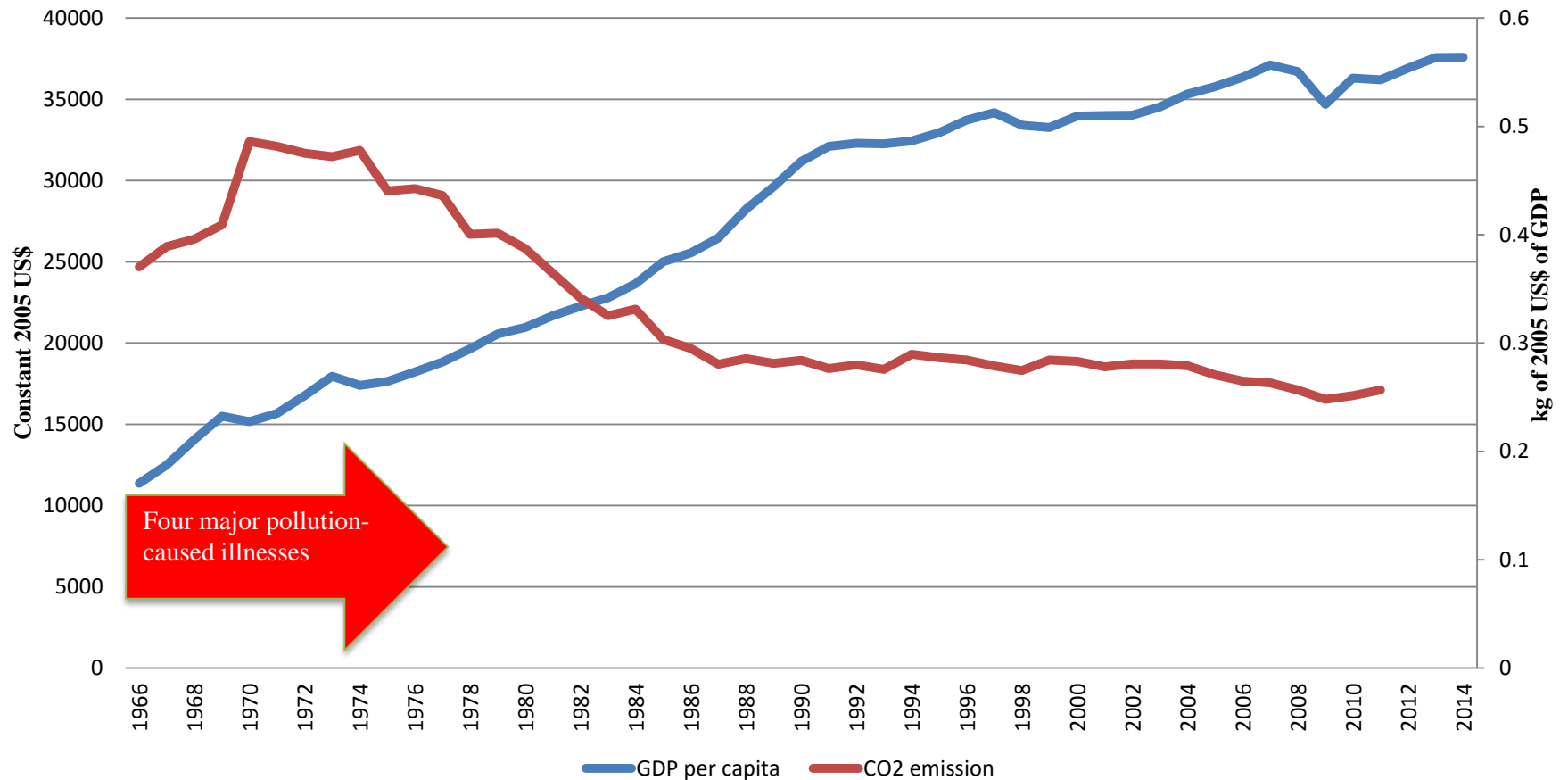
(Source: Author based on WDI)

## CO2 emissions and GDP per capita (South Korea)



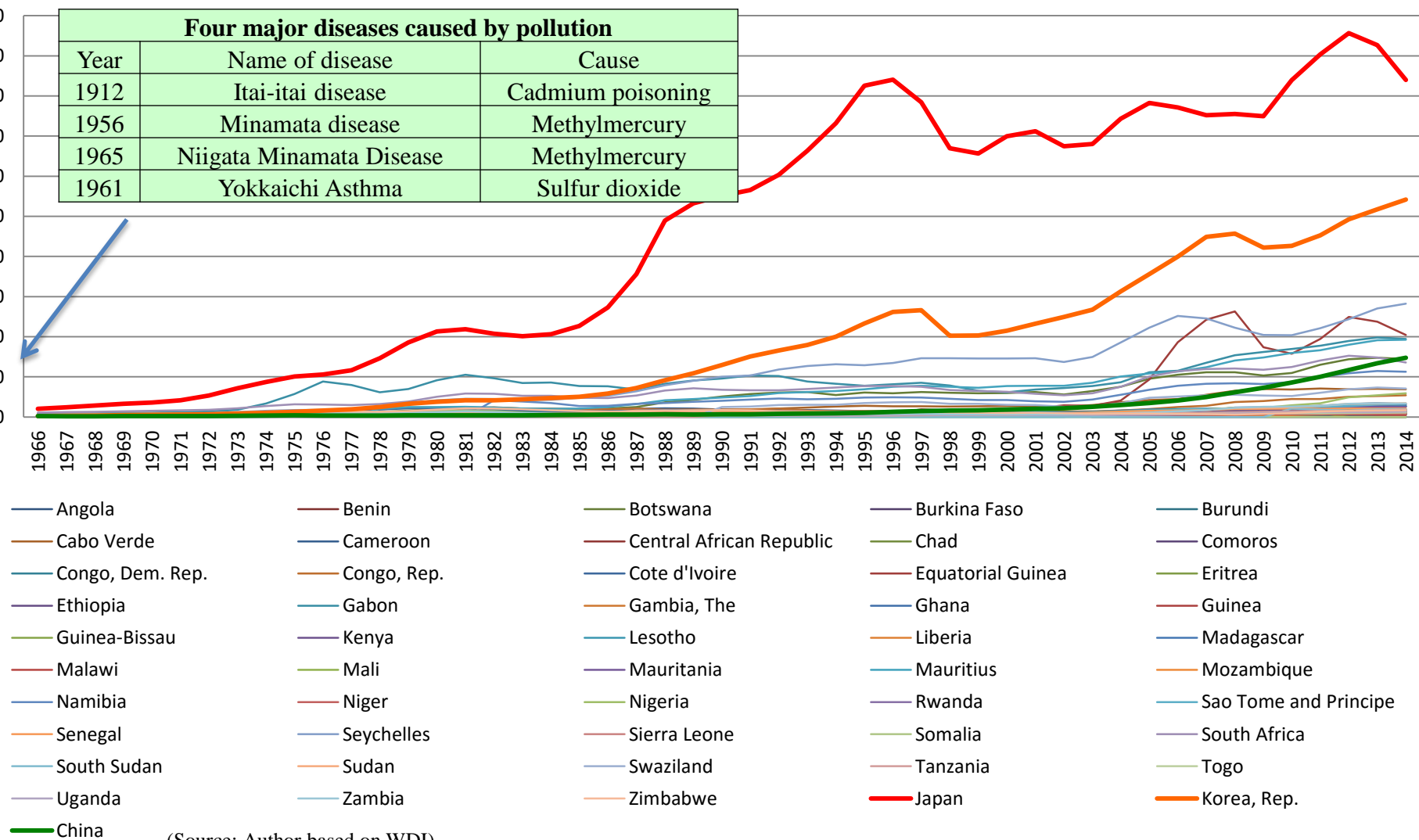
(Source: Author based on WDI)

## CO2 emissions and GDP per capita (Japan)



(Source: Author based on WDI)

# Even in countries with low per capita GDP, environmental pollution could become problem



# Kaldor-Hicks criterion for Environment?

- Environmental problem = Externality (failure of industrial policy) = Dead Weight Loss (DWL).
- Then, can we compensate DWL *ex post*?
- Environmental problem, especially pollution, is not just “social cost” (Kapp 1950), but “social loss.”
- Social “cost” and “loss.”
- Social loss = absolute loss (or irreversible loss) is something we can not compensate *ex post*.
- Pollution = economic damage (social cost) + human health damage.
- Therefore, preventive environmental policy needs to be implemented.

# Is environment a priority for African opinion leaders? An analysis from Kenya

**Analysis based on Kenya** – World Bank Country Survey 2012 (by Public Opinion Research Group of the Bank Group).

- Sampling

In April-June 2012, 600 stakeholders of the World Bank in Kenya were invited to provide their **opinions on the Bank's assistance** to the country by participating in a country survey. Participants in the survey were drawn from among the office of the President, Prime Minister; the office of a Minister; the office of a Parliamentarian; employees of a ministry, ministerial department, or implementation agency; consultants/contractors working on World Bank-supported projects/programs; project management units (PMUs) overseeing implementation of a project; local government officials or staff; bilateral agencies; multilateral agencies; private sector organizations; private foundations; the financial sector/private banks; NGOs; community-based organizations (CBOs); the media; independent government institutions; trade unions; faith-based groups; academia/research institutes/think tanks; and the judiciary branch.

- Response rate

A total of **373 stakeholders** participated in the country survey (**62% response rate**).

# Environmental issues are not a priority

When considering development priorities, which ONE development priority below is the most important in KENYA?

First Priority			Second Priority		Third Priority	
1	Agriculture/rural development	19.690	Transport	10.660	Agriculture/rural development	7.837
2	Education	11.560	Agriculture/rural development	8.464	Poverty reduction	7.837
3	Poverty reduction	8.125	Job reation/employment	7.837	Job reation/employment	7.837
4	Transport	7.813	Health	7.837	Education	6.583
5	Governance	6.250	Education	6.583	Economic growth	5.643
6	Job reation/employment	6.250	Poverty reduction	6.270	Food security	5.643
7	Health	5.313	Governance	5.643	Governance	4.702
8	Economic growth	5.000	Water and Sanitation	4.702	Health	4.702
9	Basic infrastructure	3.125	Anti-corruption	4.075	Energy	4.389
10	Energy	3.125	Financial Markets	4.075	Transport	4.075
11	Anti-corruption	2.813	Food security	3.762	Basic infrastructure	4.075
12	Social protection	2.188	Energy	3.135	Anti-corruption	4.075
13	Public financial management	2.188	Economic growth	2.821	Public sector reform	4.075
14	Public sector reform	2.188	Equality of opportunity	2.821	Water and Sanitation	2.821
15	Food security	2.188	Basic infrastructure	2.508	Public financial management	1.881
16	Water and Sanitation	2.188	Public sector reform	2.508	FDI	1.881
17	Equality of opportunity	1.875	Environmental sustainability	2.194	Urban development	1.881
18	Financial Markets	1.563	Public financial management	1.881	Regulatory framework	1.881
19	Law and justice	1.250	Trade and exports	1.567	Law and justice	1.567
20	Gender	0.938	Domestic private sector development	1.567	Climate change	1.567
21	Climate change	0.625	Gender	1.254	Information and communications technology	1.567
22	Monitoring and evaluation	0.625	FDI	1.254	Social protection	1.254
23	FDI	0.625	Social protection	0.949	Gender	1.254
24	Trade and exports	0.625	Monitoring and evaluation	0.949	Trade and exports	1.254
25	Environmental sustainability	0.625	Regional Integration	0.940	Environmental sustainability	1.254
26	Global integration	0.313	Urban development	0.940	Domestic private sector development	1.254
27	Disaster management	0.313	Natural resource management	0.940	Crime and violence	1.254
28	Regional Integration	0.313	Law and justice	0.627	Equality of opportunity	0.940
29	Urban development	0.313	Climate change	0.314	Monitoring and evaluation	0.940
30	Domestic private sector development	0.313	Disaster management	0.314	Regional Integration	0.940
31	Regulatory framework	0.000	Crime and violence	0.314	Communicable/non-communicable deases	0.940
32	Information and communications technology	0.000	Communicable/non-communicable deases	0.314	Disaster management	0.627
33	Crime and violence	0.000	Global integration	0.000	Natural resource management	0.627
34	Communicable/non-communicable deases	0.000	Regulatory framework	0.000	Financial Markets	0.000
35	Natural resource management	0.000	Information and communications technology	0.000	Global integration	0

(Source: Author based on the data base of the World Bank 2012)

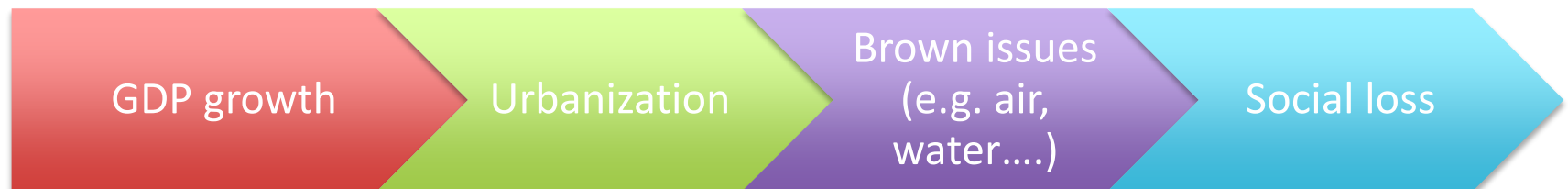


## Section 4

# CONCLUSIONS AND POLICY IMPLICATIONS

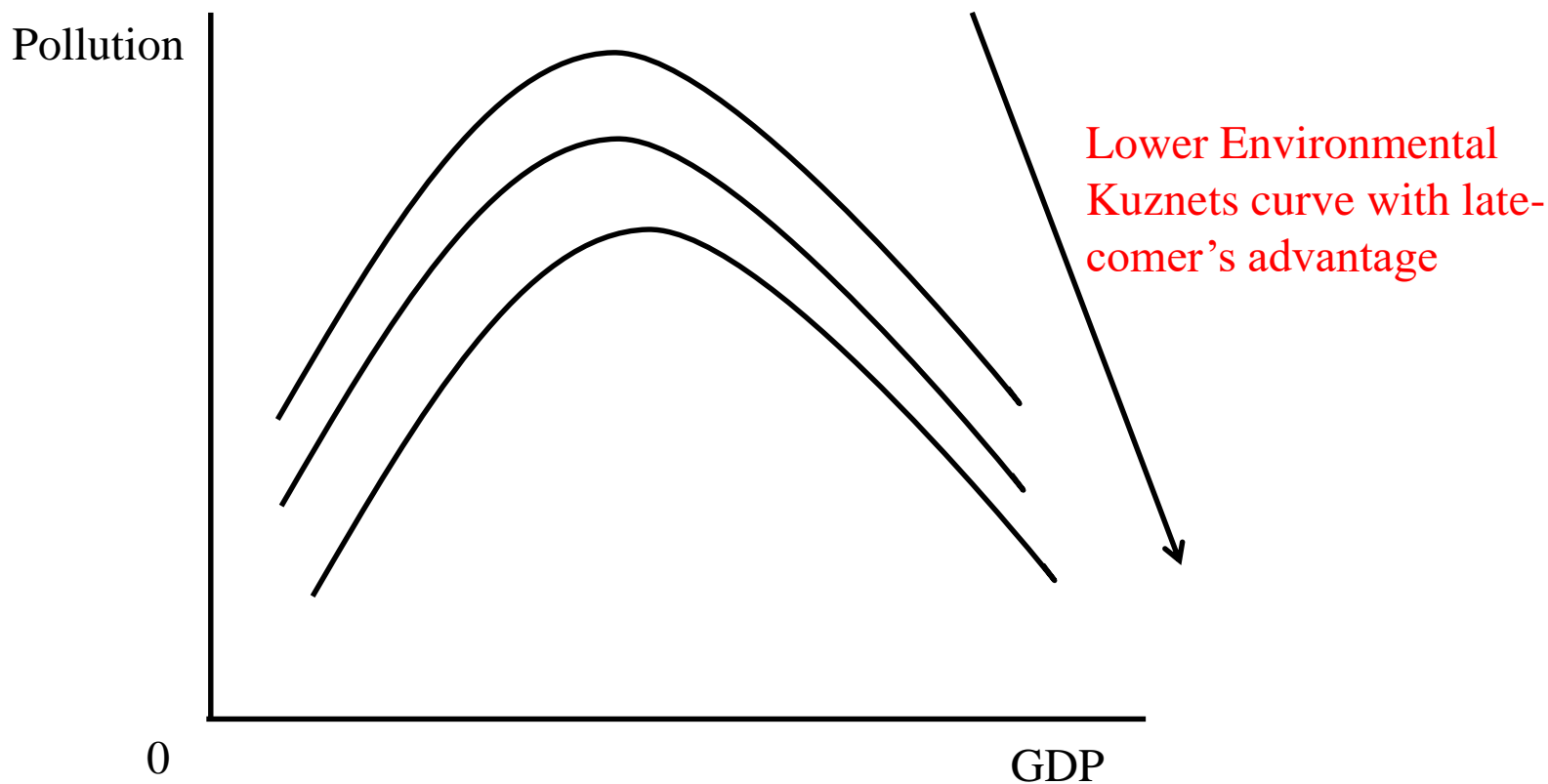
# Conclusions and policy implications (1)

- Natural disasters are no longer black swans. Agricultural policy (and industrial policy too) needs to take impacts into account.
- We do not know the extent of environmental pollution in African cities (no comprehensible data).
- Preventive pollution policy, before it becomes too late.



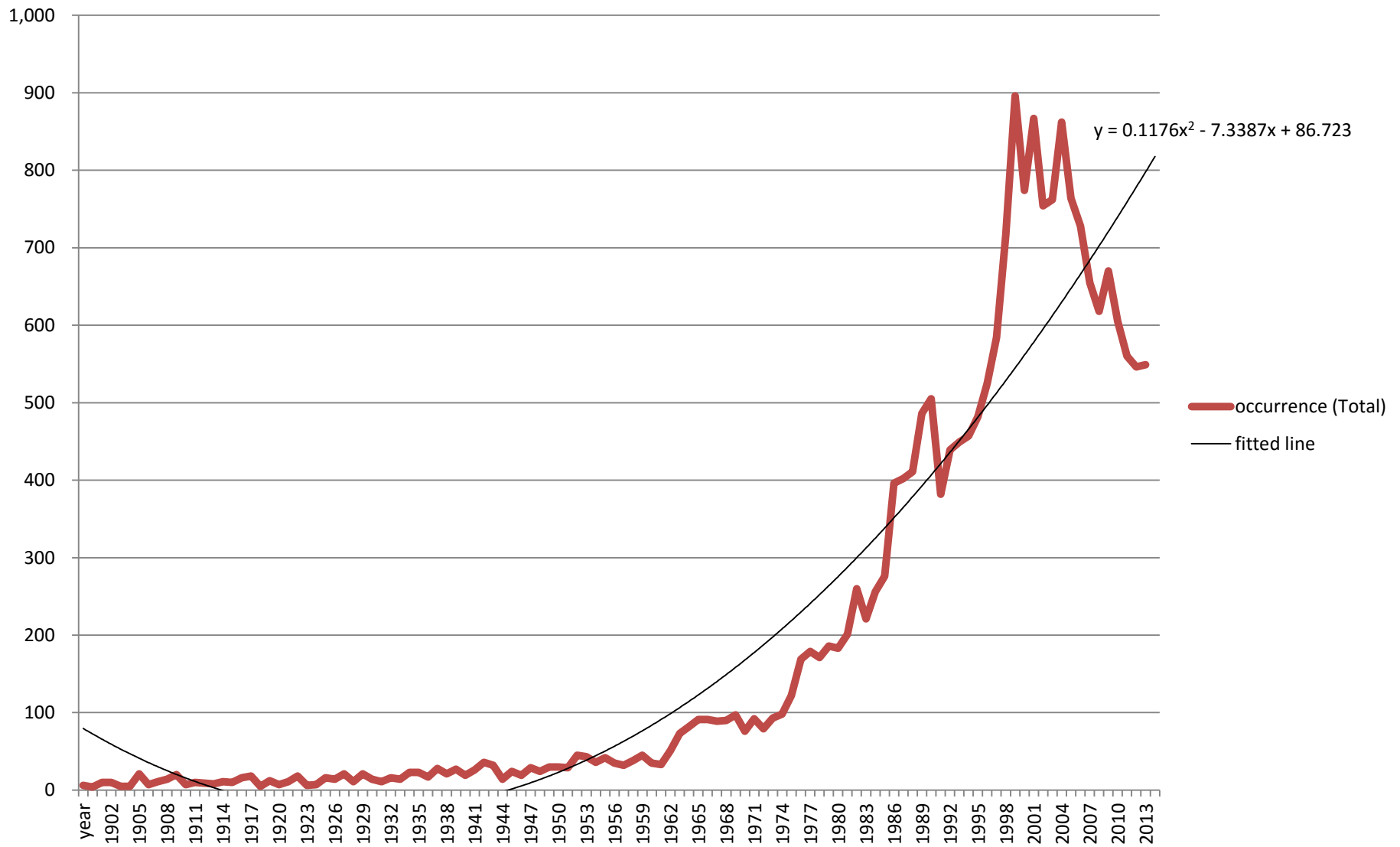
# Conclusions and policy implications (1)

- Use latecomer's advantage with new technology (e.g. desulfurization equipment).
- Donors should support this field more.



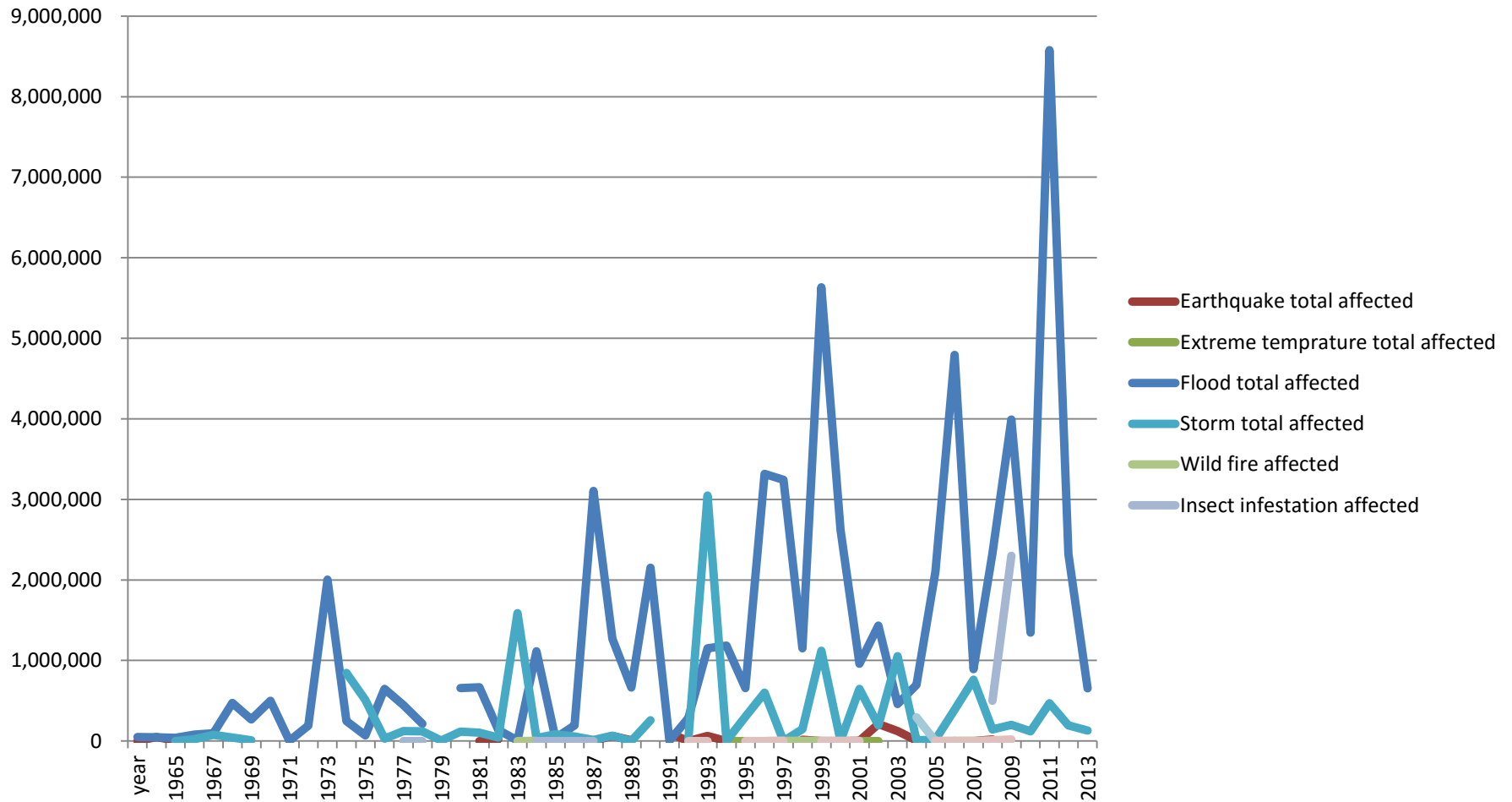


# The number of natural disasters has been increasing in Africa



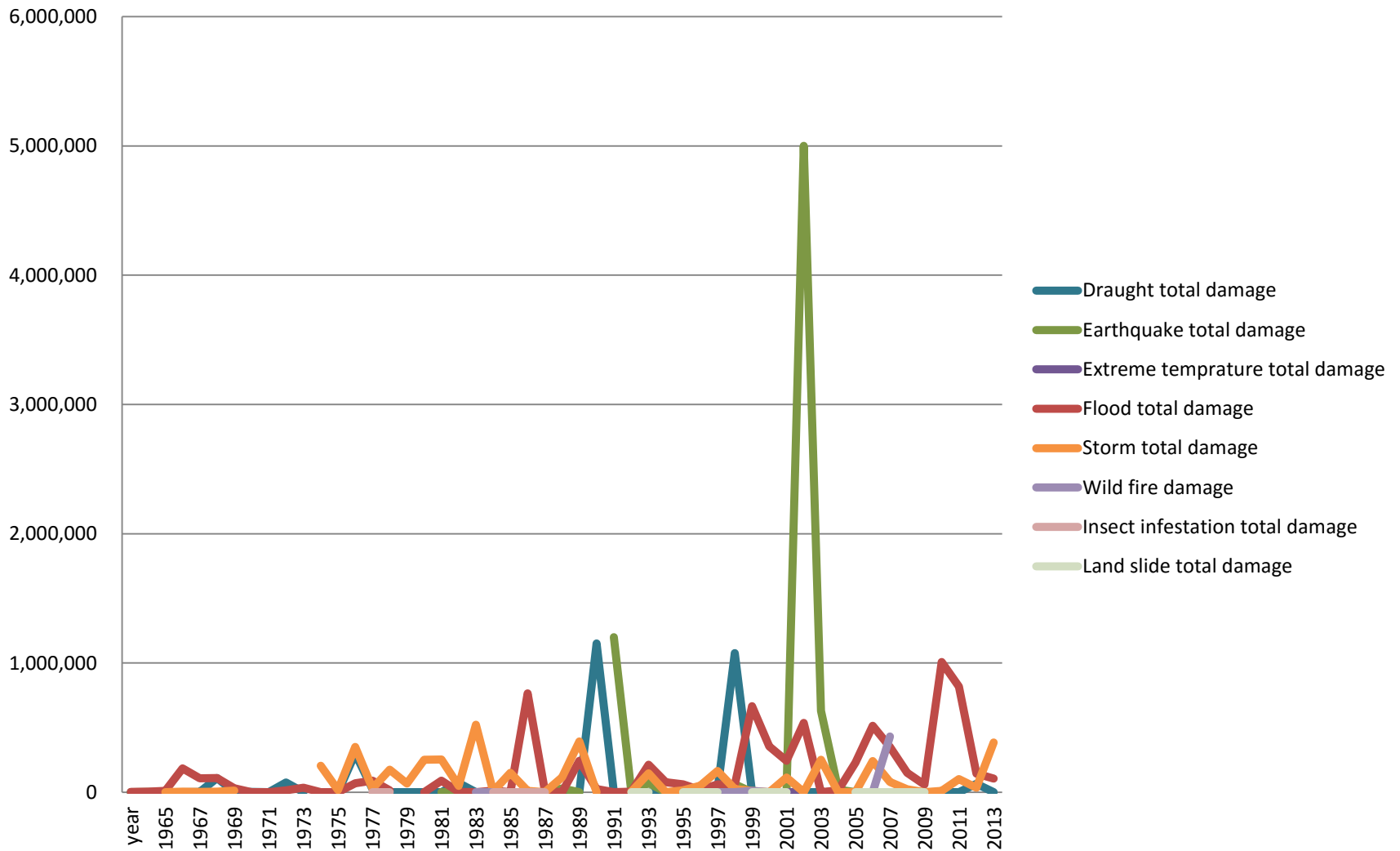
(Source: Author based on EM-DAT date base)

## Total affected persons by natural disasters In Africa (climate-related natural disasters, excluding drought):



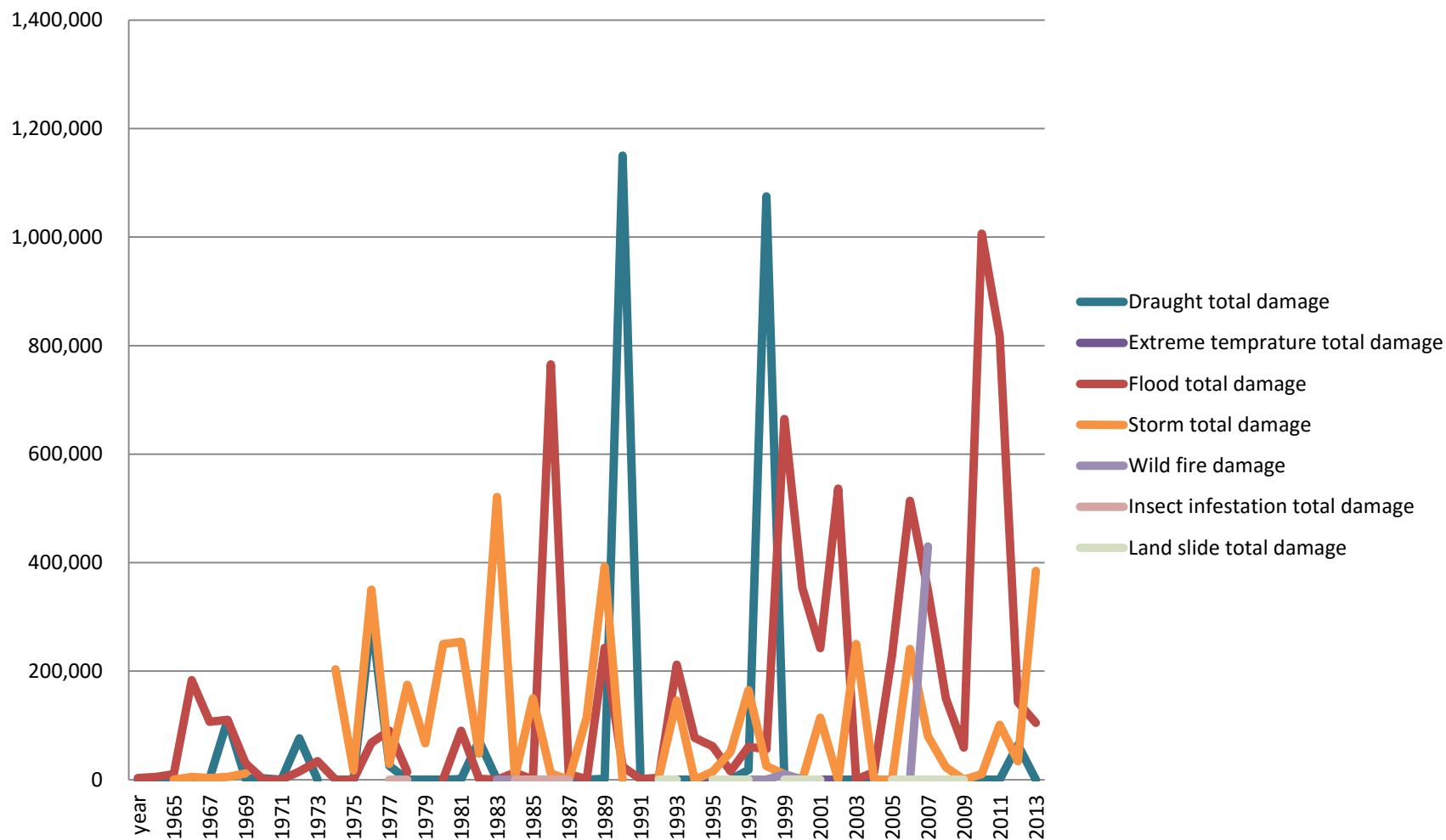
(Source: Author based on EM-DAT date base)

## Total damage (1000 US\$) caused by natural disasters in Africa:



(Source: Author based on EM-DAT date base)

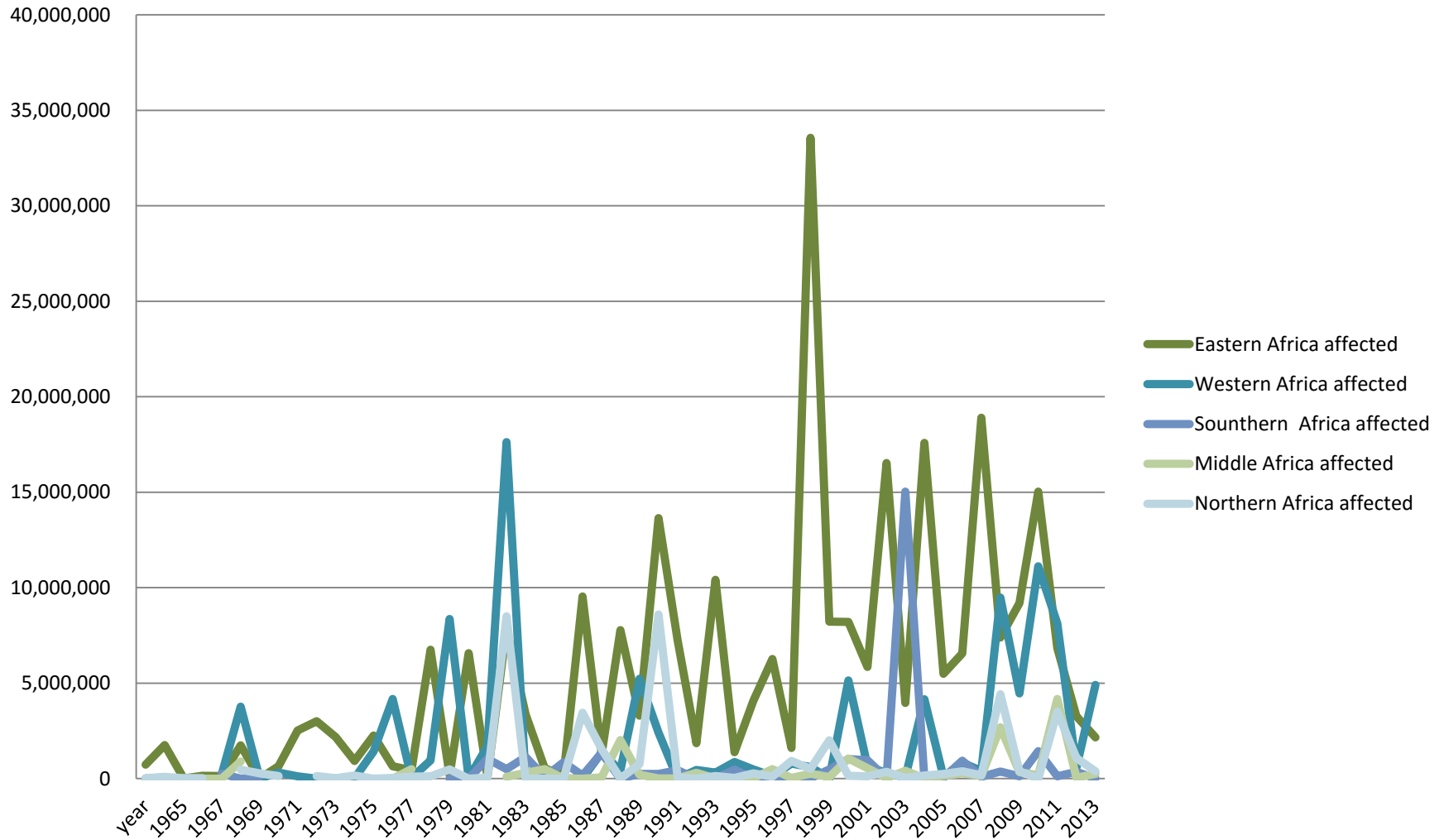
## Total damage (1000 US\$) caused by natural disasters in Africa (other than earthquakes):



(Source: Author based on EM-DAT date base)



## Number of People Affected by Natural Disasters (by Region):



(Source: Author based on EM-DAT date base)

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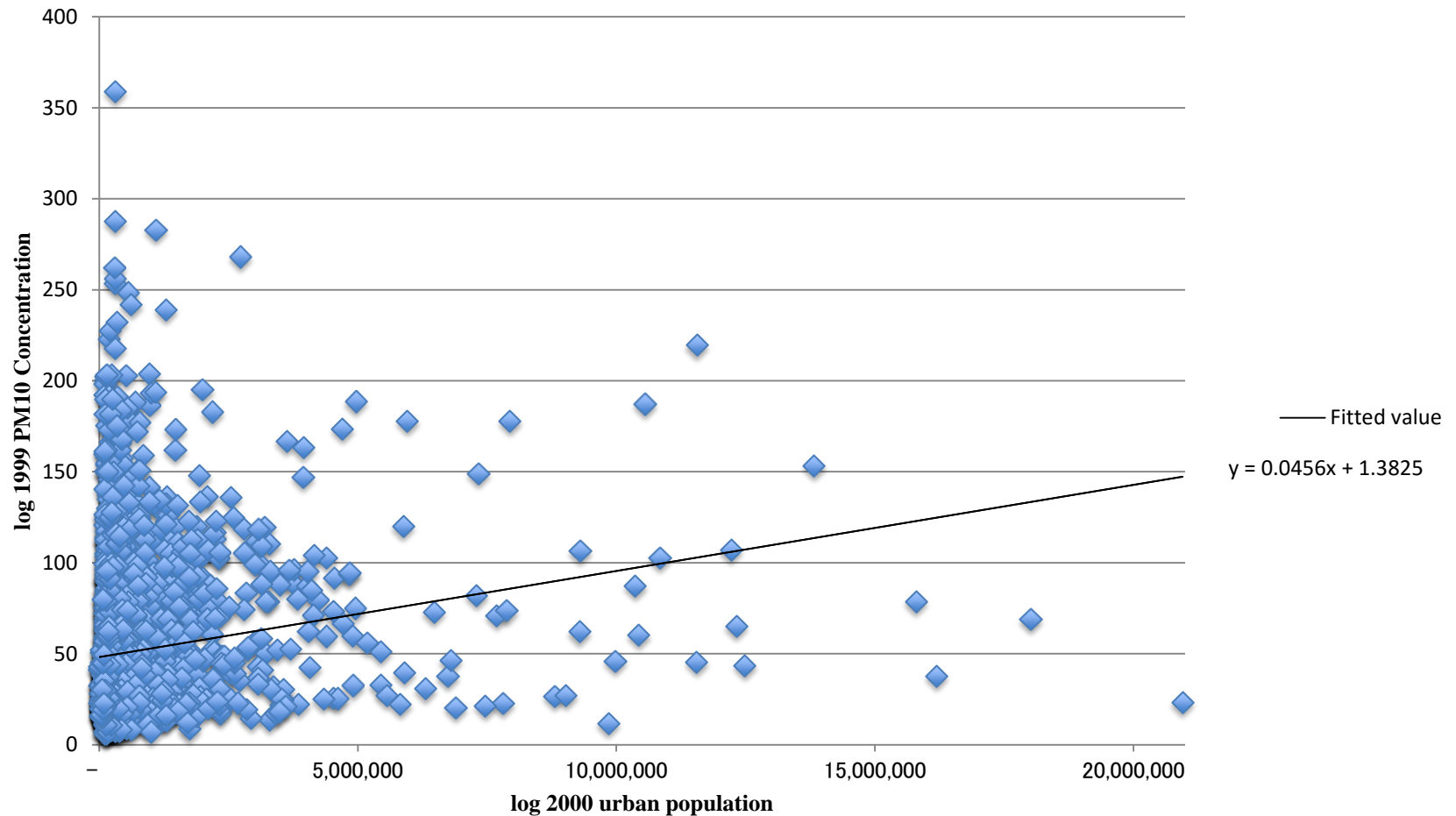
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A scatter plot showing the relationship between 1999 PM10 Concentration (Y-axis, 0 to 400) and 2000 urban population (X-axis, 0 to 20,000,000). The data points are blue diamonds. A black line represents the fitted value, with the equation  $y = 6E-07x + 74.744$  displayed on the plot. The legend indicates 'Fitted value'.

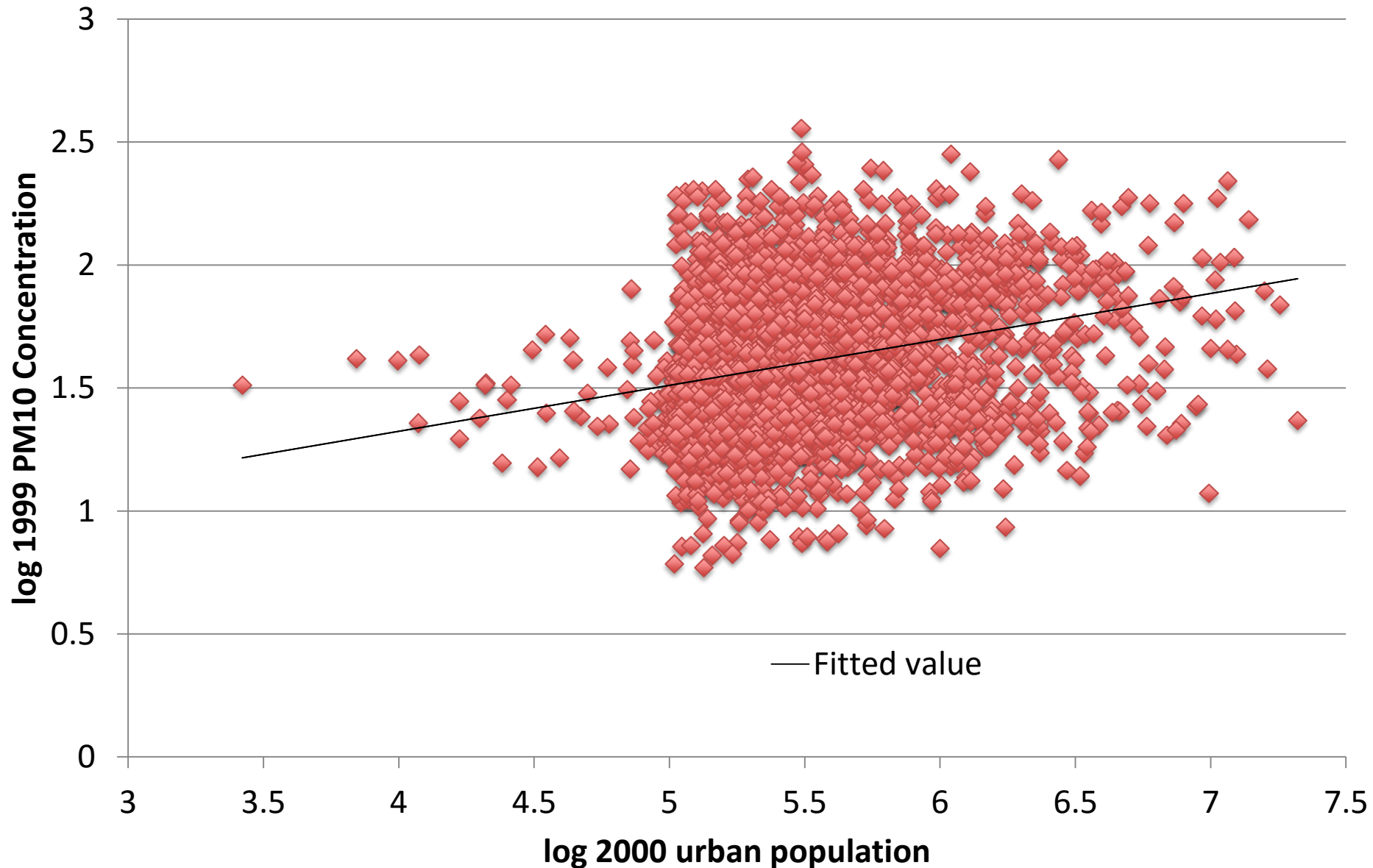
(Source: Author based on Air Pollution in World Cities 2000, PM10 Concentrations Data by Development Economic Research Group, World Bank(1999) [http://microdata.worldbank.org/index.php/catalog/424/get\\_microdata](http://microdata.worldbank.org/index.php/catalog/424/get_microdata)

## Urbanization and PM10 (World 3226 Cities)



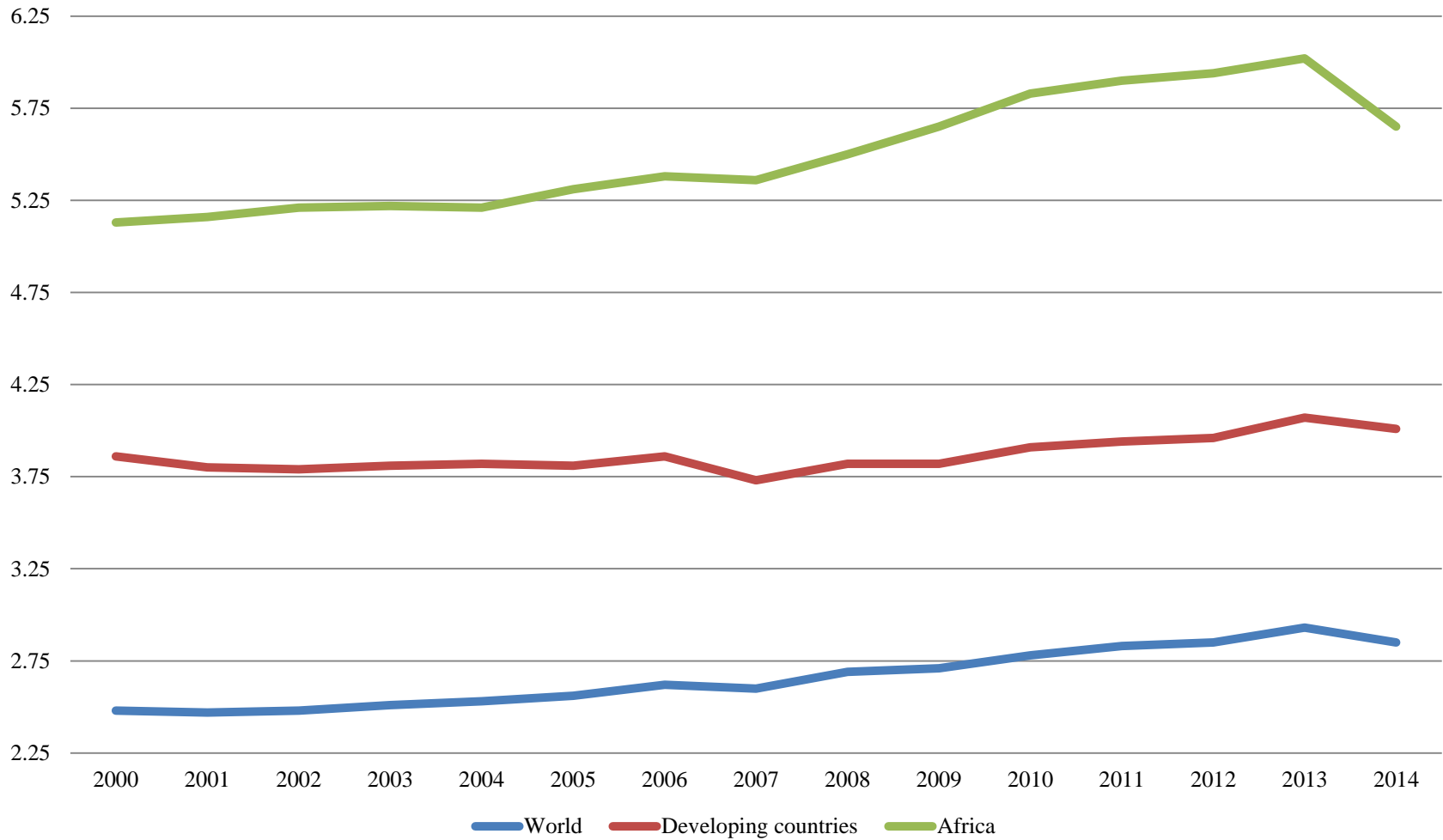
(Source: Author based on Air Pollution in World Cities 2000, PM10 Concentrations Data by Development Economic Research Group, World Bank(1999) [http://microdata.worldbank.org/index.php/catalog/424/get\\_microdata](http://microdata.worldbank.org/index.php/catalog/424/get_microdata))

# Urbanization and PM10 (World 3226 cities)



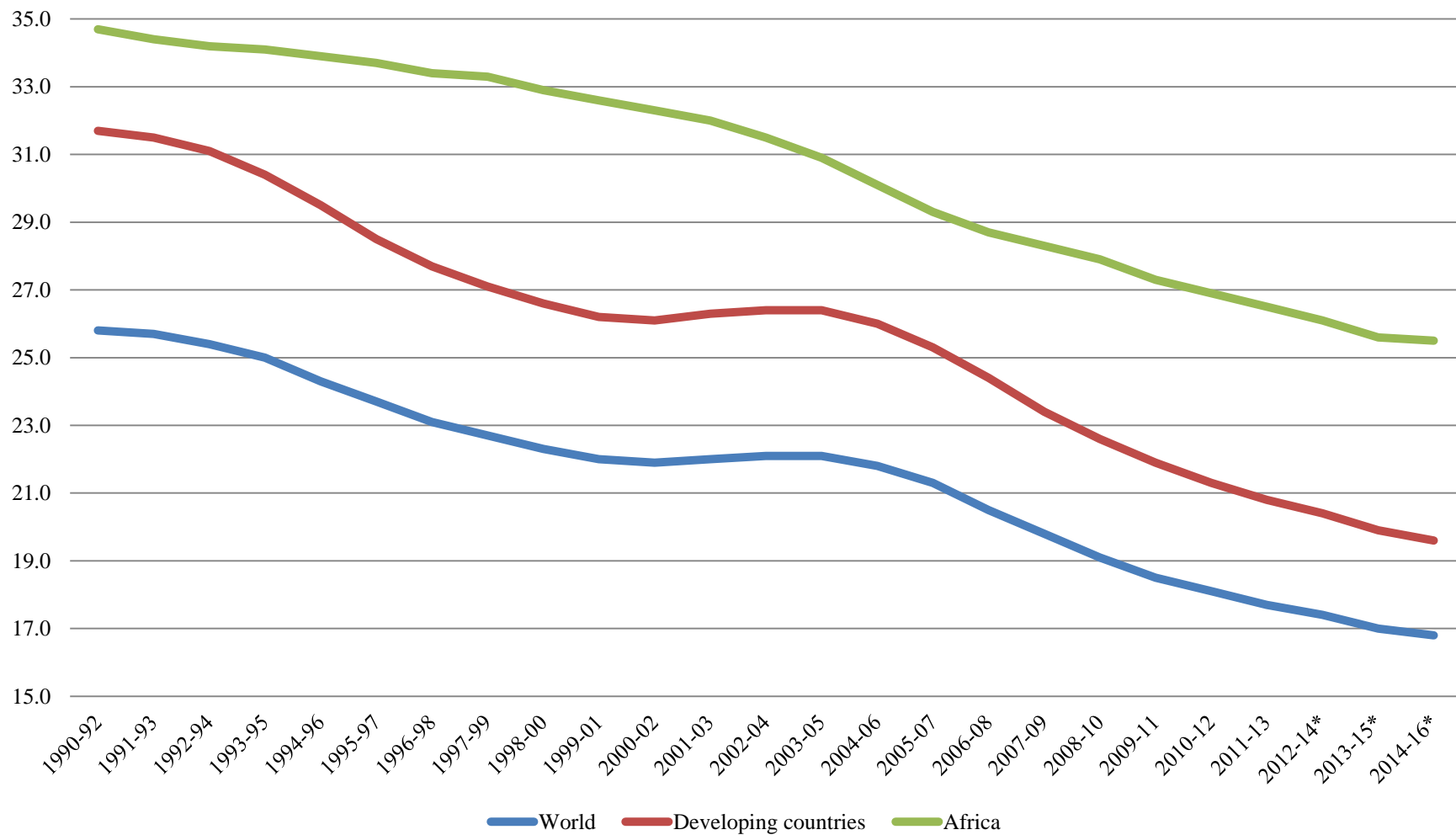
(Source: Author based on Air Pollution in World Cities 2000, PM10 Concentrations Data by Development Economic Research Group, World Bank(1999) [http://microdata.worldbank.org/index.php/catalog/424/get\\_microdata](http://microdata.worldbank.org/index.php/catalog/424/get_microdata))

Figure: Domestic Food Price Level Index



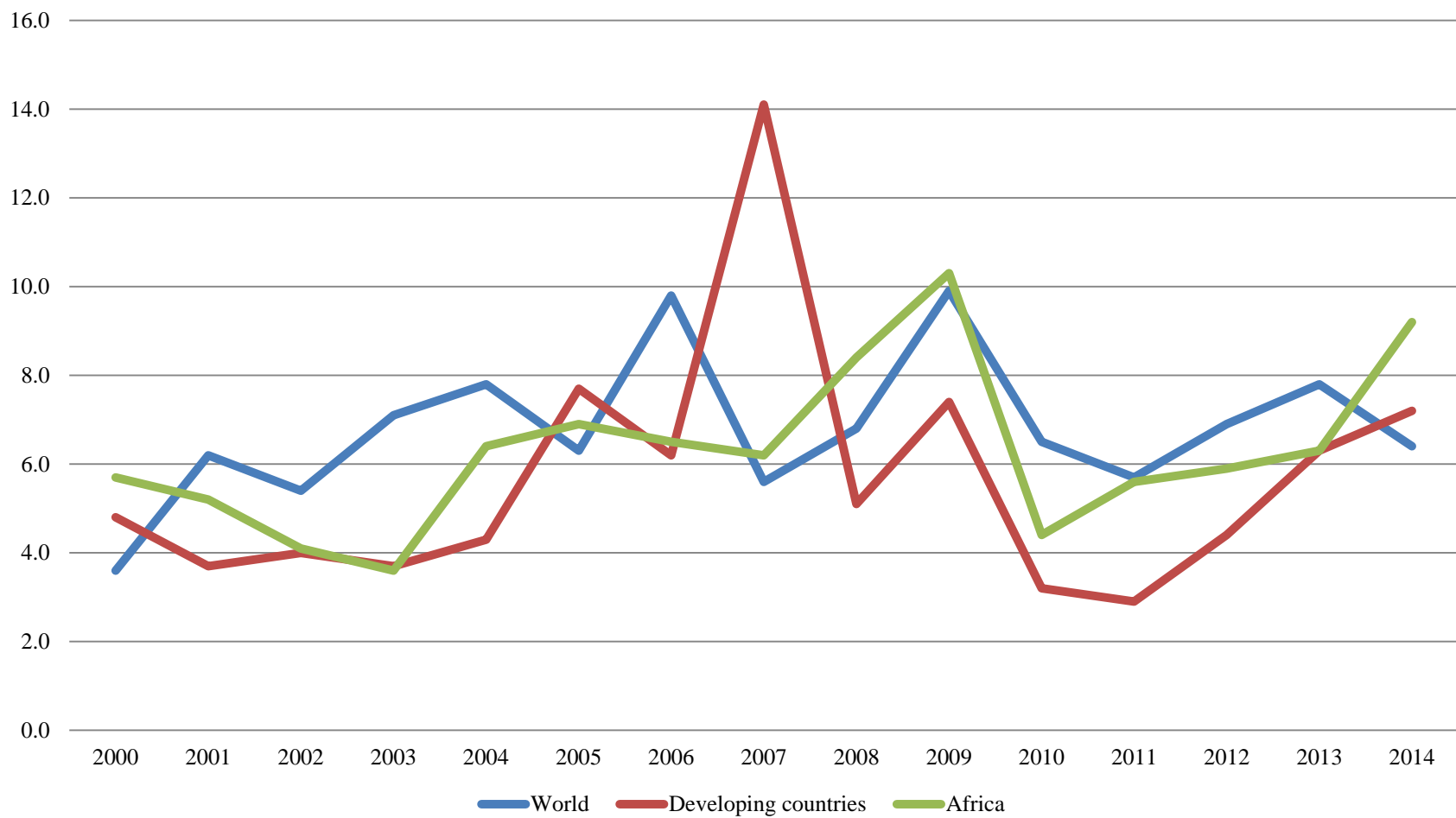
(Source: By the Author, based on FAOSTAT)

Prevalence of Food Inadequacy (Three years average)



(Source: By the Author, based on FAOSTAT)

Domestic Food Price Volatility Index



(Source: By the Author, based on FAOSTAT)