Socioeconomic information in climate impact, vulnerability, and adaptation assessment for human health

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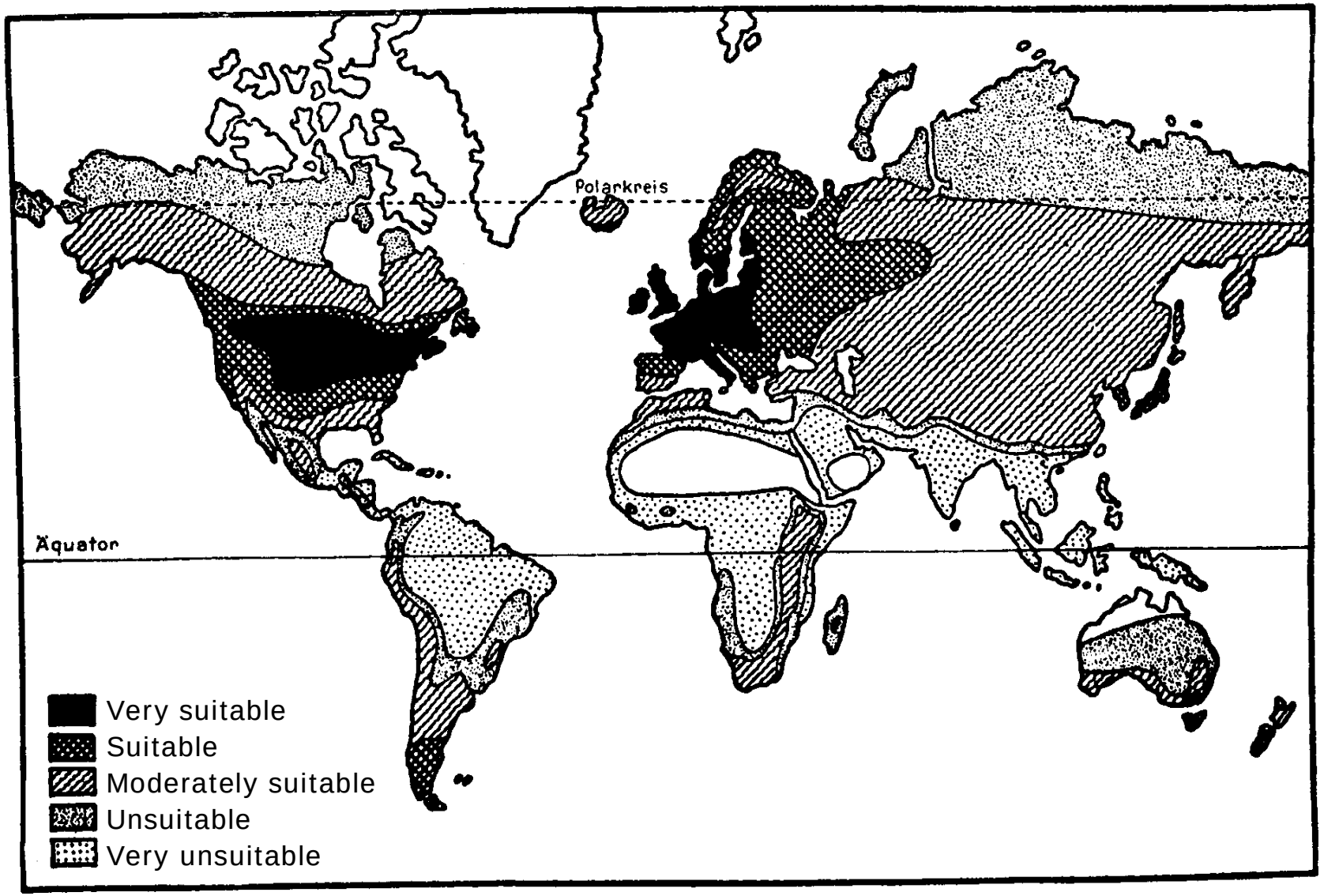
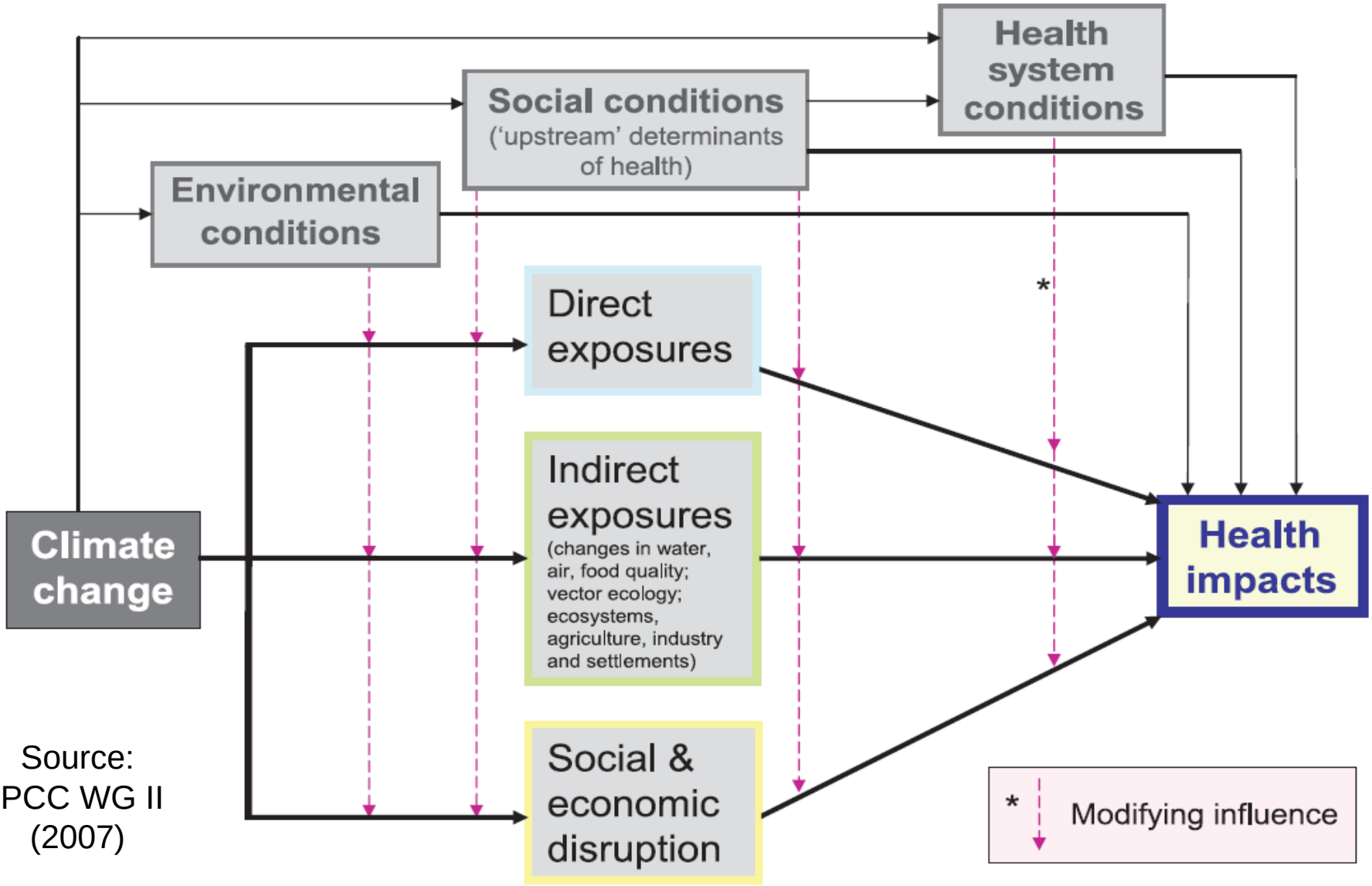
“Human health is largely determined by climate”



Source: Henry Chapin & F.G. Walton Smith: *The Ocean River*, 1952

Climate-health relationship



Source:
IPCC WG II
(2007)

Climate change and human health

- Diverse range of climate-sensitive health risks (e.g., heat stress, extreme weather events, vector/water-borne diseases, malnutrition, allergies)
- Complex relationships between climate and health
- Strong influence of non-climatic factors (e.g., environmental, socio-economic, behavioural)
- Large uncertainty about future risk levels
- Separation between first-order (biophysical) and second-order (social) impacts not possible
- Health is already strongly managed
- Diverse actors involved in health risk reduction: public & environmental health, natural hazards, urban & spatial planning, housing, agriculture, etc.

Methods to assess future health effects

1. **Process-based models**
   - limited consideration of socio-econ. information
   - less importance compared to other impact domains (e.g., agriculture, ecosystems, coasts)
2. **Empirical-statistical models**
   - based on epidemiological information
   - distinction between different population groups
3. **Geographical or historical analogues**
   - include socio-economic information implicitly
4. **Expert judgement**
   - considers broad range of information, including available socio-economic information

Guidelines for assessments of climate impacts and adaptation

Evaluation of assessment guidelines

Source:
Füssel (2008)

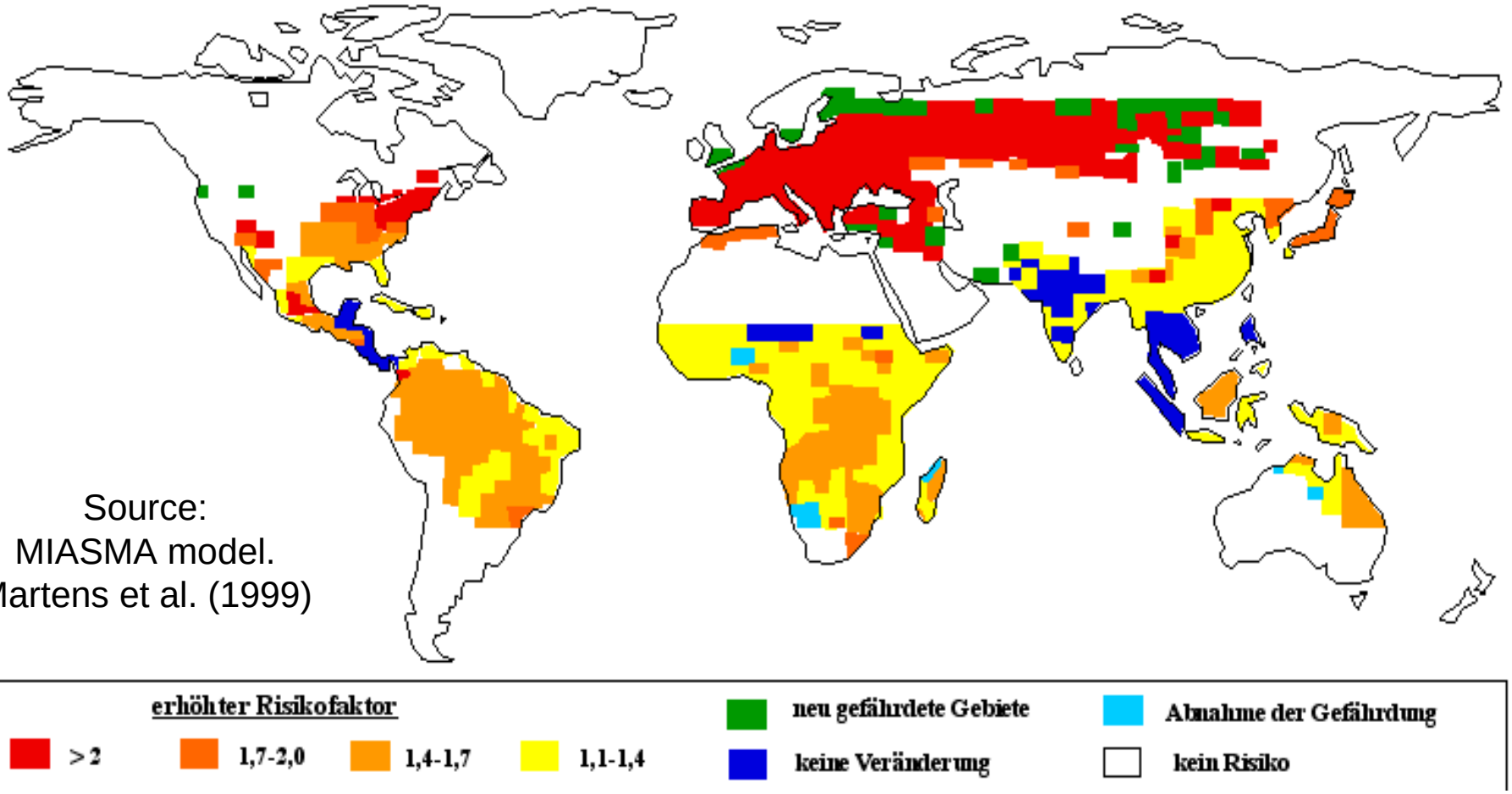
	IPCC 1994 3.1	USCSP 1996 3.2	UNEP 1998 3.3	UKCIP 2003 3.4	UNDP 2005 3.5	WHO 2003 3.6
Clear procedural structure	+	+	o	+	+	o
Flexible assessment procedure	o	o	o	+	+	o
Prioritization of assessment efforts	o	o	o	+	o	o
Identification of key information needs	−	−	−	+	o	o
Inclusion of key stakeholders	−	o	o	o	+	+
Choice of relevant spatial and temporal scales	−	o	o	+	+	o
Balanced consideration of current and future risks	−	o	o	o	+	+
Management of uncertainties	o	o	o	+	+	o
Policy guidance in the absence of quantitative risk estimates	−	−	o	+	+	o
Prioritization of adaptation actions	−	o	o	+	+	-
Mainstreaming of climate adaptation	−	o	o	+	+	+
Cross-sectoral integration	o	o	+	−	+	+
Disease-specific methods and tools	−	o	+	−	−	+
Assessment of key obstacles to adaptation	−	−	−	−	o	o

Four stages of climate assessment

	Climate Impact assessment	First-generation vulnerability assessment	Second-generation vulnerability assessment	Adaptation policy assessment
Analytical approach	Positive	Positive	Positive	Normative
Main result	Potential impacts	Pre-adaptation vulnerability	Post-adaptation vulnerability	Recommended adaptations
Consideration of adaptation	Little	Partial	Full	Full
Integration of natural and social science	Low	Low – medium	Medium – high	High
Illustrative research question	What are potential biophysical impacts of climate change?	Which socioeconomic and health impacts are likely to result from climate change?	What is the vulnerability to climate change, considering feasible adaptations?	Which adaptations are recommended to reduce the vulnerability to climate change?

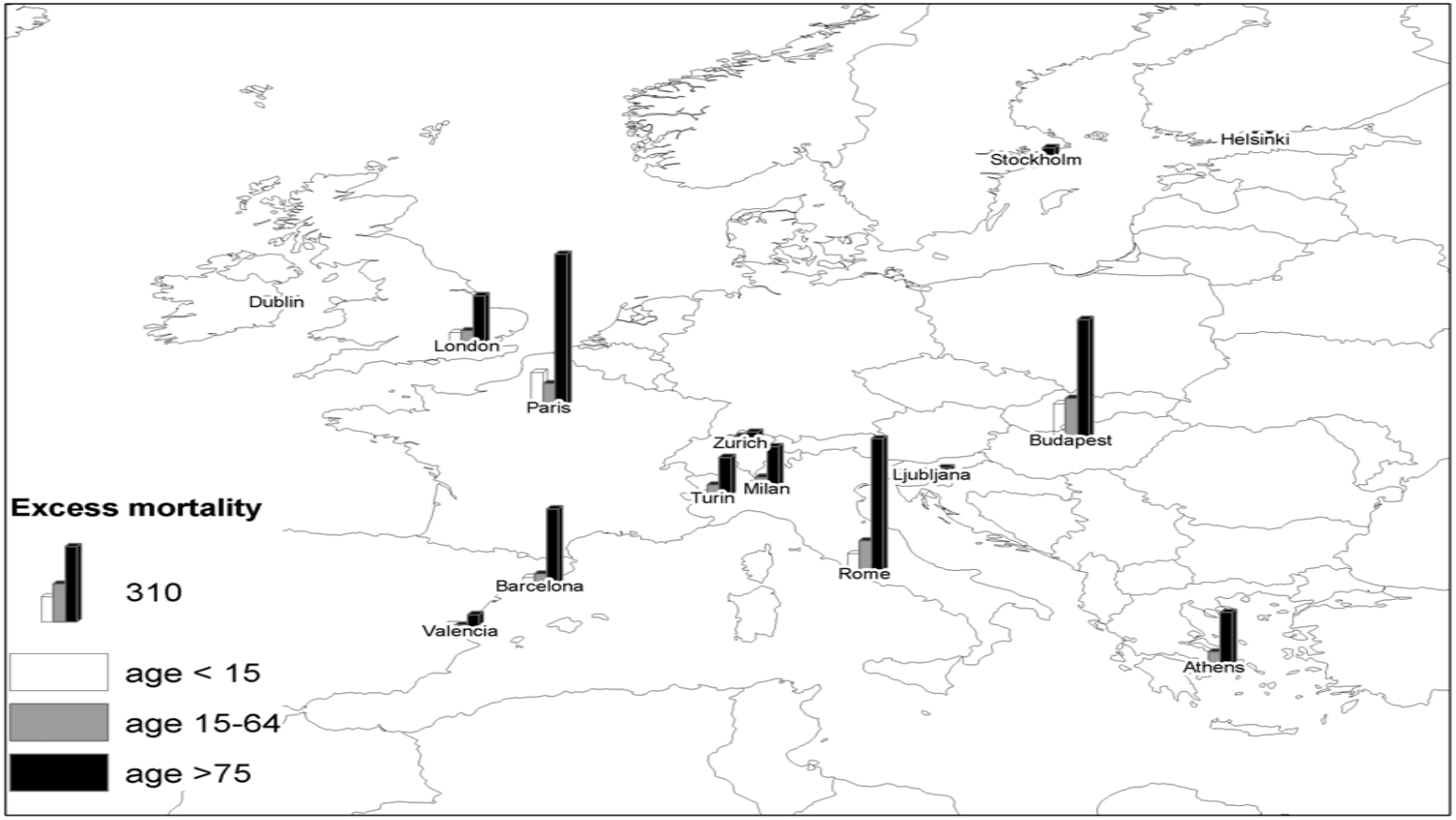
Source: Füssel (2003)

Model-based climate impact assessment: Changes in climatic suitability for malaria



Source:
MIASMA model.
Martens et al. (1999)

First-generation vulnerability assessment: Expected heat deaths in Europe



Estimated excess mortality for 2030 in 15 European cities

Source: WHO (forthcoming)

Factors influencing vulnerability (1)

- **Environment** (air and water quality, land use)
- **Infrastructure** (housing standards, water supply, sanitation, communication, transport, dams)
- **Institutions** (disaster preparedness, insurance)
- **Information** (radios, telephones, literacy)
- **Socio-economic** (income, poverty, livelihoods)
- **Social** (family types, support networks)
- **Behaviour** (physical activity, clothing, siesta)
- **Demographic** (age structure, gender, ethnicity)
- **Health status** (HIV/AIDS, malnutrition, immunity)
- **Health services** (availability, accessibility, quality)
- **Disease control** (history, effectiveness)

Factors influencing vulnerability (2)

Level	Influence on vulnerability	Description
Individual	Disease status	Those with pre-existing cardiovascular disease, for example, may be more vulnerable to direct effects such as heatwaves
	Socioeconomic factors	Poor in general are more vulnerable
	Demographic factors	Elderly are more vulnerable to heatwaves, infants to diarrhoeal diseases
Community	Integrity of water and sanitation systems and their capacity to resist extreme events	
	Local food supplies and distribution systems	
	Access to information	Lack of early warnings of extreme events
	Local disease vector distribution and control programmes	
Geographical	Exposure to extreme events	Influence of El Niño cycle or occurrence of extreme weather events more common in some parts of the world
	Altitude	Low-lying coastal populations more vulnerable to the effects of sea level rise
	Proximity to high-risk disease areas	Populations bordering current distributions of vector-borne disease may be particularly vulnerable to changes in distribution
	Rurality	Rural residents often have less access to adequate health care; urban residents more vulnerable to air pollution and heat island effects
	Ecological integrity	Environmentally degraded and deforested areas more vulnerable to extreme weather events.

Source: IPCC (2001)

Selected international data sources

- **WHO databases**
  - World Health Report: http://www.who.int/whr/
  - Malnutrition: http://www.who.int/nutgrowthdb/
  - Water and sanitation: http://www.who.int/water_sanitation_health/database/
- **CRED-EMDAT**
  - Data on disasters: http://www.em-dat.net
- **Global socio-economic scenarios**
  - IPCC Special Report on Emissions Scenarios
  - Millennium Ecosystem Assessment
  - UNEP Global Environmental Outlook
  - UN World Water Development Report

Health Effects of Climate Change in the UK

- Health outcomes:
  - temperature-related morbidity and mortality
  - food poisoning
  - vector-borne diseases
  - water-borne diseases
  - deaths & injuries due to storms and flooding
  - respiratory diseases due to air pollution
- Methods: spatial analogues, predictive modelling, and expert judgement
- Use of detailed climate change projections
- Limited use of socio-economic information

US Human Health Impacts Assessment

- Health outcomes:
  - temperature-related morbidity and mortality
  - injuries & illnesses from extreme events
  - air pollution-related health effects
  - water- and food-borne diseases
  - vector- and rodent-borne diseases
- Methods: literature review, expert judgement, some limited impact modelling
- Limited use of climate change projections
- No consideration of socio-economic projections

Human Health Vulnerability to Climate Variability and Change in Cuba

- Health outcome: dengue
- Method: Epidemiological analysis
- Main climate driver: El Nino/Southern Oscillation
- Use of regional climate projections from one GCM
- Socio-economic information used:
  - percentage of houses without potable water
  - percentage of houses with dirt floors
  - adult illiteracy rate

Climate Change in Portugal (SIAM)

- Health outcomes:
  - heat-related mortality
  - air pollution-related effects
  - vector-borne diseases
- Methods: epidemiol. modelling, expert judgement
- Use of detailed climate change projections
- Downscaling projections from 4 SRES storylines:
  - population (urban & rural)
  - economic activity & distribution of wealth
  - role of the state & civil society
  - environmental awareness and policy & values

Summary

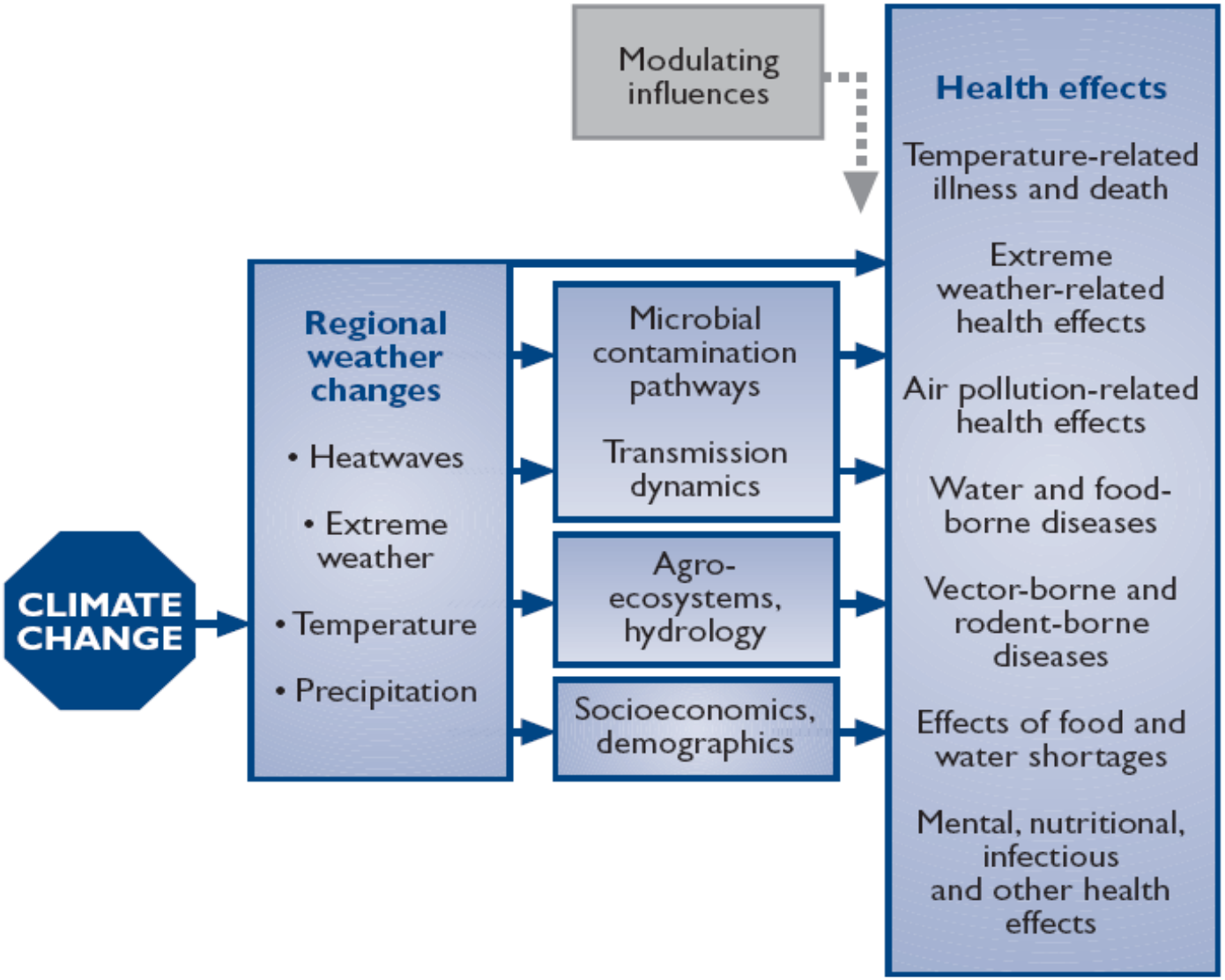
- Socio-economic information needs depend on the purpose, scale, and time horizon of the CCIAV
- Use of socio-economic scenarios to explore climate impacts on population health is currently limited
- *Generic* socio-economic information typically considered in scenarios for human health CCIAVs:
  - economic factors (income, income inequality)
  - demographics (population size, age structure)
  - internal migration (to urban and coastal areas)
  - health services (availability, access, prevention)
- Health CCIAVs may additionally consider scenarios of *disease-specific* socio-economic information

Further information available online

- U. Confalonieri & B. Menne (2007): *Human health.* IPCC WG II AR4. http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter8.pdf
- R.S. Kovats *et al*. (2003): *National assessments of health impacts of climate change: a review*. http://www.who.int/globalchange/publications/climatechangechap9.pdf
- J.D. Scheraga *et al*. (2003): *From science to policy: developing responses to climate change*. http://www.who.int/globalchange/publications/climatechangechap12.pdf
- P. Barata (2002): *Socioeconomic scenarios*. http://www.siam.fc.ul.pt/SIAM_Book/3_SocioEconomicScenarios.pdf
- Mini-monograph *"Assessing Human Health Vulnerability and Public Health Interventions to Adapt to Climate Change"*. Environmental Health Perspectives 114, 12 (2006). http://www.ehponline.org/docs/2006/114-12/toc.html
- K.L. Ebi & J.L. Gamble (2005): *Summary of a Workshop on the Development of Health Models and Scenarios: Strategies for the Future.* Environmental Health Perspectives 113, 3. http://www.ehponline.org/docs/2004/7380/abstract.html

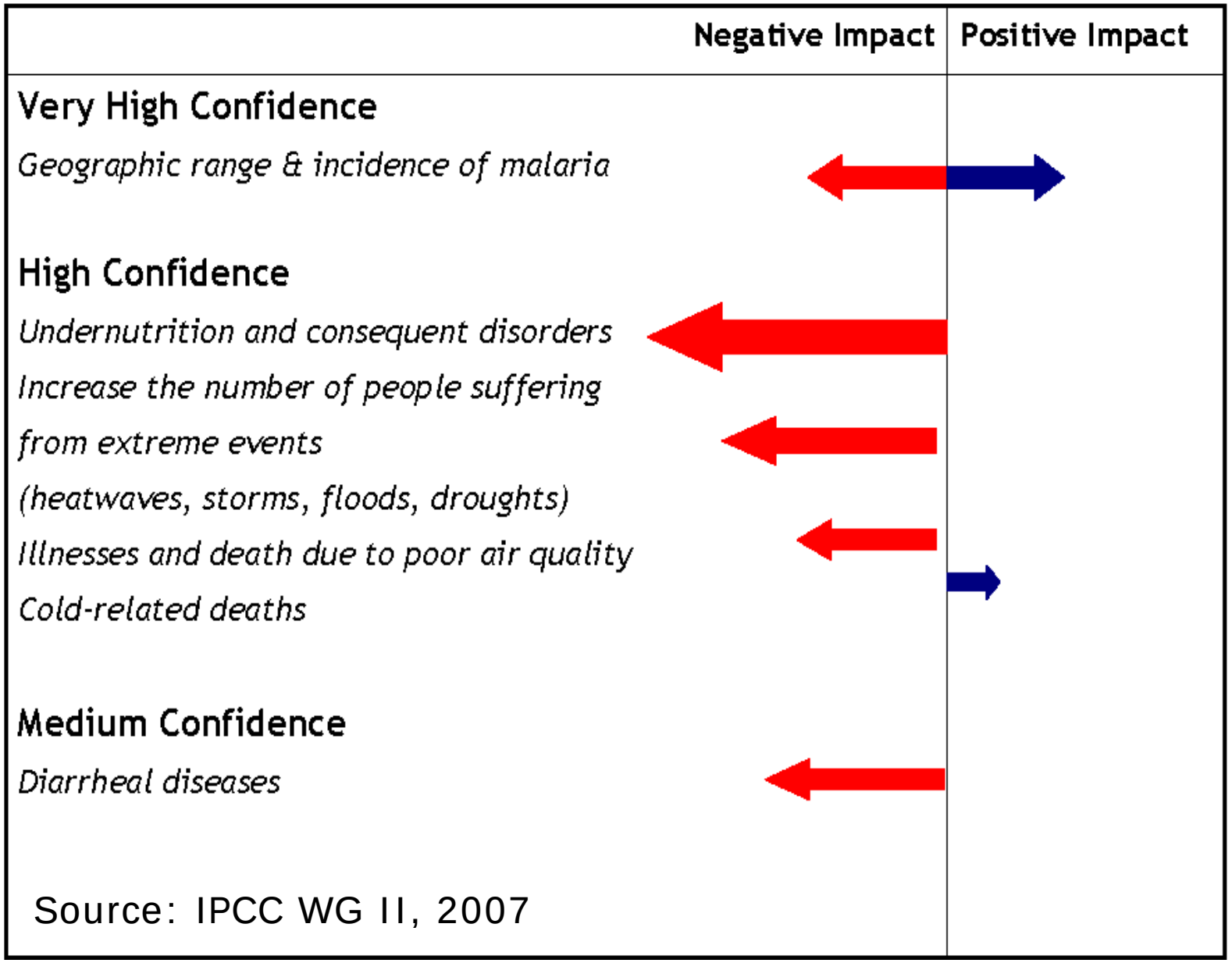
Backup slides

Climate-health relationships



Source:
Patz et al.
(2000)

Expected climate impacts on health



Reducing climate-sensitive health risks involves many sectors

- Public health
- Environmental health
- Climate and weather forecast
- Climate impacts and adaptation
- Natural hazards
- Urban and spatial planning
- Settlements and housing
- Livelihoods
- Agriculture
- etc.

Population health risk management

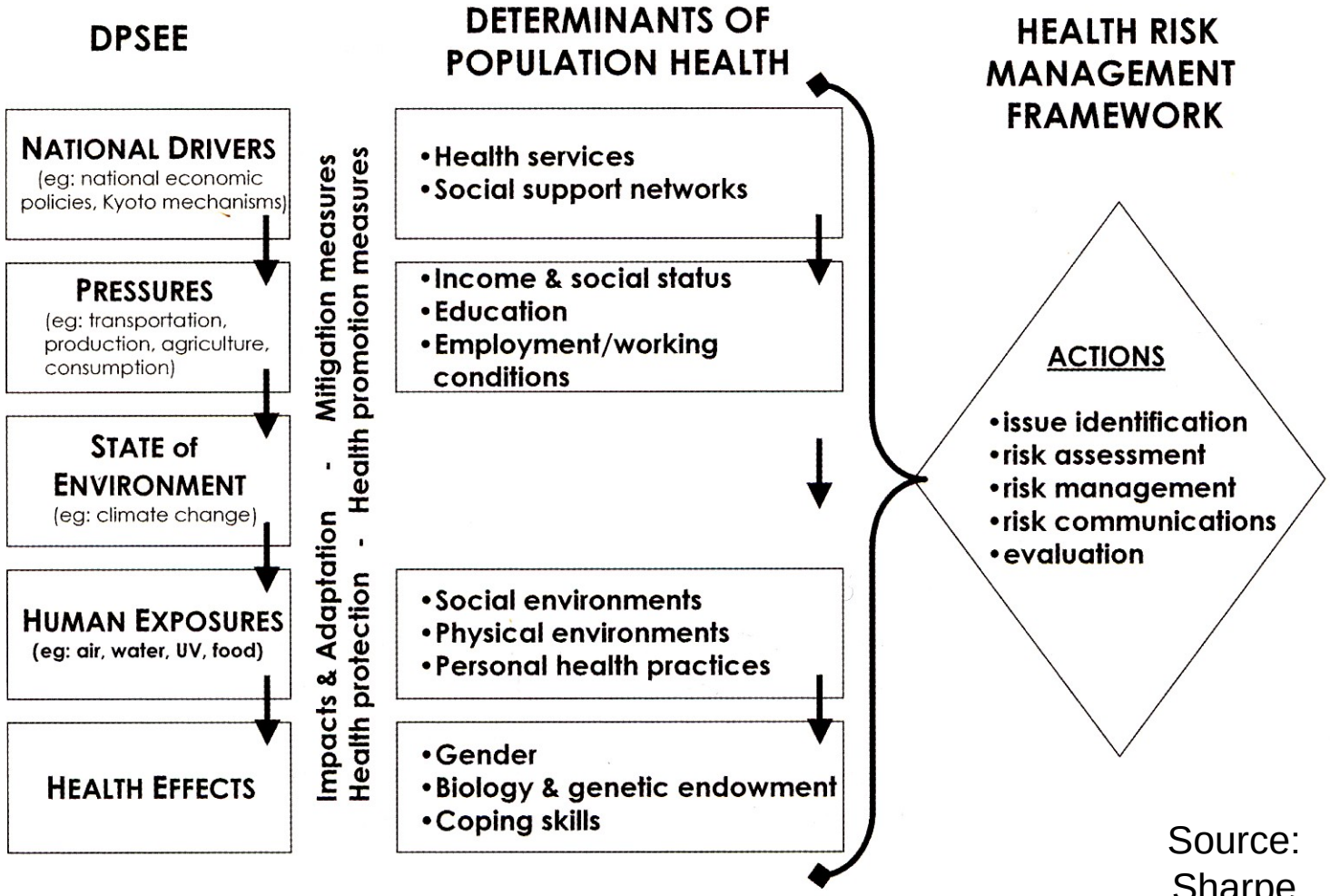


Figure 13.1 Integrated population health risk management model

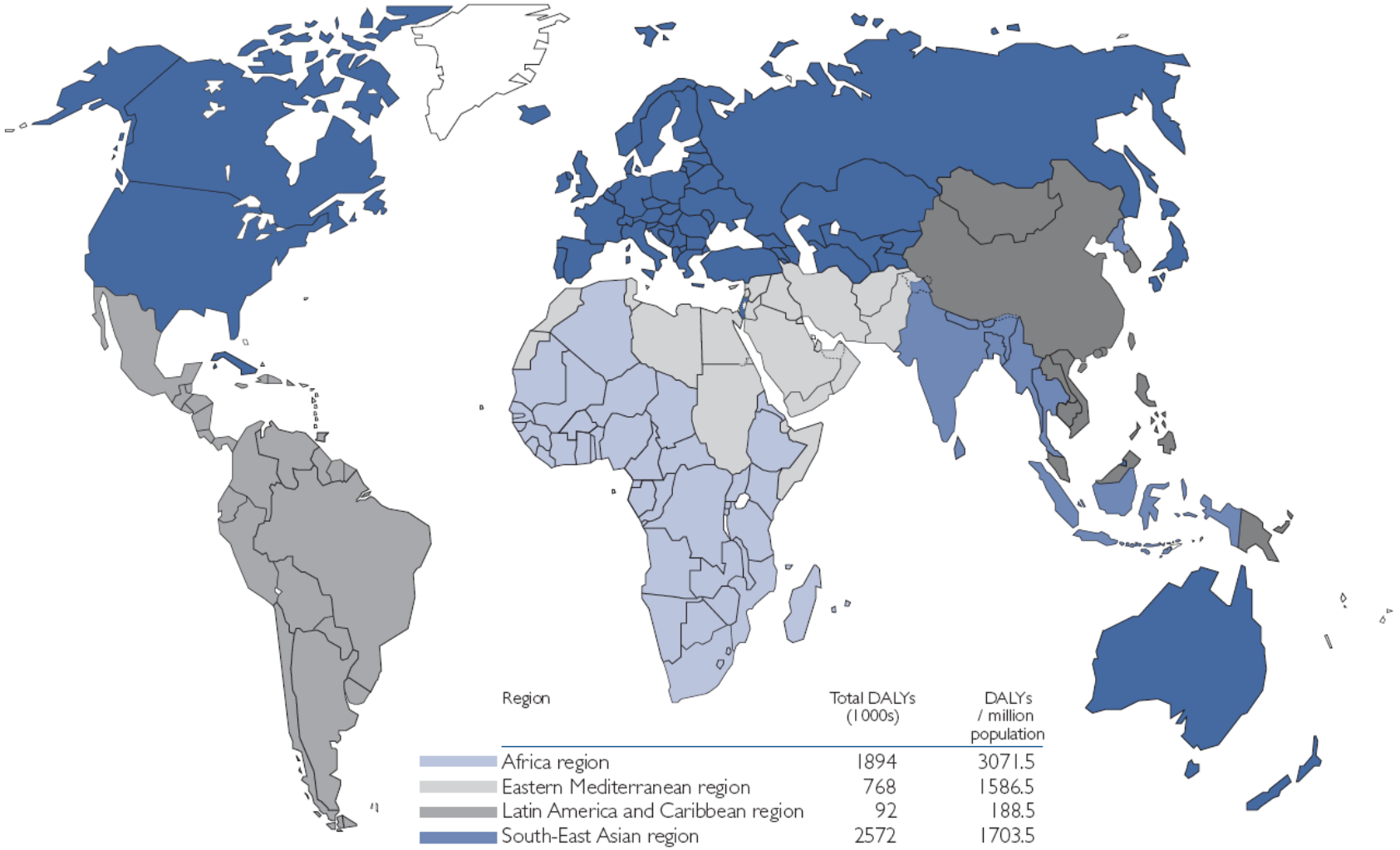
Source: Sharpe (2005)

Preconditions for planned adaptation

1. **Awareness** of the problem
2. **Availability** of effective adaptation measures
3. **Information** about effective measures
4. **Resources** available for implementing them
5. **Cultural acceptability** of effective measures
6. **Incentives** for actually implementing them

- Adaptation (assessment) should focus on those preconditions most in need of improvement.

Health impacts of climate change in 2000



Region	Total DALYs (1000s)	DALYs / million population
Africa region	1894	3071.5
Eastern Mediterranean region	768	1586.5
Latin America and Caribbean region	92	188.5
South-East Asian region	2572	1703.5
Western Pacific region*	169	111.4
Developed countries**	8	8.9
WORLD	5517	920.3

* without developed countries; ** and Cuba

National health impact assessments

Country	Reference	Methods	Areas of concern for climate change
Antigua and Barbuda	O'Marde & Michael, 2000 (*17*)	Forecasting by analogy.	Coastal flooding due to sea level rise, impacts of hurricanes, increases in dengue transmission.
Australia	NHMRC, 1991 (*18*)	Expert judgement.	None specified, focuses on adaptation.
Australia	McMichael et al., 2002 (*19*)	Predictive modelling.	No impact on heat stress. Changes in distribution of malaria vectors. Increases in diarrhoeal disease.
Cameroon	UNEP/ Ministry of Environment and Forestry, Cameroon, 1998 (*20*)	Expert judgement.	Possible increases in cholera, malaria, yellow fever, meningitis, malnutrition.
Canada	Duncan et al., 1997 (*21*)	Literature review, expert judgement, predictive modelling.	Increases in heat-related deaths, risk that vector-borne diseases may extend north into Canada, environmental refugees.
Fiji	de Wet & Hales, 2000 (*22*)	Literature review, predictive modelling.	Increases in dengue, diarrhoeal disease.
Japan	Ando, 1993 (*23*)	Literature review.	Heat stress and photochemical air pollution may increase. Malaria.
Japan	Ando et al. 1998 (*24*)	Literature review, expert judgement, predictive modelling.	Heat stress. Malaria.
Kiribati	Taeuea, T. et al. 2000 (*25*)	Literature review, predictive modelling.	Increases in dengue, diarrhoeal disease and ciguatera fish poisoning.
Netherlands	Martens, 1996 (*26*)	Literature review, expert judgement.	Heat stress, flooding.
New Zealand	Woodward et al. 2001 (*27*)	Literature review, predictive modelling.	Risk of introduction of mosquito vector species into north island.
Panama	Sempris, E. & Lopez, R. eds. 2001.—ANAM/UNDP (*28*)	Quantitative assessment of climate with diarrhoeal illness and influenza.	Potential increases in diarrhoeal disease in vulnerable areas.
Portugal	Casimiro,E. & Calheiros, J.M. 2002 (*29*)	Extensive literature review, predictive modelling, identified populations at risk.	Heat-related deaths, food and water borne diseases, air pollution effects, vector and rodent borne disease.
Sri Lanka	Ratnasari, J. 1998 (*30*)	Expert judgement, predictive model.	Malaria.
St Lucia	St Lucia National Communication (*31*)	Assessment of current burden of climate sensitive diseases.	Drought and diarrhoeal disease.
United Kingdom	CCIRG. 1996 (*32*)	Literature review.	Heat-related deaths and extreme events.
	Dept of Health, 2002 (*33*)	Expert judgement, predictive modelling	Thermal stress, air pollution, flooding, water borne disease.
United States	USEPA, 1989 (*34*)	Literature review, some modelling.	Increases in vector-borne diseases. See table 9.3
	Patz et al., 2000 (*35*) +various documents	Literature review, expert judgement.	
Zambia	Phiri, J. & Msiska, D. 1998 (*36*)	Expert judgement.	Malaria, schistosomiasis, water-borne diseases and malnutrition.

Source: Kovats et al. (2003)

National health impact assessments

Country	Key findings	Adaptation recommendations
Australia (McMichael et al., 2003b)	Increase in heatwave-related deaths; drowning from floods; diarrhoeal disease in indigenous communities; potential change in the geographical range of dengue and malaria; likely increase in environmental refugees from Pacific islands.	Not considered.
Bolivia (Programa Nacional de Cambios Climaticos Componente Salud et al., 2000)	Intensification of malaria and leishmaniasis transmission. Indigenous populations may be most affected by increases in infectious diseases.	Not considered.
Bhutan (National Environment Commission et al., 2006)	Loss of life from frequent flash floods; glacier lake outburst floods; landslides; hunger and malnutrition; spread of vector-borne diseases into higher elevations; loss of water resources; risk of water-borne diseases.	Ensure safe drinking water; regular vector control and vaccination programmes; monitor air and drinking water quality; establishment of emergency medical services.
Canada (Riedel, 2004)	Increase in heatwave-related deaths; increase in air pollution-related diseases; spread of vector- and rodent-borne diseases; increased problems with contamination of both domestic and imported shellfish; increase in allergic disorders; impacts on particular populations in northern Canada.	Monitoring for emerging infectious diseases; emergency management plans; early warning systems; land-use regulations; upgrading water and wastewater treatment facilities; measures for reducing the heat-island effect.
Finland (Hassi and Rytkonen, 2005)	Small increase in heat-related mortality; changes in phenological phases and increased risk of allergic disorders; small reduction in winter mortality.	Awareness-building and training of medical doctors.
Germany (Zebisch et al., 2005)	Observed excess deaths from heatwaves; changing ranges in tick-borne encephalitis; impacts on health care.	Increase information to the population; early warning; emergency planning and cooling of buildings; insurance and reserve funds.
India (Ministry of Environment and Forest and Government of India, 2004)	Increase in communicable diseases. Malaria projected to move to higher latitudes and altitudes in India.	Surveillance systems; vector control measures; public education.
Japan (Koike, 2006)	Increased risk of heat-related emergency visits, Japanese cedar pollen disease patients, food poisoning; and sleep disturbance.	Heat-related emergency visit surveillance.
The Netherlands (Bresser, 2006)	Increase in heat-related mortality, air pollutants; risk of Lyme disease, food poisoning and allergic disorders.	Not considered.
New Zealand (Woodward et al., 2001)	Increases in enteric infections (food poisoning); changes in some allergic conditions; injuries from more intense floods and storms; a small increase in heat-related deaths.	Systems to ensure food quality; information to population and health care providers; flood protection; vector control.
Panama (Autoridad Nacional del Ambiente, 2000)	Increase of vector-borne and other infectious diseases; health problems due to high ozone levels in urban areas; increase in malnutrition.	Not considered.
Portugal (Casimiro and Calheiros, 2002; Calheiros and Casimiro, 2006)	Increase in heat-related deaths and malaria (Tables 8.2, 8.3), food- and water-borne diseases, West Nile fever, Lyme disease and Mediterranean spotted fever; a reduction in leishmaniasis risk in some areas.	Address thermal comfort; education and information as well as early warning for hot periods; and early detection of infectious diseases.
Spain (Moreno, 2005)	Increase in heat-related mortality and air pollutants; potential change of ranges of vector- and rodent-borne diseases.	Awareness-raising; early warning systems for heatwaves; surveillance and monitoring; review of health policies.
Tajikistan (Kaumov and Muchmadeliev, 2002)	Increase in heat-related deaths.	Not considered.
Switzerland (Thommen Dombois and Braun-Fahrlaender, 2004)	Increase of heat-related mortality; changes in zoonoses; increase in cases of tick-borne encephalitis.	Heat information, early warning; greenhouse gas emissions reduction strategies to reduce secondary air pollutants; setting up a working group on climate and health.
United Kingdom (Department of Health and Expert Group on Climate Change and Health in the UK, 2001)	Health impacts of increased flood events; increased risk of heatwave-related mortality; and increased ozone-related exposure.	Awareness-raising.

Source:
IPCC WG II (2007)

Climate Change in Portugal (SIAM)

Indicators	Today	2020 (linear projection)	Globalized	Protectionism Economy	Global Sustainability	Rural Sustainability
Economic Development						
GDP average growth rate		3	4	2	3	1,75
GDP factor cost, current prices, billion €	68,85	124,265	150,755	102,24	124,265	97,34
Per capita GDP (market prices) in €	7260	2539	13110	10760	12425	9735
Income distribution (ratio of first to tenth decile)	1:5	1:6	1:6.5	1:6	1:5	1:3.5
Poverty rate (% below poverty line = 60% median income)	23	23	23	25	15	12
Government final consumption expenditure (% GDP)	51%	45%	45%	48%	51%	55%
Exports (%GDP)	30%	30%	35%	32%	20%	35%
Value Added	13461831					
services	60%	73%	85%	75%	85%	62%
industry	35%	25%	14%	22,5%	12%	34%
agriculture	4%	2%	1%	2,5%	3%	4%
Demographics and living conditions						
Population	9474070	9788222	11500000	9500000	10000000	10000000
Immigration (official numbers)	177774	285000				
Total immigration	500000	801580	1500000	700000	800000	700000
Immigration rate	7%	5%	13%	7%	8%	7%
Average household size	3	3,05	3	3	3	4
Hoseuhold numbers	3,15 milhões	3,2	3,8	3	3,3	2,5
Occupaction of dwellings	3,3 milhões					
Average construction area (m^2)	83	110	115	100	110	100
Length of daily stay in house	15 horas	15 horas	13 horas	15 horas	15 horas	16 horas
Geographical Distribution of Housing						

Hot weather watch / warning systems

1. City-specific identification of most dangerous weather conditions from past data
2. Identification of vulnerable population groups (age, mobility, living alone, housing type)
3. Continuous monitoring and forecasting of weather conditions
4. Alerting the public about the expected timing and severity of a heatwave
5. Providing targeted advice on adaptive responses to be undertaken by individuals and institutions

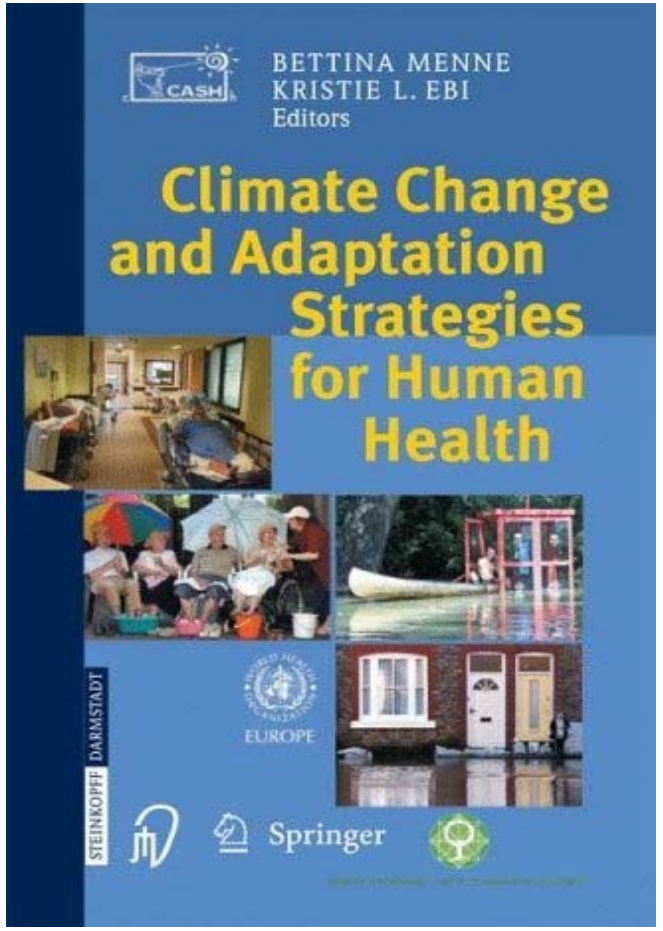
Screening options for malaria control

Theoretical Range of Choice	Technically feasible?	Effective?	Environmentally acceptable?	Financially Feasible?	Socially and Legally Acceptable?	Closed/Open (Practical Range of Choice)
Improved public health infrastructure	Yes	Low	Yes	Sometimes	Yes	Open
Forecasting & early warning systems	Yes	Medium	Yes	Often	Yes	Open
Public information & education	Yes	Low	Yes	Yes	Yes	Open
Control of vector breeding sites	Yes	Yes	Spraying - no	Yes	Sometimes	Open
Impregnated bed nets	Yes	Yes	Yes	Yes	Yes	Open
Prophylaxis	Yes	Yes	Yes	Only for the few	Yes	Closed for many
Vaccination	No					Closed

Source: Ebi and Burton (2005)

Climate Change and Adaptation Strategies for Human Health in Europe

- **Funding:**
  European Union (FP6)
- **Duration:**
  2001-2004
- **Consortium:**
  8 partners, 6 countries
- **Lead agency:**
  WHO Regional Office for Europe



cCASHh project

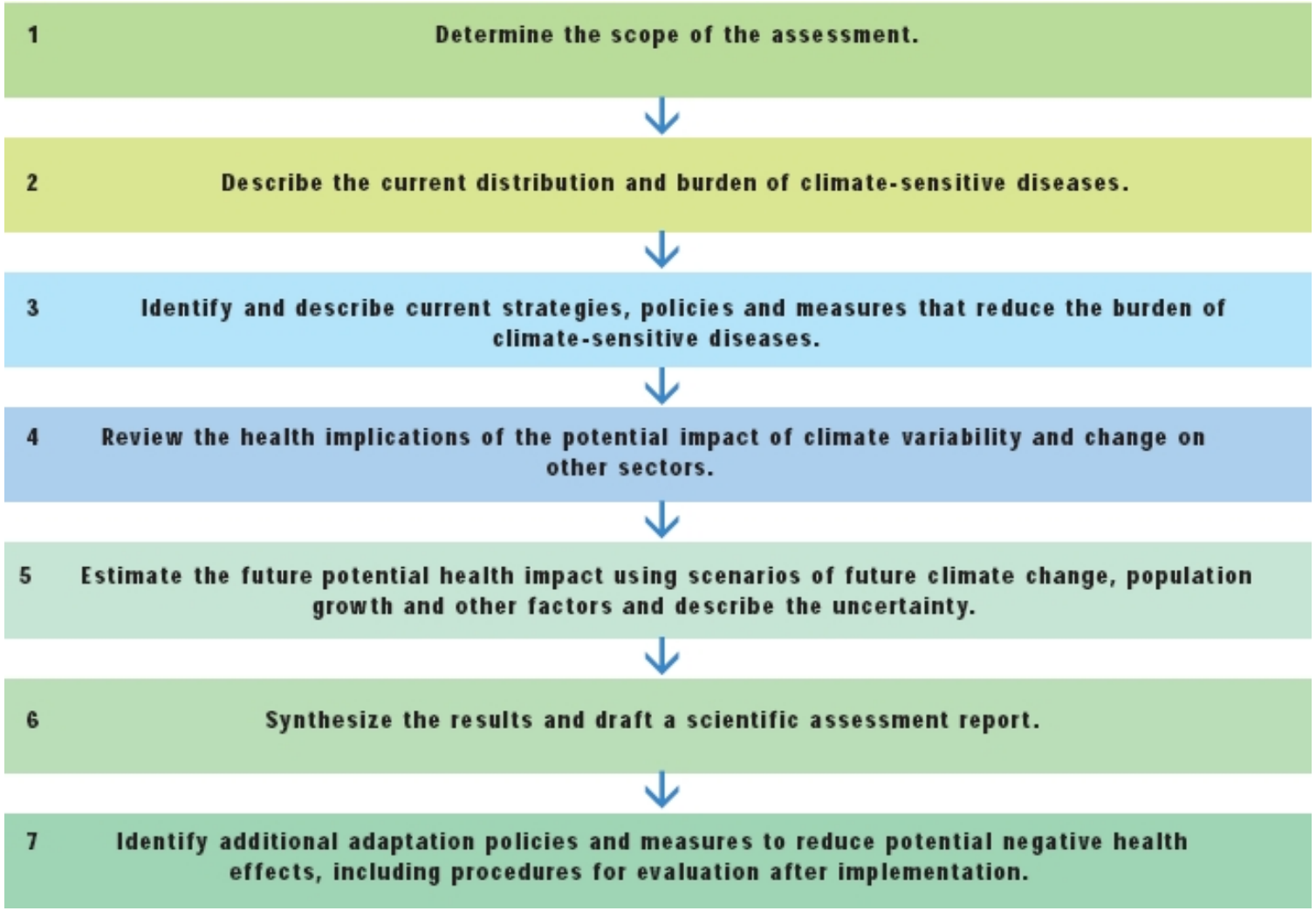
Key objectives:

- to identify vulnerability of population health in Europe to climate change
- to identify the most appropriate measures and policies to successfully adapt to climate change
- to identify barriers to improving adaptive capacity

Health effects considered:

- Heat-related mortality and morbidity
- River floods
- Vector- and rodent-borne diseases
- Food-borne diseases

Steps in assessing human health vulnerability and adaptation



Source: Kovats et al. (2003)

A sequential risk-management strategy for health adaptation assessment

1. **Scoping** the assessment (regions, resources, criteria)
2. **Risk screening** and final scoping decisions
3. Examination of the **adaptation baseline**
4. **Analysis** of future risks (incl. uncertainties)
5. **Evaluation** of future risks
6. Identification and evaluation of **adaptation options**
7. **Prioritization** of adaptation options
8. *Decision about adaptation strategy*
9. *Implementation of adaptation strategy*
10. *Monitoring, evaluation, and revision of strategy*

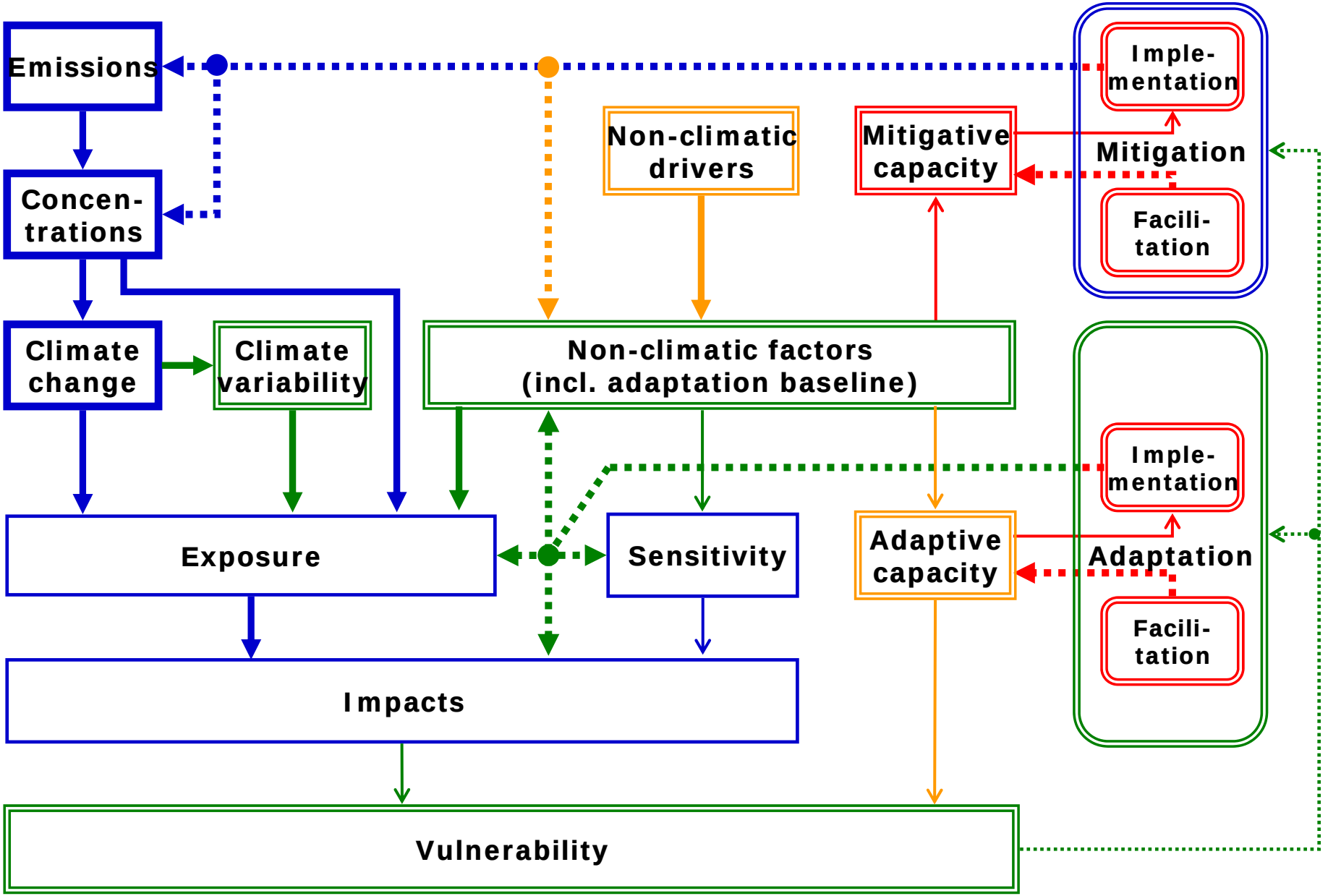
Source: Füssel et al. (2005)

Four stages of climate assessment

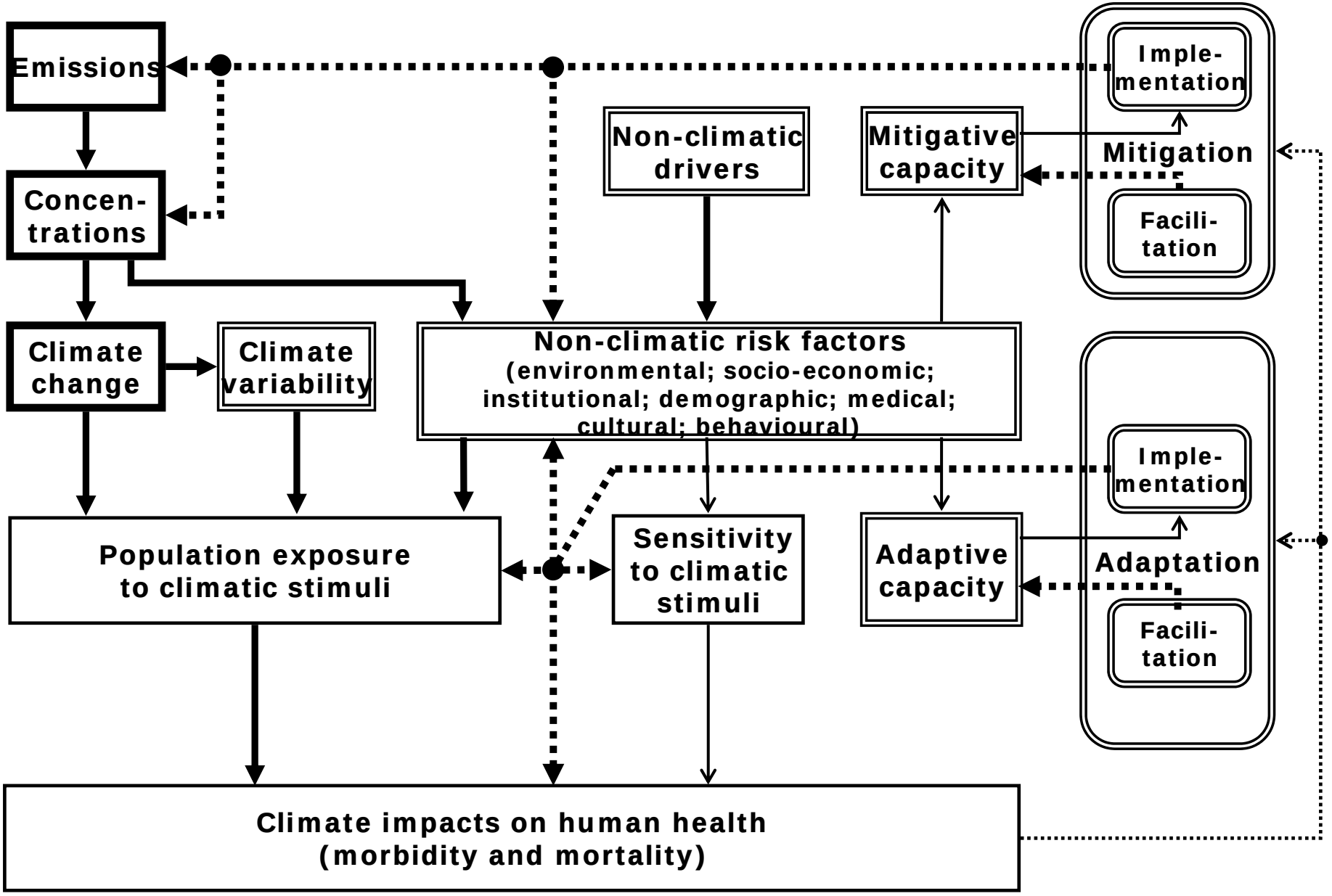
	Impact assessment	Vulnerability assessment		Adaptation policy assessment
		First generation	Second generation	
Main policy focus	Mitigation policy	Mitigation policy	Resource allocation	Adaptation policy
Analytical approach	Positive	Mainly positive	Mainly positive	Normative
Main result	Potential impacts	Pre-adaptation vulnerability	Post-adaptation vulnerability	Recommended adaptation strategy
Time horizon	Long-term	Long-term	Mid- to long-term	Short- to long-term
Spatial scale	National to global	National to global	Local to global	Local to national
Consideration of climate variability, non-climatic factors, and adaptation	Little	Partial	Full	Full
Consideration of uncertainty	Little	Partial	Partial	Extensive
Integration of natural and social sciences	Low	Low to medium	Medium to high	High
Degree of stakeholder involvement	Low	Low	Medium	High
Illustrative research question	What are potential biophysical impacts of climate change?	Which socio-economic impacts are likely to result from climate change?	What is the vulnerability to climate change, considering feasible adaptations?	Which adaptations are recommended for reducing vulnerability to climate change and variability?

Source:
Füssel & Klein (2006)

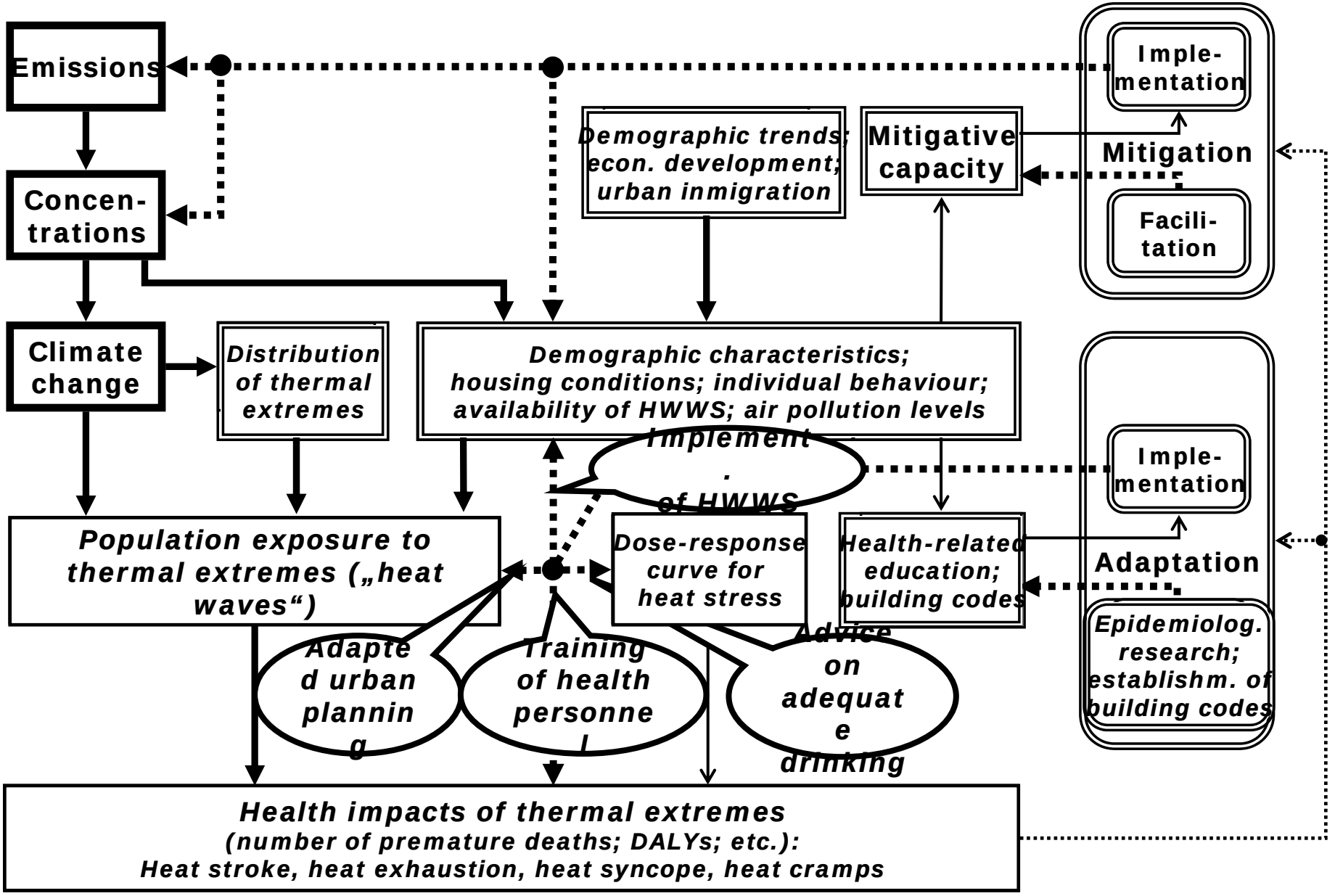
Adaptation policy assessment



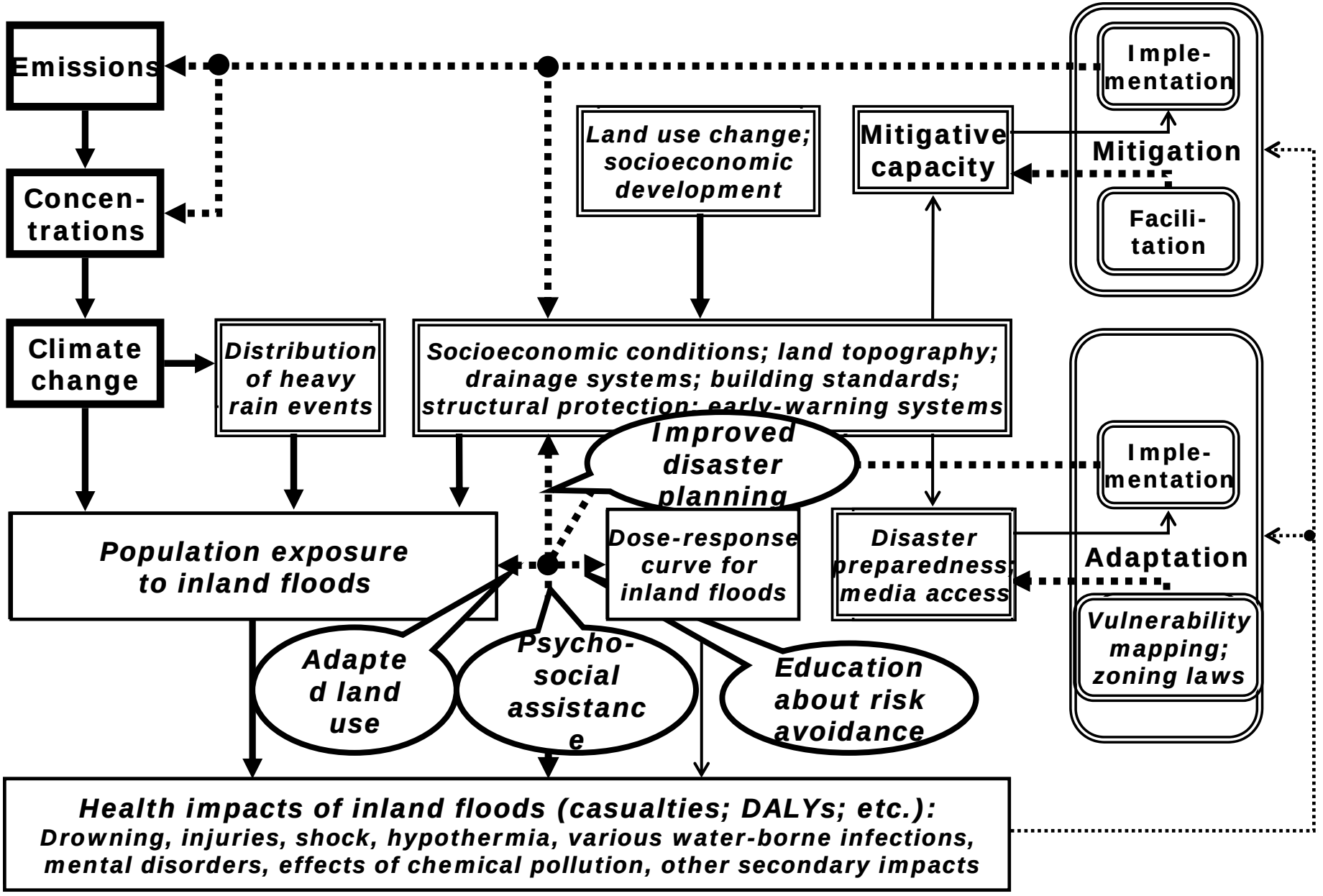
Health Adaptation to Climate Change



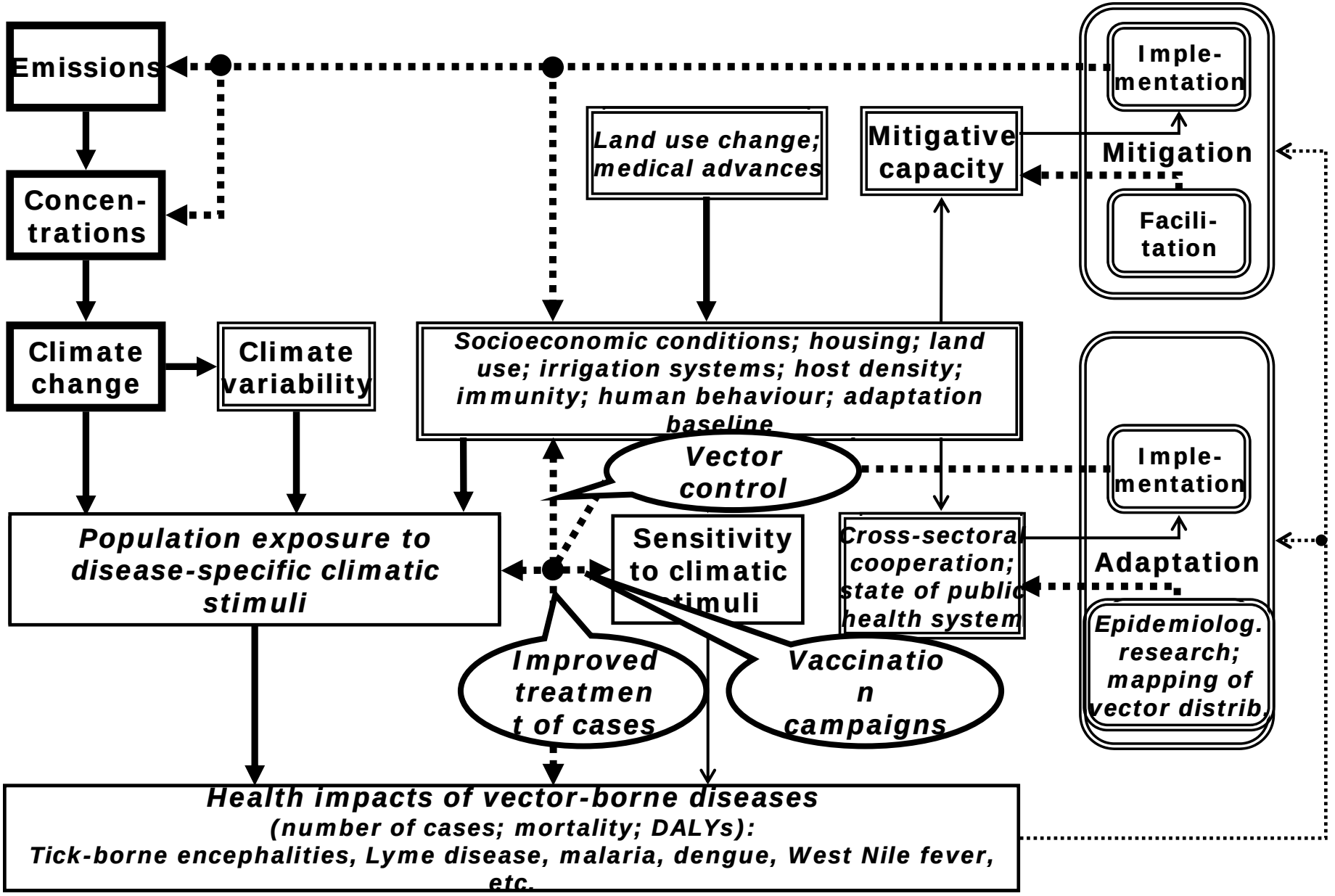
Adaptation to Heat Stress



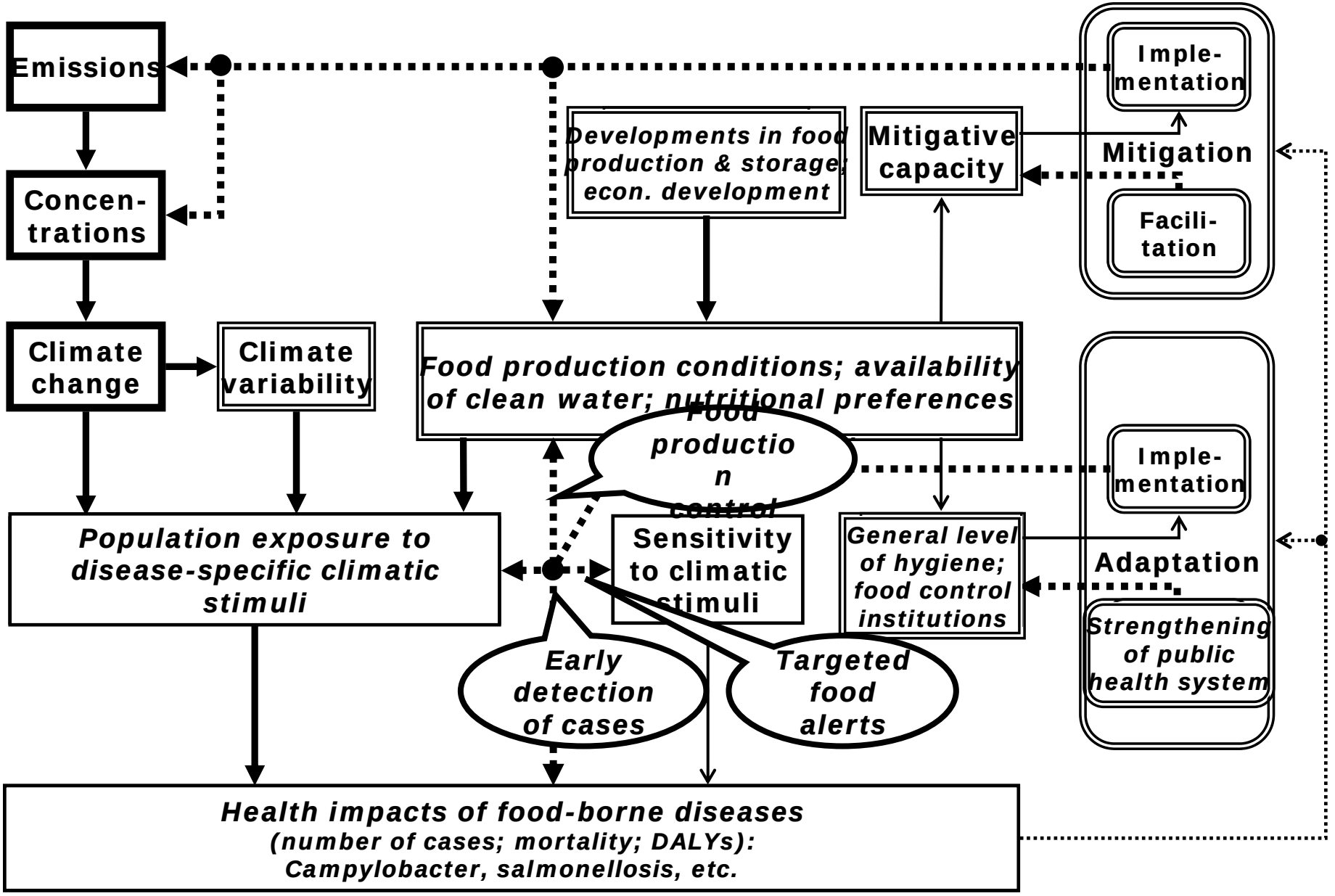
Adaptation to Inland Floods



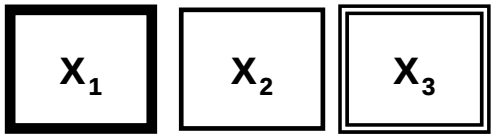
Adaptation to Vector-borne Diseases



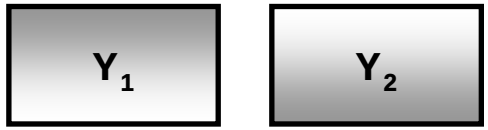
Adaptation to Food-borne Diseases



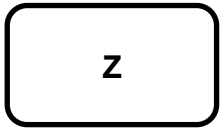
Legend



Important concept from the IPCC TAR applicable at the global level (X_1), at the regional level (X_2), and at diverse levels (X_3)



Key input (Y_1) and key output (Y_2) of the assessment, respectively



Response action

Physical cause-effect relationship: “A causes (changes in) B“

Effect of human actions

Functional relationship: “A is a determinant of B“

Perception and interpretation of information