International Institute for Applied Systems Analysis
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science for global insight

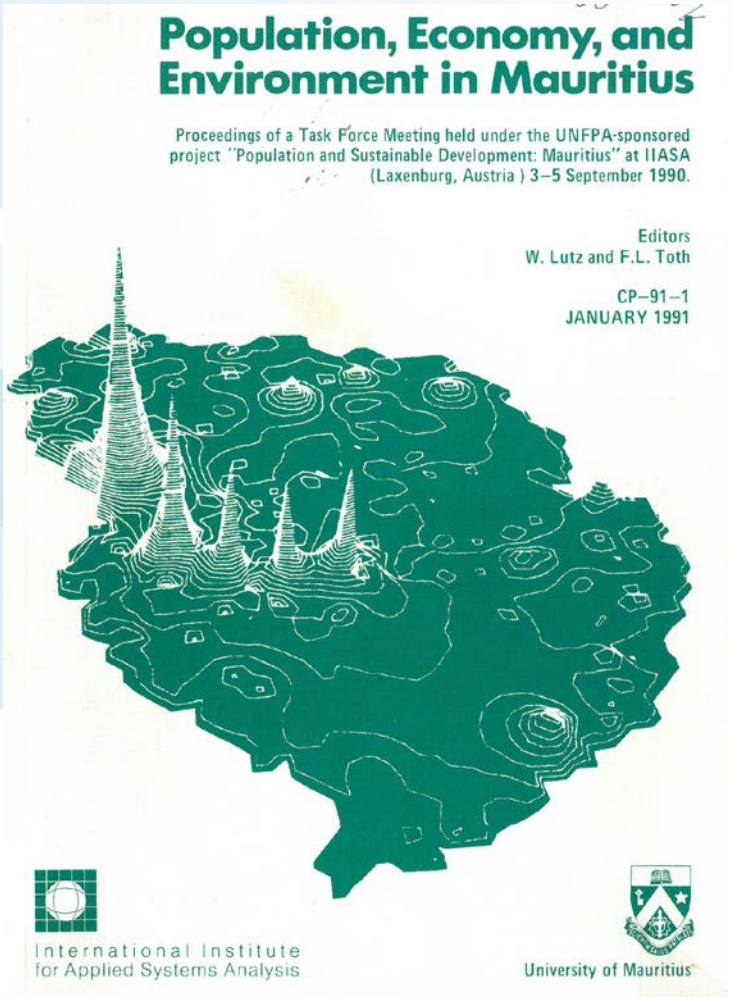
Wittgenstein Centre
FOR DEMOGRAPHY AND GLOBAL HUMAN CAPITAL

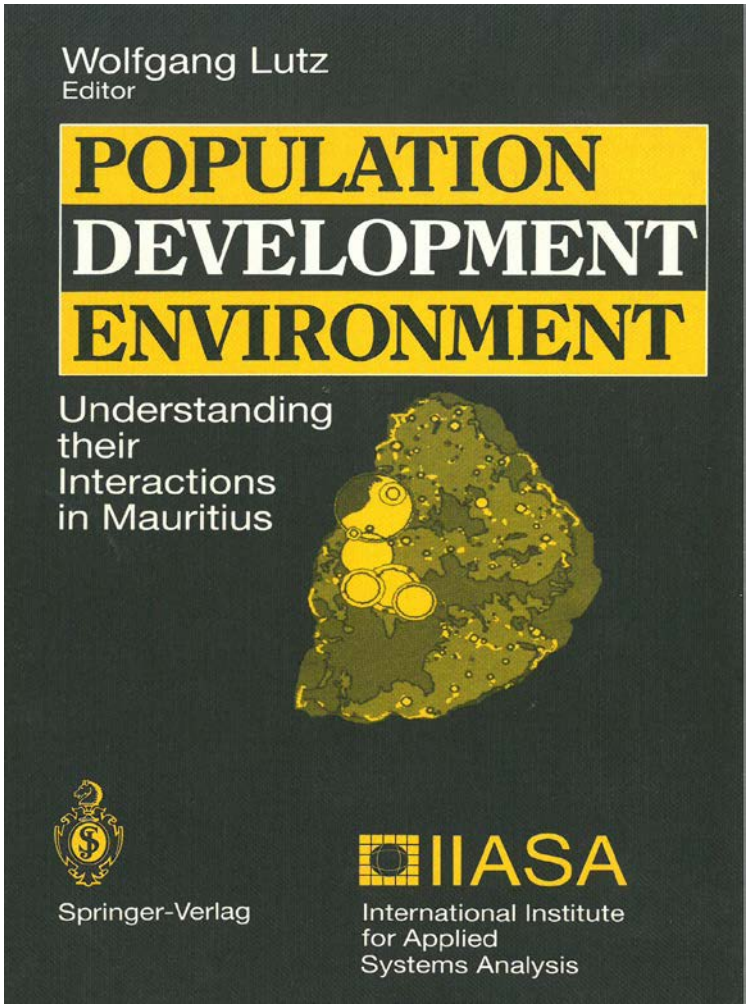
What should be the sustainability criteria in systems models?

Systems Analysis 2015
11 November 2015
IIASA

Wolfgang Lutz
Director, World Population Program

IIASA‘s holistic systems study of a micro-cosmos: Mauritius (1990-94)





How to conceptualize and measure human – environment interactions ?

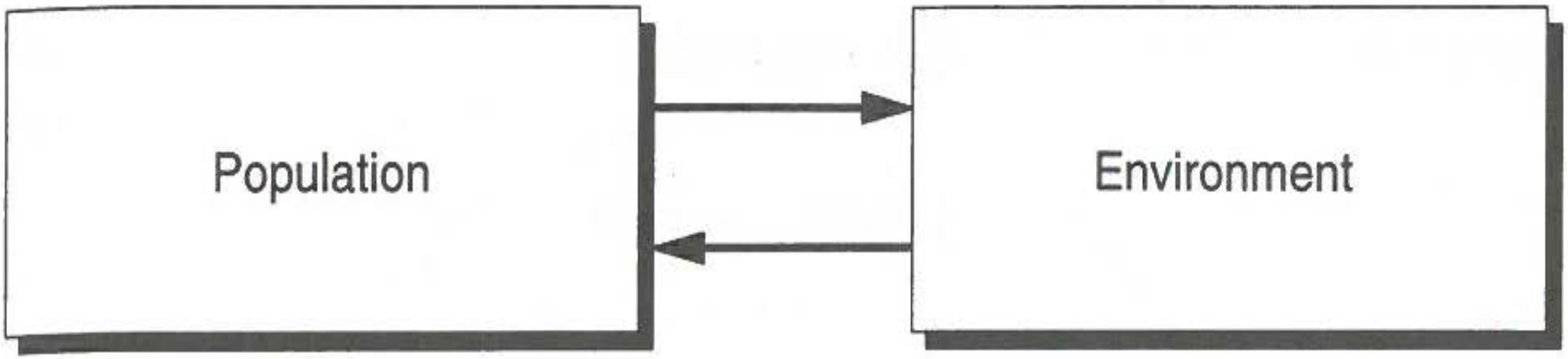


Figure 11.1. The "box approach" to studying population and environment.

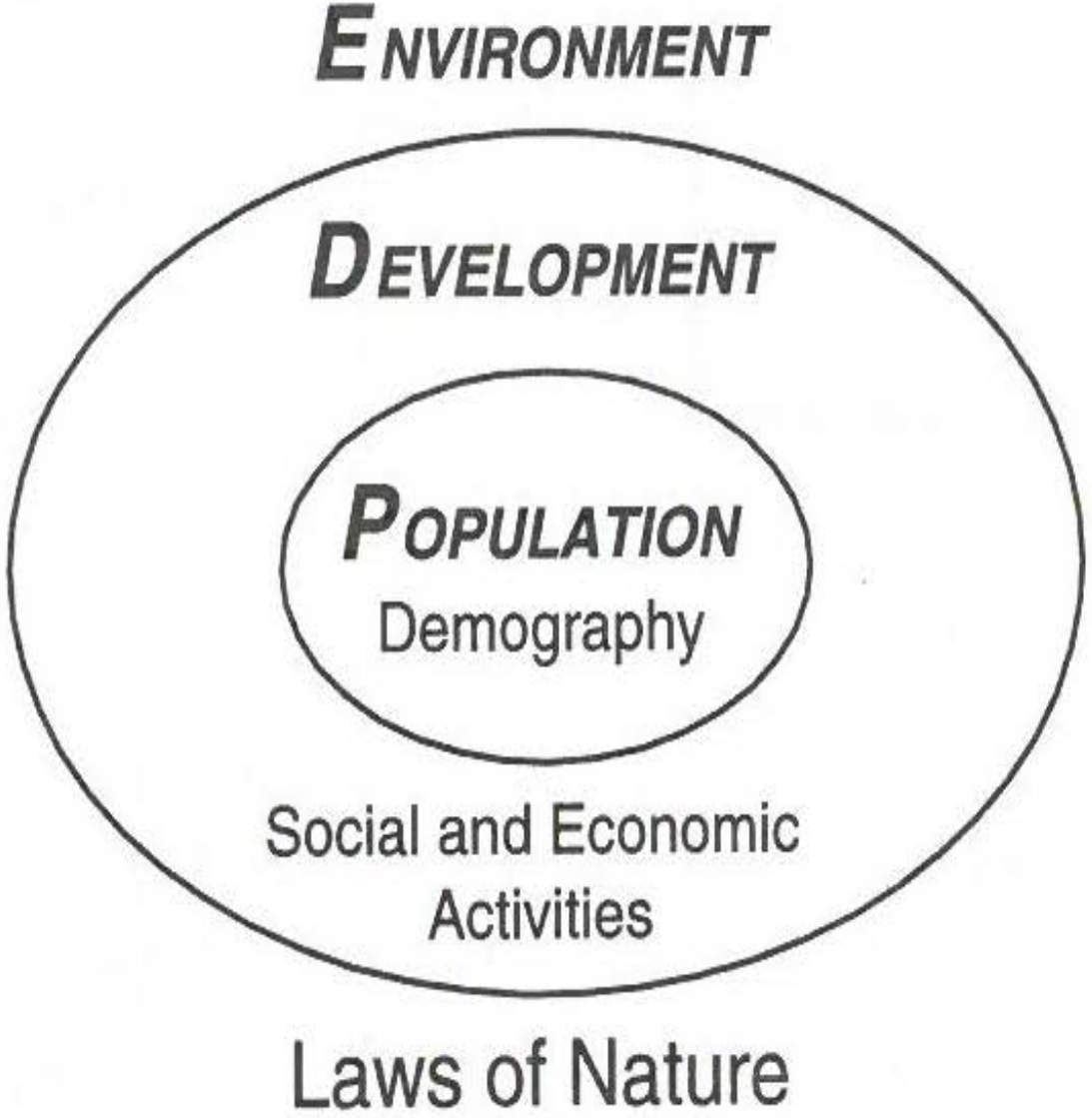


Figure 11.2. Population embedded in a socioeconomic sphere and environment.

FIGURE 1 The human population and the human-made infrastructure as being fully embedded in the natural environment and subject to the laws of nature. P–E studies may analyze certain sectors (see dotted lines) or try to comprehensively study the full system.

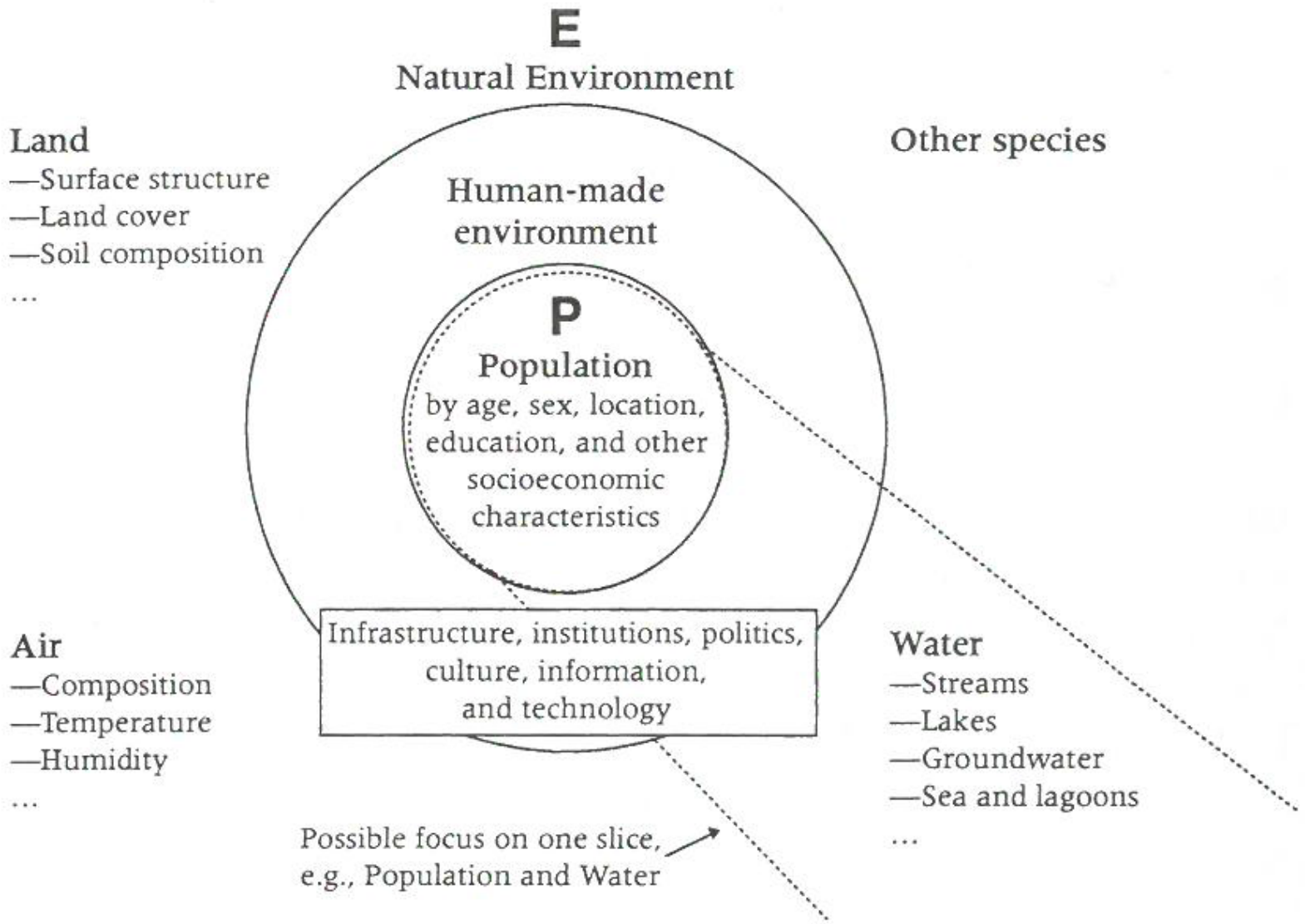
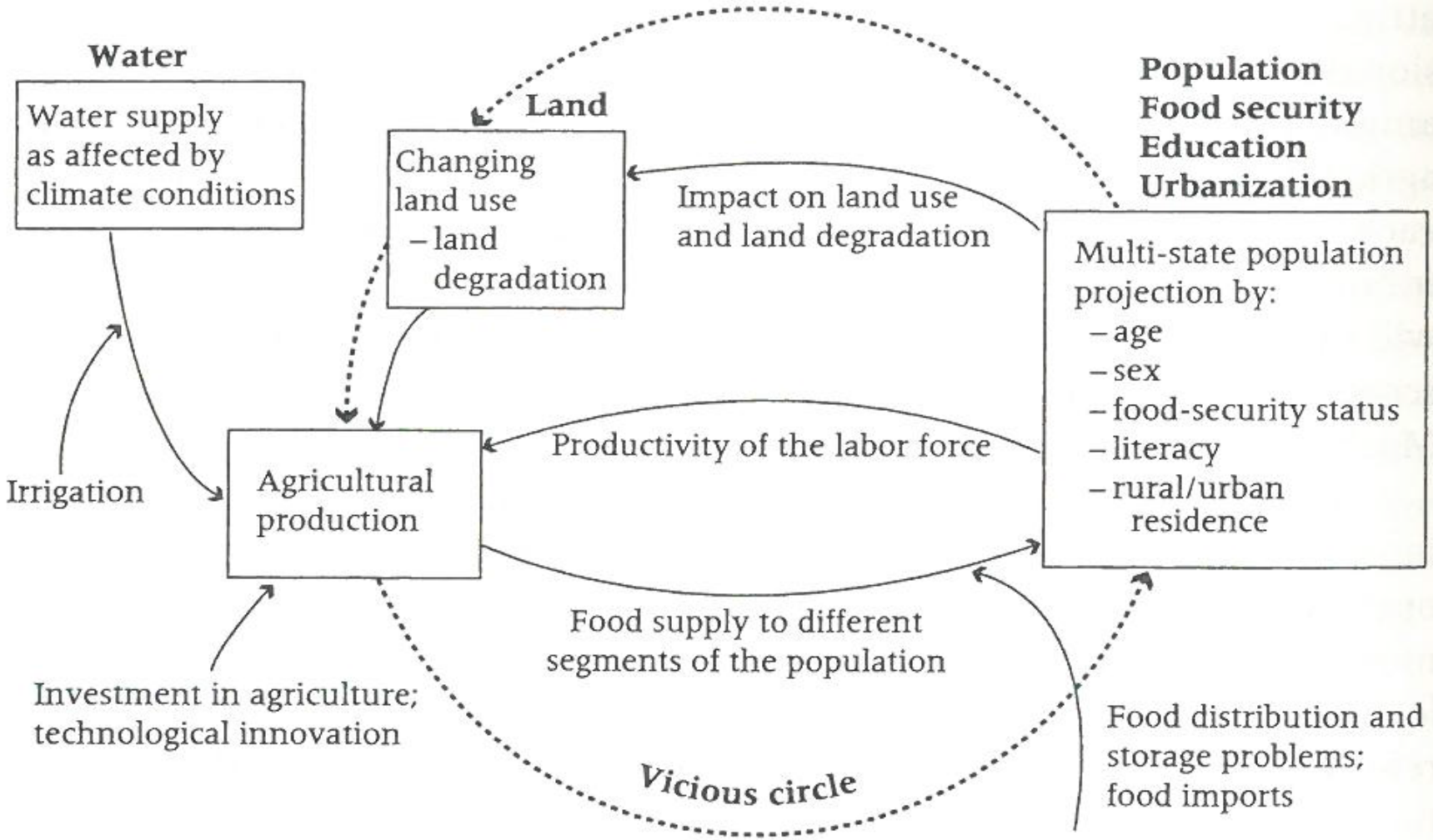
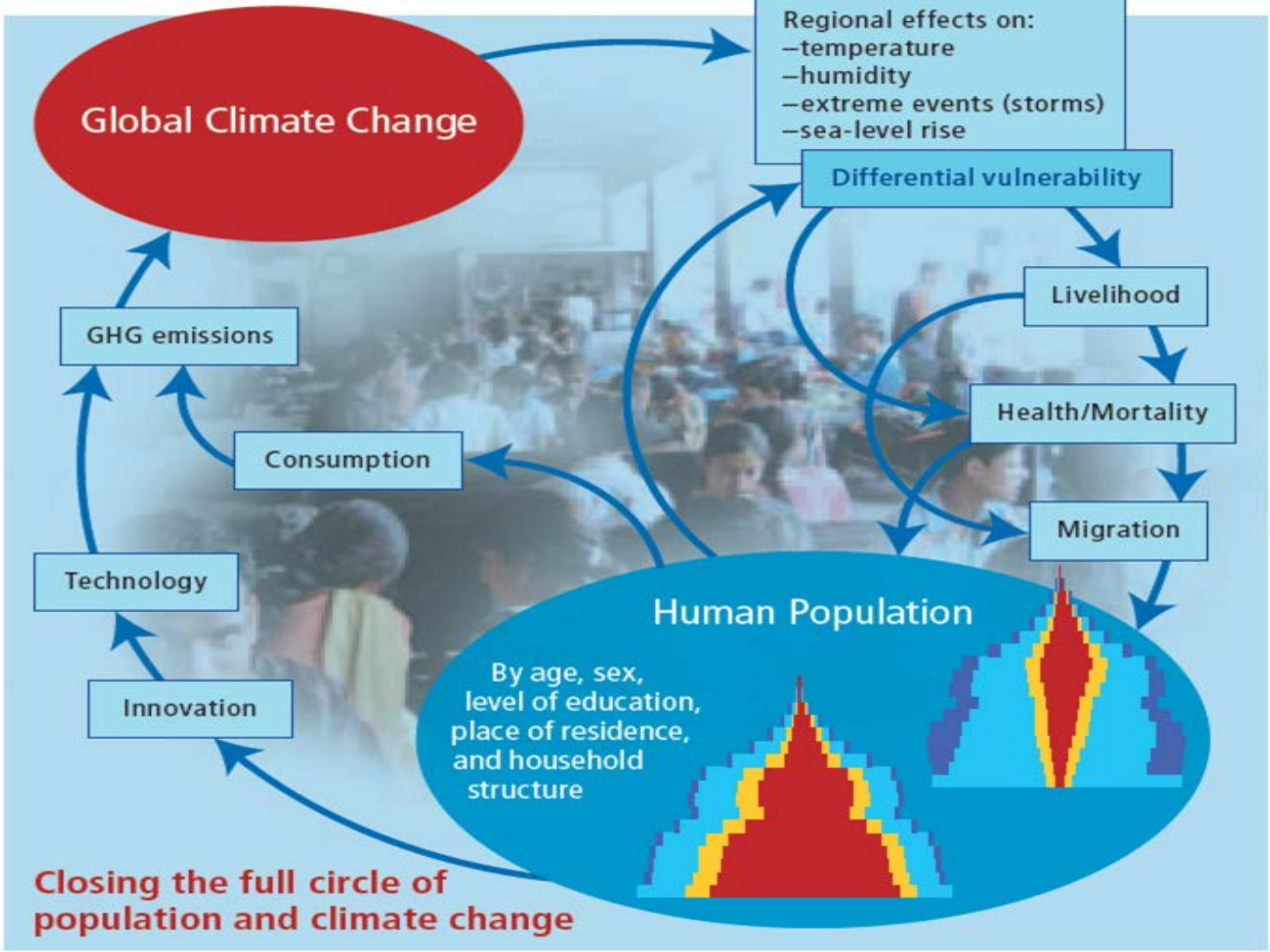


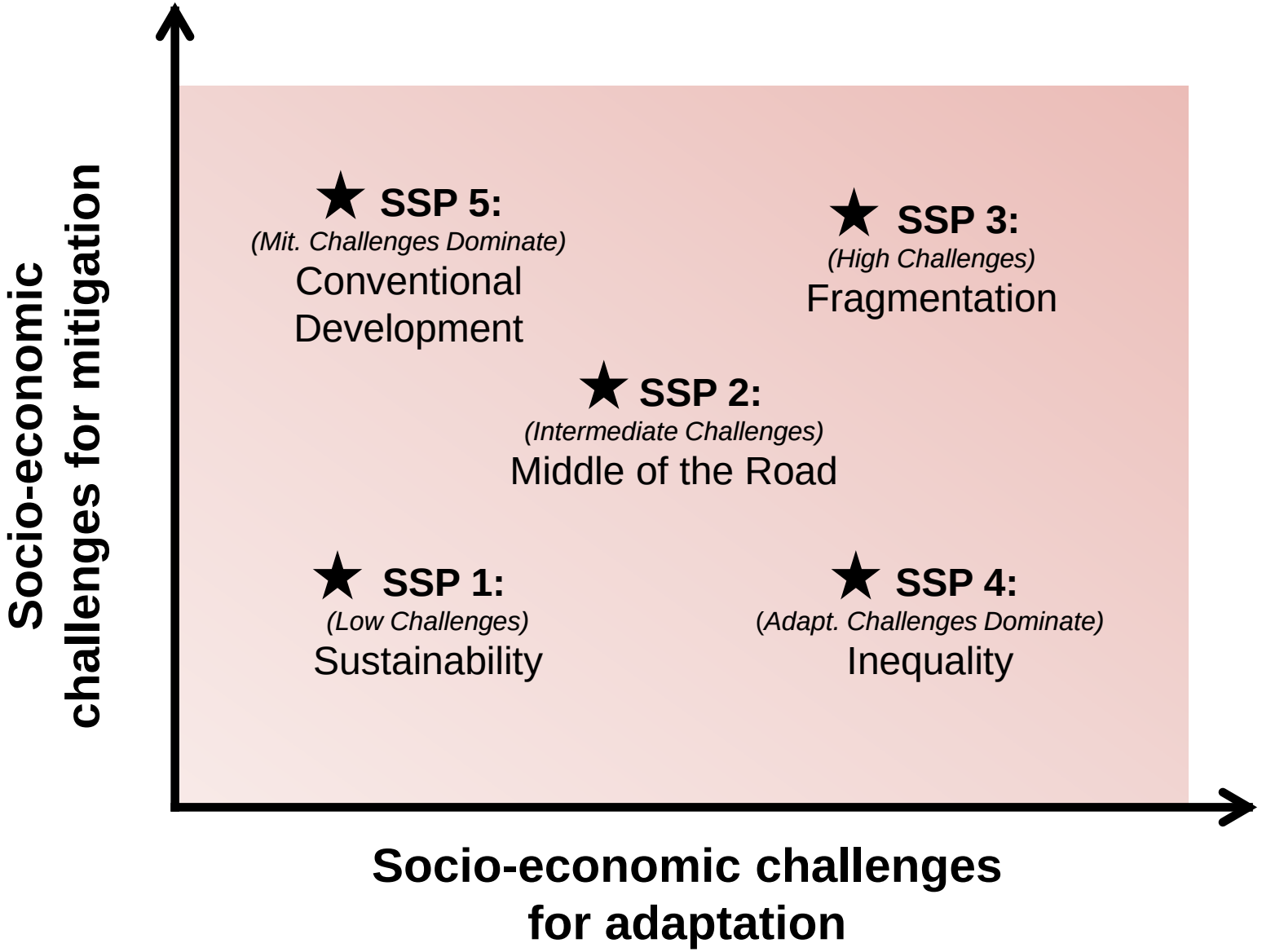
FIGURE 1 Basic structure of the PEDA model linking population, food security, and the environment in Africa



NOTE: In a vicious circle, high population growth of the rural food-insecure population contributes to degradation of marginal lands. This decreases agricultural production, which in turn increases the number of food-insecure persons.


Global Climate Change
Regional effects on:
–temperature
–humidity
–extreme events (storms)
–sea-level rise
Differential vulnerability
Livelihood
Health/Mortality
Migration
Human Population
By age, sex, level of education, place of residence, and household structure
Innovation
Technology
GHG emissions
Consumption
Closing the full circle of population and climate change

Shared Socioeconomic Pathways (SSP) Logic



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EXECUTIVE SUMMARY

WORLD POPULATION & HUMAN CAPITAL IN THE TWENTY-FIRST CENTURY

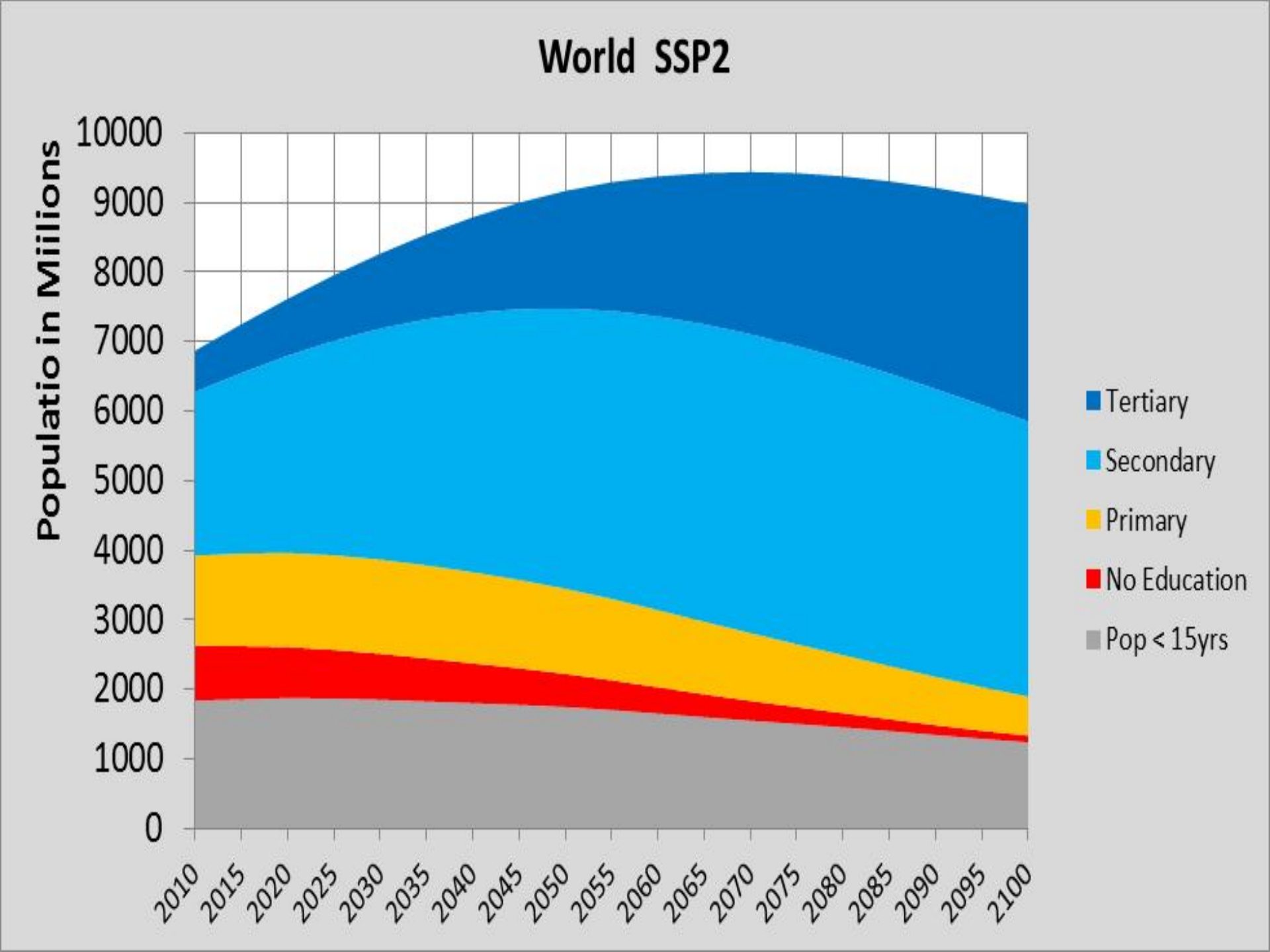
EDITED BY
WOLFGANG LUTZ | WILLIAM P. BUTZ | SAMIR KC

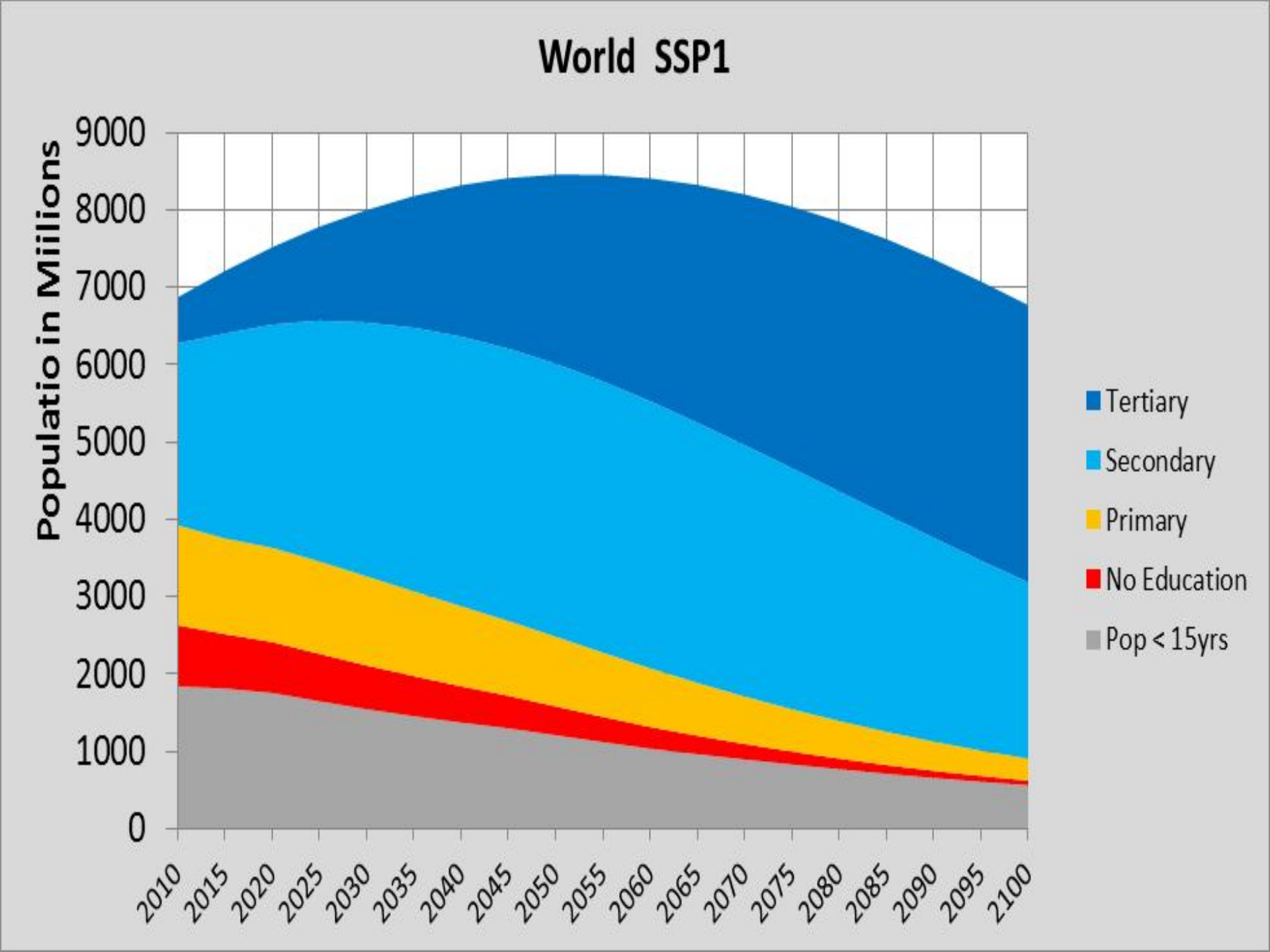
DEDICATED TO THE MEMORY OF NATHAN KEYFITZ ON THE OCCASION OF HIS 100TH BIRTH YEAR, 2013.

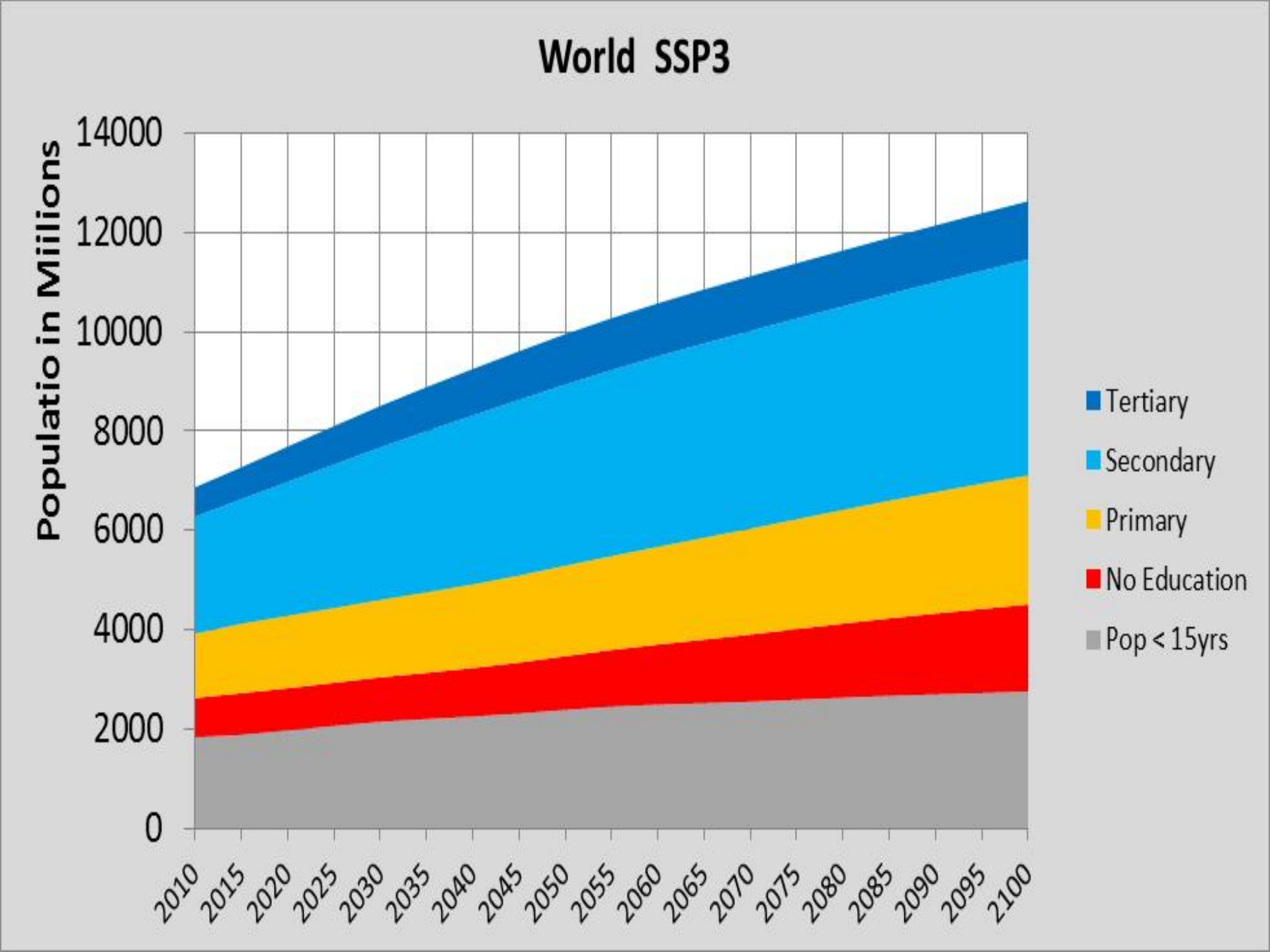
Oxford University Press

2014

1056 pages,
26 lead authors,
46 contributing authors,
550 expert assessments,
191 country tables


World SSP2
Populatio in Miilions
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
2065
2070
2075
2080
2085
2090
2095
2100
Tertiary
Secondary
Primary
No Education
Pop < 15yrs


World SSP1
Populatio in Miilions
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
2065
2070
2075
2080
2085
2090
2095
2100
Tertiary
Secondary
Primary
No Education
Pop < 15yrs


World SSP3
Populatio in Miilions
14000
12000
10000
8000
6000
4000
2000
0
2010
2015
2020
2025
2030
2035
2040
2045
2050
2055
2060
2065
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2075
2080
2085
2090
2095
2100
Tertiary
Secondary
Primary
No Education
Pop < 15yrs

Special Feature

IIASA RP-14-001 • March 2014

Education and Differential Vulnerability to Natural Disasters

Guest Editors: William P. Butz, Wolfgang Lutz, Jan Sendzimir
Managing Editor: Stefanie Andruchowitz

Ecology and Society

F&S

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ENVIRONMENT AND DEVELOPMENT

Universal education is key to enhanced climate adaptation

Fund more educators rather than just engineers

By **Wolfgang Lutz, Raya Muttarak, Erich Striessnig***

Over the coming years, enormous amounts of money will likely be spent on adaptation to climate change. The international community recently made pledges of up to $100 billion per year by 2020 for the Green Climate Fund. Judging from such climate finance to date, funding for large proj-

the best available information on the number of disasters and reported fatalities from around the world (*5*).

EDUCATE FEMALES, REDUCE FATALITIES. Because the literature on disaster vulnerability has conventionally emphasized economic growth while disregarding education, our statistical analysis focuses on the relative assessment of these two factors as measured by Gross Domestic Product (GDP)

When is adaptation successful?
What are the criteria for sustainability in systems models?

- Different people have different values and preferences and views about what is desirable.
- Does this mean that there cannot be any broadly agreed criteria of what is a desirable development and what is to be avoided? Is complete relativism the only option?
- Alternatively, one can confine the criteria to the basics: Survival, i.e. being alive, is undisputably a basic prerequisite for enjoying any quality of life.
- But mere survival is mostly not considered enough. For this reason I propose an indicator called Empowered Life Years (ELY).

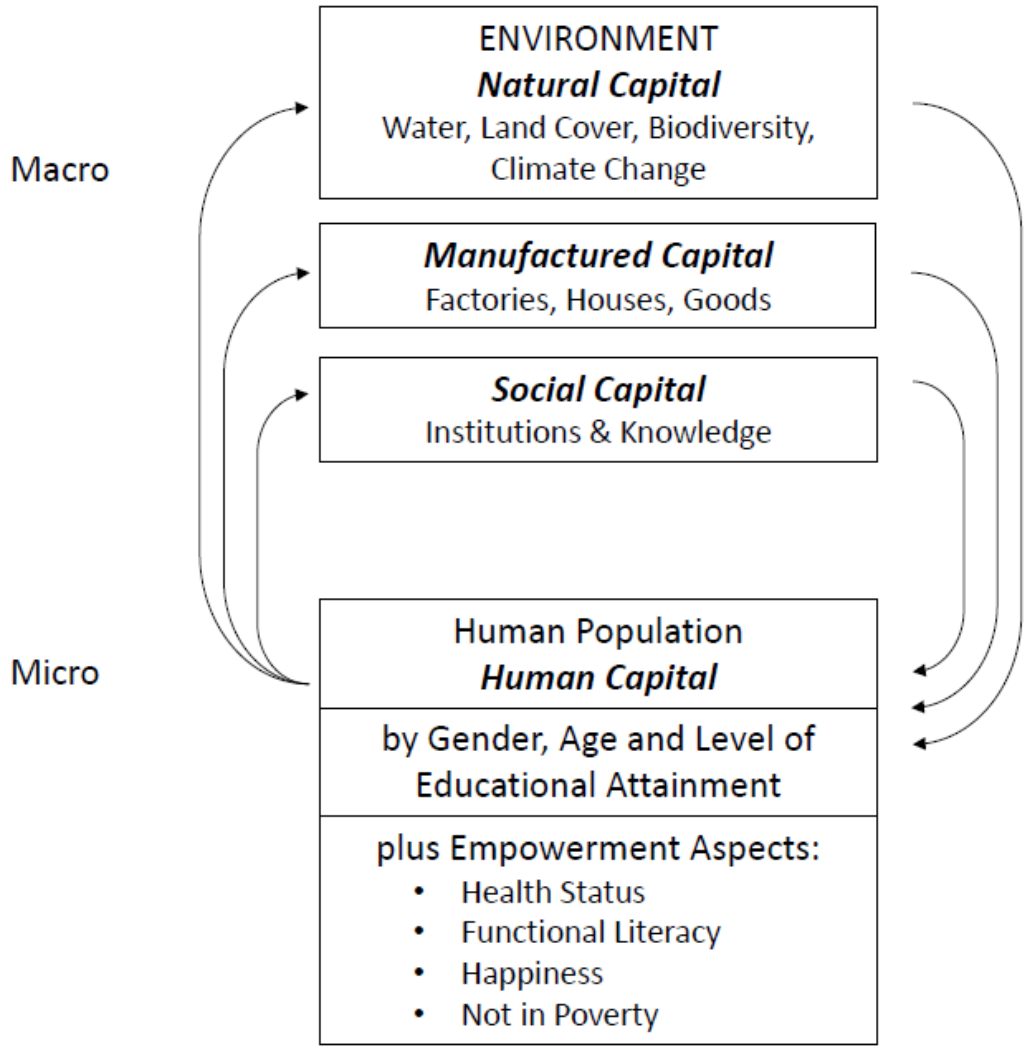
Bill Clark on Sustainability Science at IIASA Conference 2012

- Formalizing Brundtland's "meet the needs…":

$$W = f(C_i, I, K)$$

- W is 'human well-being' (intra- and inter-generational)
- C_i are 'Capital assets' (from which services flow)
  - C_m is 'manufactured capital' (factories, homes, roads)
  - C_h is 'human capital' (population, health, education)
  - C_n is 'natural capital' (ecosystems and their services)
- I is 'Institutions' (laws, rules; norms, expectations)
- K is 'knowledge' (scientific, practical; innovation)
- Challenge:
  - Measure, evaluate sustainability of "alternative worlds"

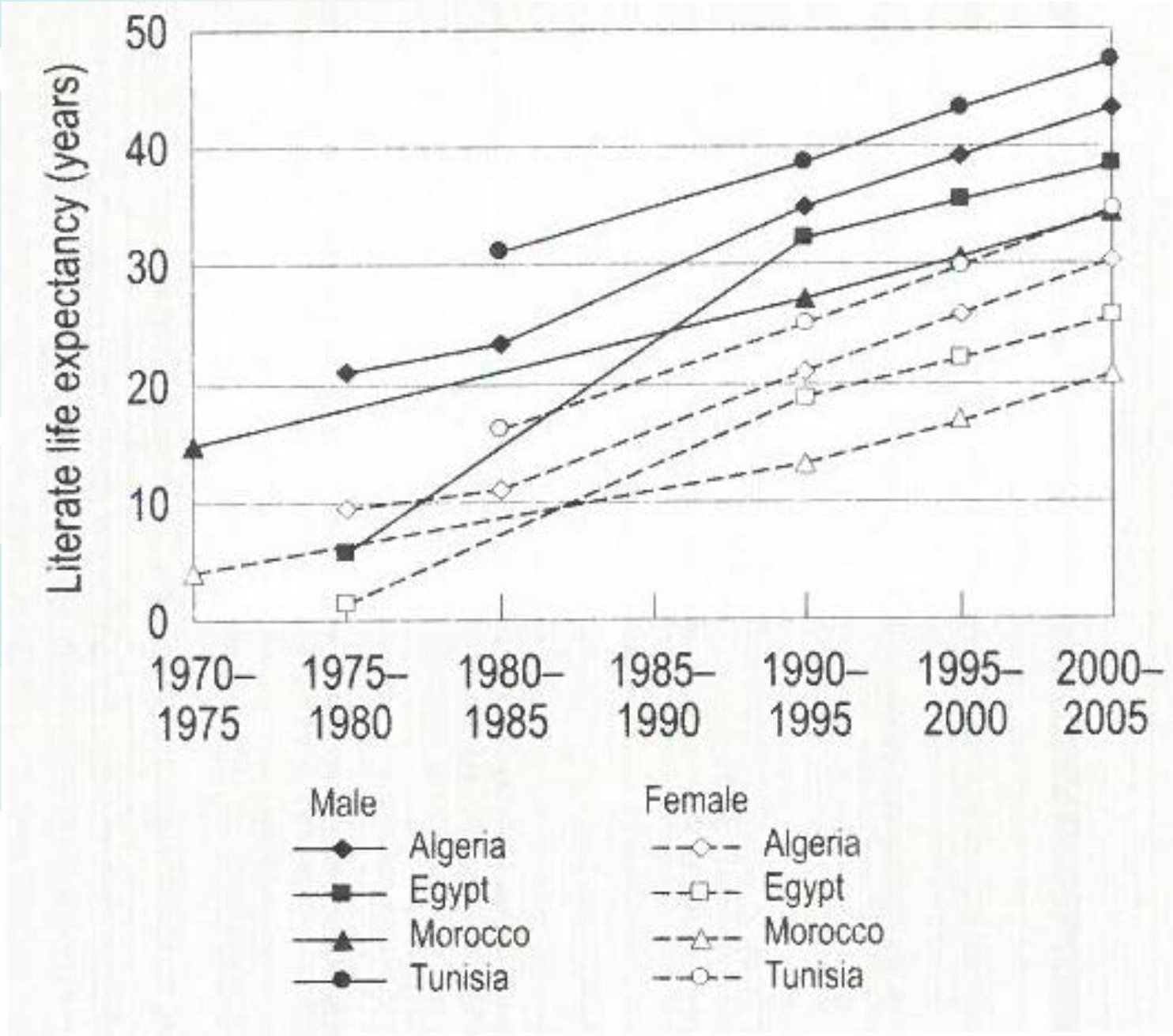
Putting Clark‘s Sustainability Science model to work

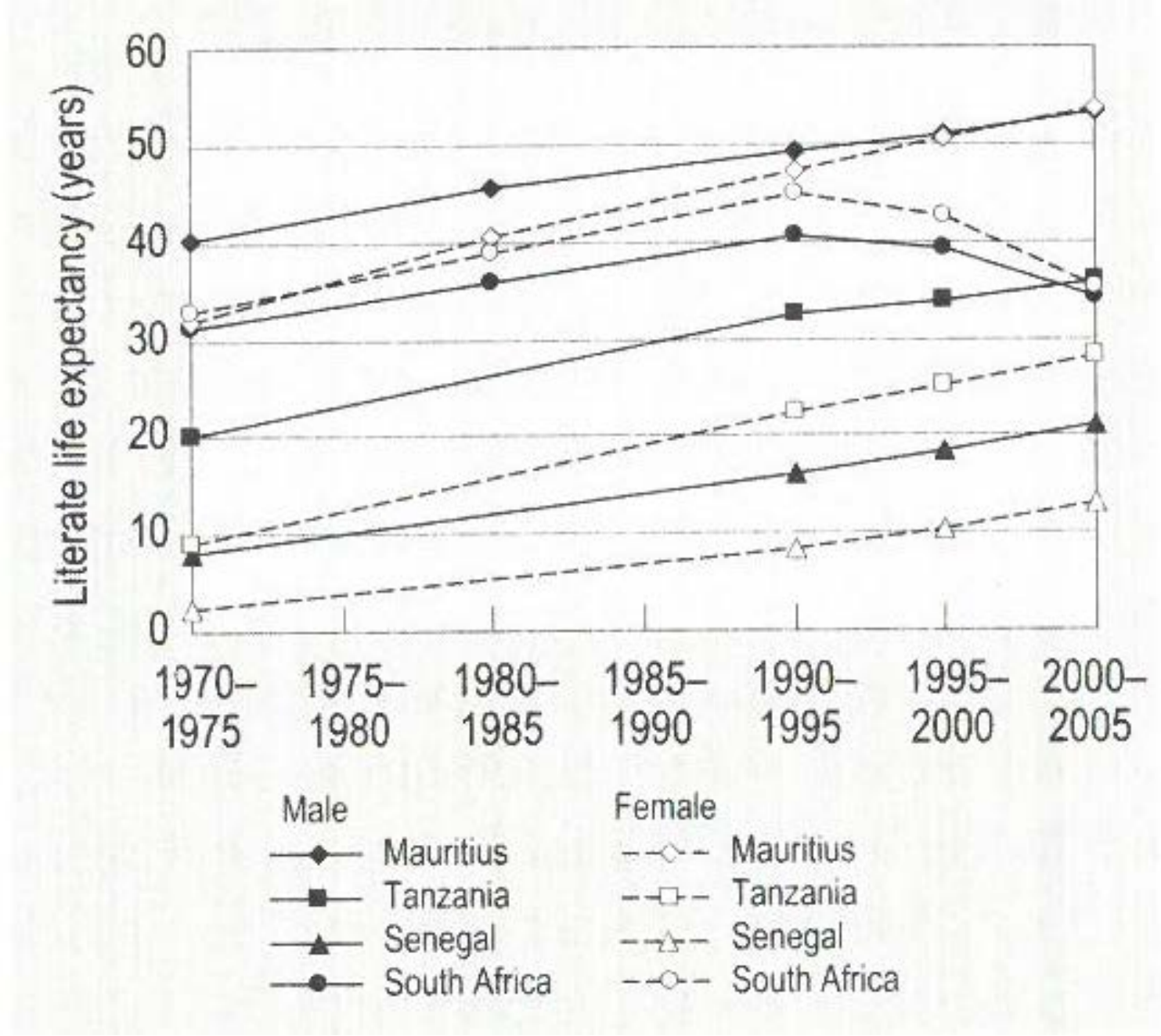


Literate Life Expectancy: Years a person is expected to be alive and able to read.
Example of men in rural Egypt 1986

Age (years)	Regular life table				Literate life table			
	m_x	l_x	L_x	e_x^0	PL_x	LL_x	LT_x	Le_x^0
<1	1.041	100,000	93,340	58.60	0.00	0	2,382,889	23.8
1–4	0.081	90,105	353,413	64.00	0.00	0	2,382,889	26.4
5–9	0.017	87,232	434,130	62.06	0.42	183,203	2,382,889	27.3
10–14	0.010	86,494	431,434	57.57	0.84	364,130	2,199,686	25.4
15–19	0.012	86,062	429,077	52.84	0.68	290,485	1,835,556	21.3
20–24	0.017	85,548	426,000	48.15	0.78	333,558	1,545,071	18.1
25–29	0.021	84,824	421,991	43.54	0.48	202,978	1,211,513	14.3
30–34	0.027	83,938	416,986	38.97	0.48	200,570	1,008,535	12.0
35–39	0.032	82,812	410,905	34.46	0.38	156,966	807,964	9.8
40–44	0.035	81,498	404,094	29.98	0.38	154,364	650,999	8.0
45–49	0.069	80,084	393,900	25.46	0.30	118,170	496,635	6.2
50–54	0.121	77,368	375,934	21.26	0.30	112,780	378,465	4.9
55–59	0.240	72,824	344,335	17.43	0.25	85,051	265,684	3.6
60–64	0.252	64,580	304,529	14.32	0.25	75,219	180,633	2.8
65–69	0.572	56,925	250,441	10.89	0.20	50,088	105,415	1.9
70–74	0.682	42,681	183,565	8.66	0.20	36,713	55,327	1.3
75+	1.625	30,247	186,136	6.15	0.10	18,614	18,614	0.6

Source: Lutz (1994/95)


Literate life expectancy (years)
50
40
30
20
10
0
1970–1975
1975–1980
1980–1985
1985–1990
1990–1995
1995–2000
2000–2005
Male
Algeria
Egypt
Morocco
Tunisia
Female
Algeria
Egypt
Morocco
Tunisia


Literate life expectancy (years)
60
50
40
30
20
10
0
1970–1975
1975–1980
1980–1985
1985–1990
1990–1995
1995–2000
2000–2005
Male
Mauritius
Tanzania
Senegal
South Africa
Female
Mauritius
Tanzania
Senegal
South Africa

Possible further dimensions of ELY (Empowered Life Years)

- Healthy life expectancy
- Out-of-poverty life expectancy
- Happy life expectancy

….. or a combination of them

Possible criterion: Indicator should not decline over time in any sub-population.

This is work in progress. The choice of sustainability indicator will also depend on the ability to model the feed-backs from changes in the rest of the system onto the indicator.