Water As The Most Crucial Health Related Challenge in Rural Africa

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12th AFRICANDO 2009
Workshop and Expo on Smart, Appropriate and resource Efficient Technologies for Rural Communities
(***NUTS AND BOLTS OF SMART APPROPRIATE TECHNOLOGIES FOR RURAL COMMUNITY DEVELOPMENT – FOCUS ON HEALTH***)

September 18-19, 2009
MIAMI BEACH RESORT
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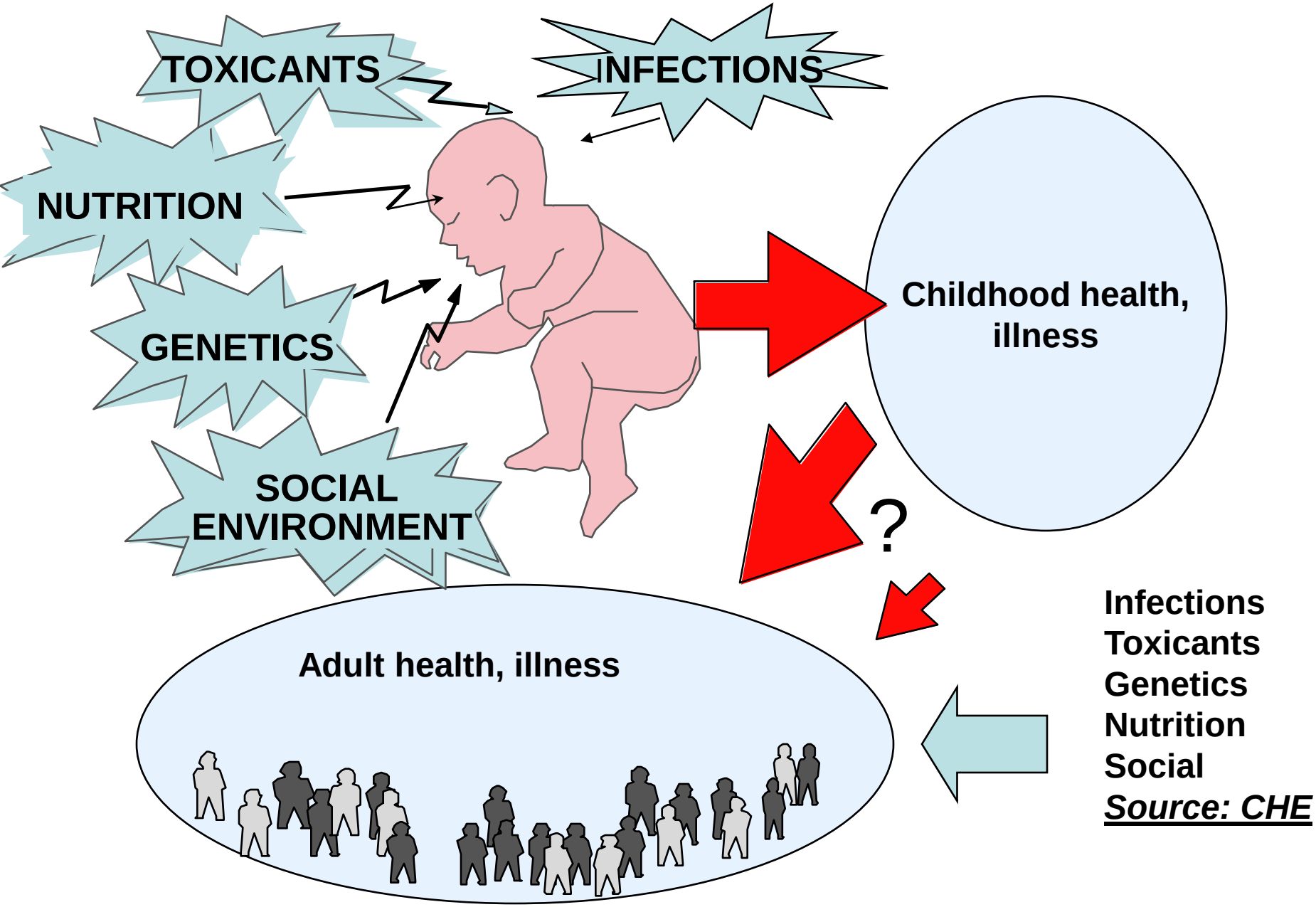

TOXICANTS
INFECTIONS
NUTRITION
GENETICS
SOCIAL ENVIRONMENT
Childhood health, illness
?
Adult health, illness
Infections
Toxicants
Genetics
Nutrition
Social
Source: CHE

Health Risks

Water can be a source of disease in people through at least five avenues:

1. Water-borne diseases
2. Water-privation diseases
3. Water-based diseases
4. Water-related diseases
5. Water-dispersed infections

Source: Yassi, 2001

Waterborne Diseases

- Arise from the contamination of water by human or animal feces or urine infected by pathogenic viruses or bacteria, which are directly transmitted
  - when the water is drunk or used in the preparation of food.

- Cholera, *typhoid*, and cryptosporidiosis are typical examples of Waterborne diseases

Water-privation diseases

- This category of diseases is affected more by the quantity of water rather than by quality.
- These diseases spread through direct contact with infected people or materials contaminated with the infectious agent.
- Infrequent washing and inadequate personal hygiene are the main factors in these types of diseases, such as certain types of diarrheal diseases, helminths, and skin and eye infections.

Water-based diseases

- In these diseases, water provides the habitat for intermediate host organisms in which some parasites pass part of their life cycle.
- These are later the cause of disease in people as their infective larval forms in fresh water find their way back to humans, either by boring through wet skin or by being ingested with water plants, minute water crustacea, or raw or inadequately cooked fish.
- Schistosomiasis is an example of a water-based disease.

Water-related diseases

- Water may provide a habitat for insect vectors of water-related diseases.
- Mosquitoes breed in water and the adult mosquitoes may transmit parasite diseases, such as
  - malaria, and
  - virus infections,such as
    - dengue,
    - yellow fever, and
    - Japanese encephalitis.

Water-dispersed infections

- A fifth category of diseases associated with water is emerging in developed countries-infections whose pathogens can proliferate in freshwater and enter the body through the respiratory tract.
- Some freshwater amoebae that are not usually pathogenic can proliferate in warm water, and if they enter the host in large numbers, they can invade the body along the *olfactory tracts* and cause ***fatal meningitis***.
- These bacteria can be dispersed as aerosols from air-conditioning systems; an example of this type of disease is **Legionella**.

Human Wastes

- Human Excreta and the lack of adequate personal and domestic hygiene – implicated in the transmission of many infectious diseases including typhoid, cholera, polio, ascariasis.

- 2.2 Million people die annually from diarrheal diseases and 10% of the people are severely infected with intestinal worms related to improper waste and excreta management.

- Proper excreta disposal and minimum levels of personal and domestic hygiene are essential for protection of public health.

- Safe excreta disposal and handling act as a primary barrier for preventing excreted pathogens from entering the environment.

Magnitude of the Problem

- WHO estimated that every 8 seconds a child died from a water-related disease and that **each year 5,000,000 people died** from illnesses linked to unsafe drinking water or inadequate sanitation.

- Waterborne diseases outbreak are due to bacterial, viral and parasitic microorganism associated with the consumption of untreated or improperly treated drinking water

Causes of Gastrointestinal Illnesses

- Parasitic agents such as cryptosporidium
- Bacterial agents e.g. salmonella, shigella, E. Coli
- Viruses e.g. rotaviruses, adenoviruses
- Transmission can be in the form of water route, person to person, animal to human, food borne and aerosol routes
- Diarrhoeal disease can be due to milk or soy intolerance, diet changes, side effect of prescription drugs e.g. antibiotics

Transmission Routes

- Disease transmission is determined by several pathogen related factors including:

  -An organism ability to survive or multiply in the environments (some pathogens require the presence of specific specific intermediate hosts to complete their lifecycles)

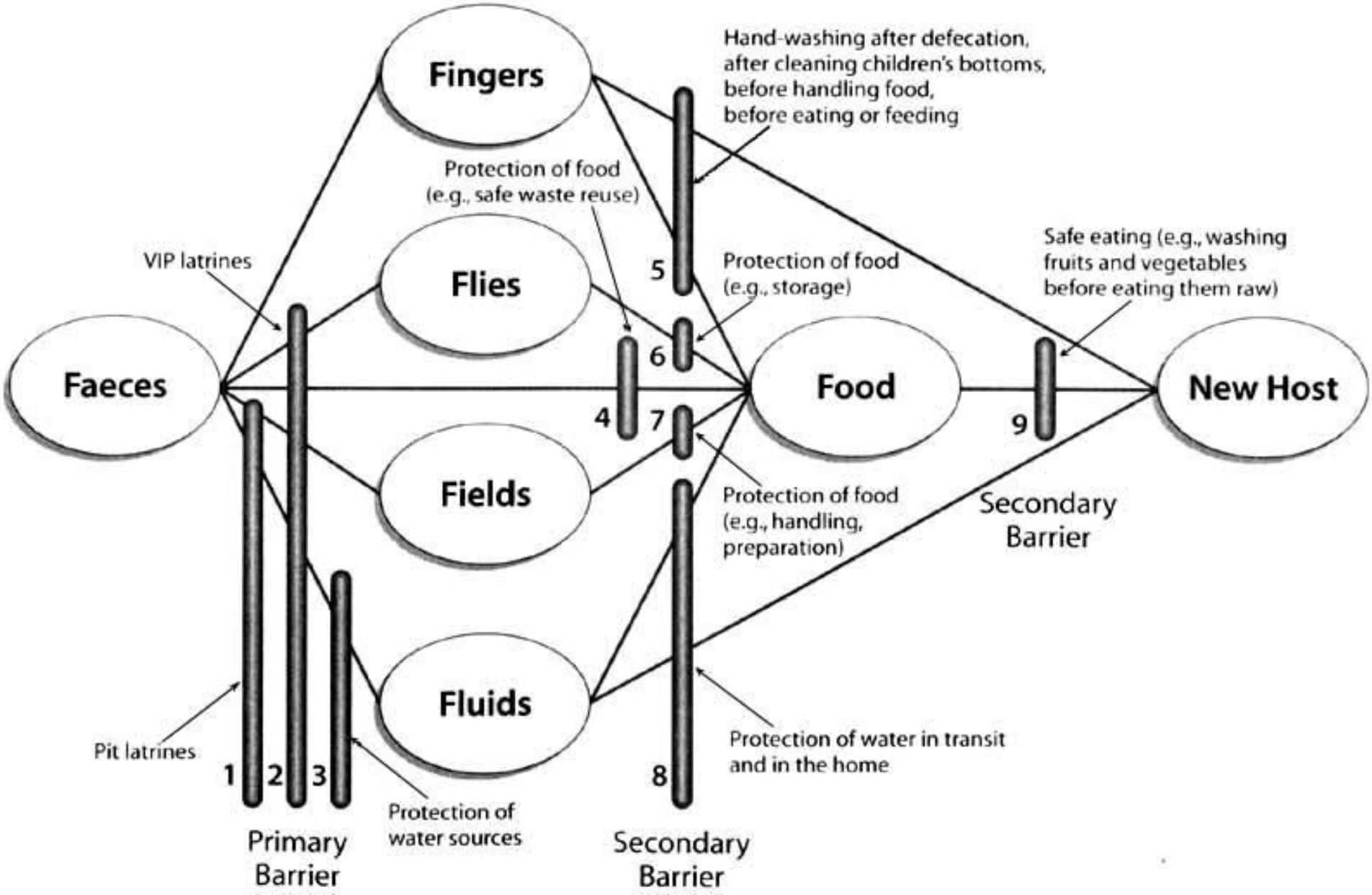
  -Latent periods (many pathogens are immediately infectious, others may require a period of time before they become infective)

  -An organism ability to infect the host (some pathogens can cause infections when present in small numbers e.g. ascaris, others may require million or more organisms to cause infection)

Disease Transmission

- Disease transmission is also affected by host characteristics and behavior, including:
  - Immunity,
  - Nutritional status,
  - Health status,
  - Age,
  - Sex,
  - Personal hygiene,
  - Food hygiene.

4Fs and Prevention Measures



CLIMATE CHANGE AND DISEASES

Planets and atmospheres

Mars
Thin atmosphere
(Almost all CO_2 in ground)
Average temperature : - 50°C

Earth
0,03% of CO_2 in the atmosphere
Average temperature : + 15°C

Venus
Thick atmosphere
containing 96% of CO_2
Average temperature : + 420°C

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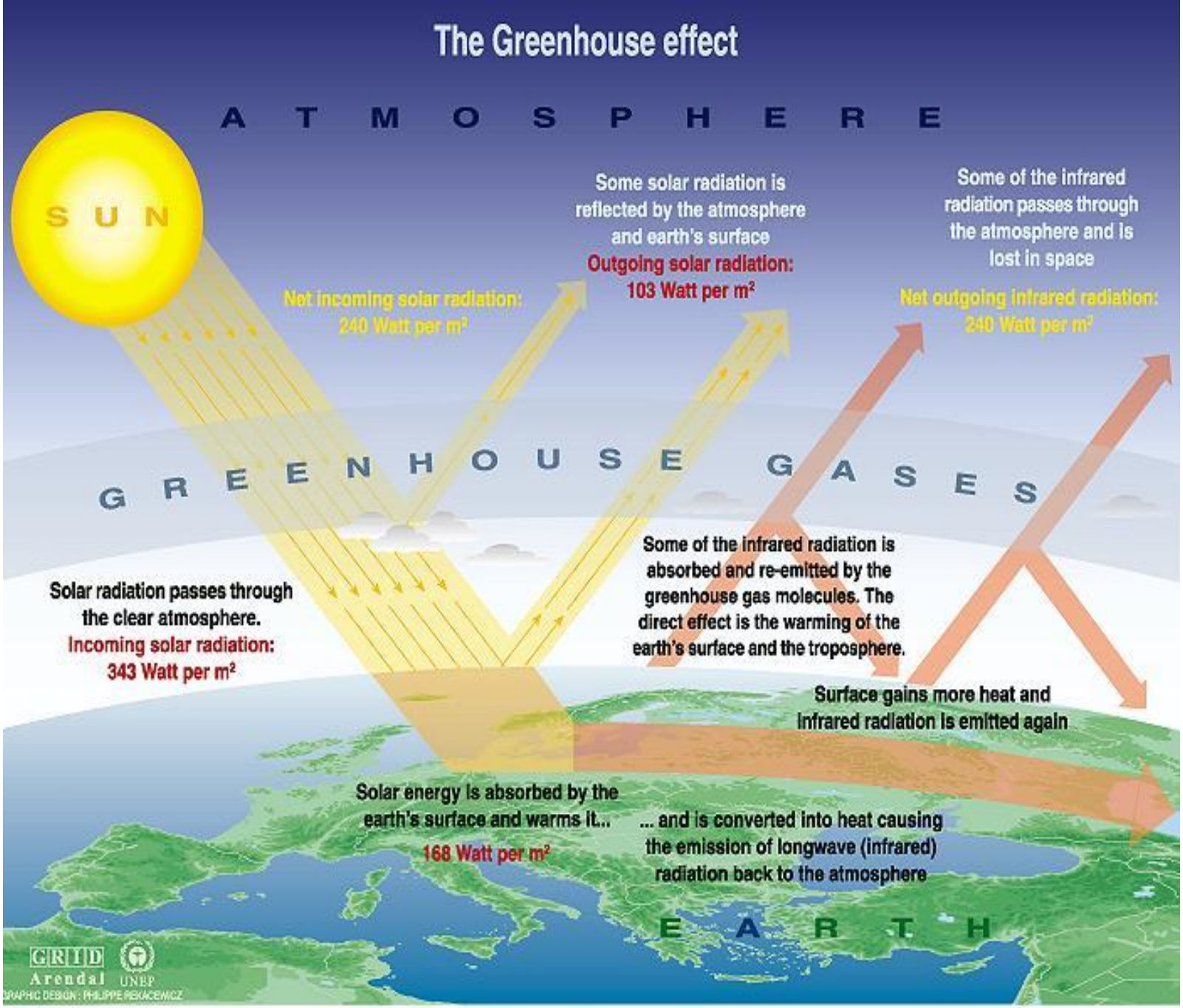
GRAPHIC DESIGN : PHILIPPE REKACEWICZ

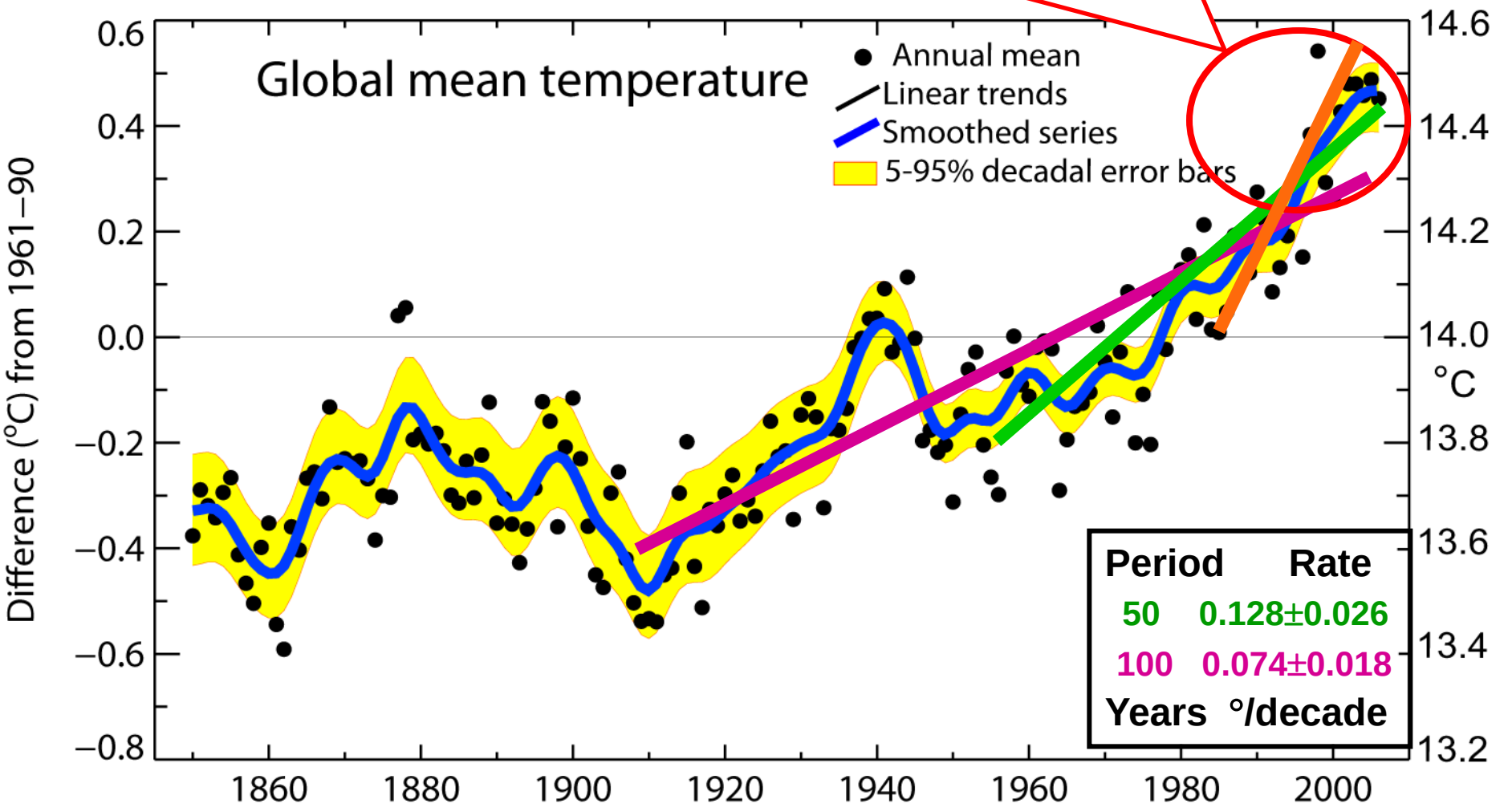
Sources: Calvin J. Hamilton, Views of the solar system, www.planetscapes.com; Bill Arnett , The nine planets, a multimedia tour of the solar system, www.seds.org/billa/tnp/nine/planets.html



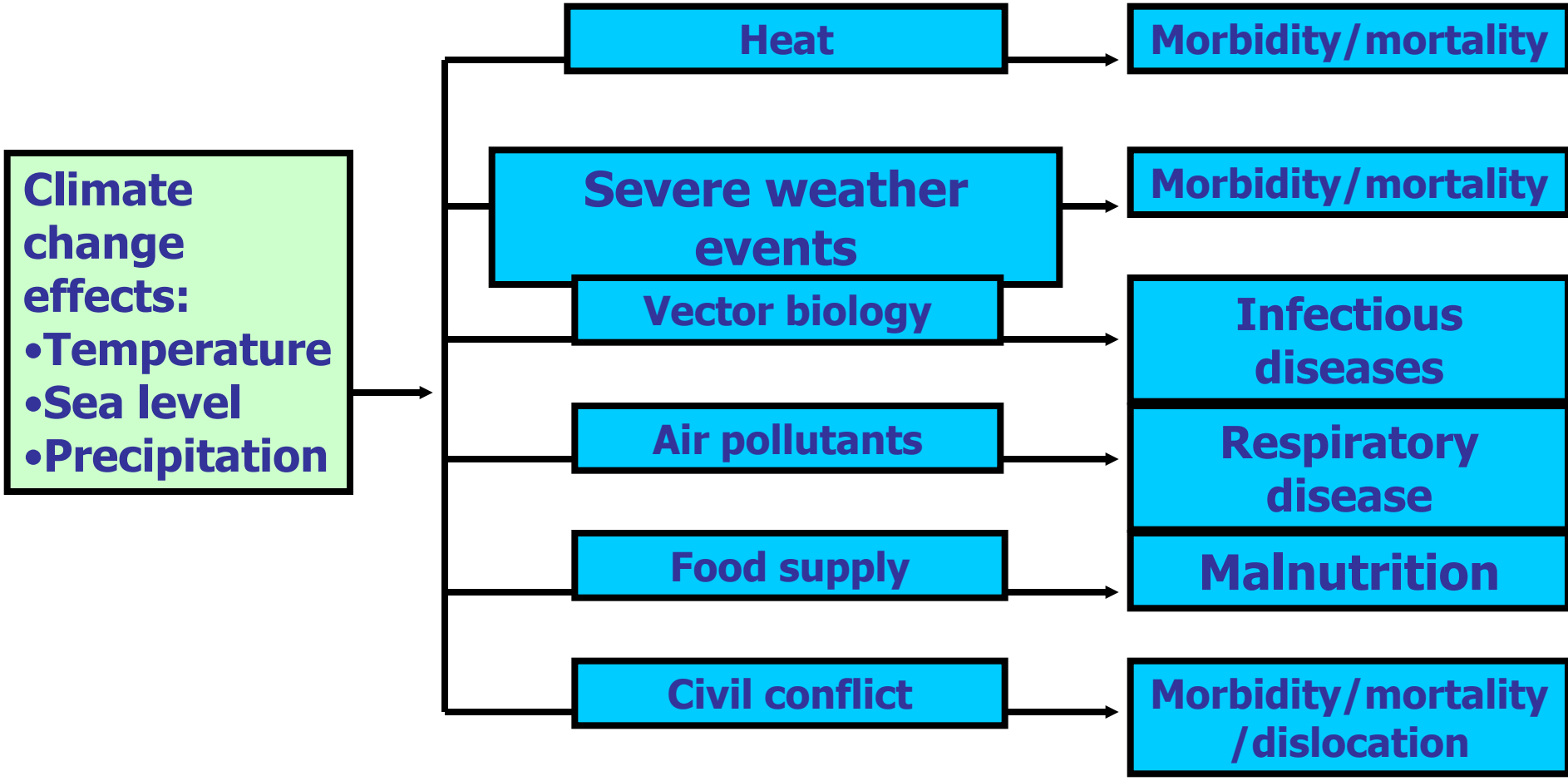
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Global mean temperatures

Warmest 12 years:
1998,2005,2003,2002,2004,2006,
2001,1997,1995,1999,1990,2000



Potential Impacts of Climate Change on Human Health



Infectious diseases

- Temperature affects vector and pathogen biology
- Humidity favors growth of some vectors
- Precipitation favors growth of some vectors
- Wind contributes to dispersal of insects

Disease	Vector	Population at risk (million)[1]	Number of people currently infected or new cases per year	Present distribution	Likelihood of altered distribution
Malaria	Mosquito	2,400[2]	300-500 million	Tropics and Subtropics	
Schistosomiasis	Water snail	600	200 million	Tropics and Subtropics	
Lymphatic Filariasis	Mosquito	1 094[3]	117 million	Tropics and Subtropics	
African Trypanosomiasis (Sleeping sickness)	Tsetse fly	55[4]	250 000 to 300 000 cases per year	Tropical Africa	
Dracunculiasis (Guinea worm)	Crustacean (Copepod)	100[5]	100 000 per year	South Asia, Arabian Peninsula, Central-West Africa	
Leishmaniasis	Phlebotomine sand fly	350	12 million infected, 500 000 new cases per year[6]	Asia, Southern Europe Africa, Americas	
Onchocerciasis (River blindness)	Black fly	123	17.5 million	Africa, Latin America	
American Trypanosomiasis (Chagas disease)	Triatomine bug	100[7]	18 million	Central and South America	
Dengue	Mosquito	1,800	10-30 million per year	All Tropical countries	
Yellow Fever	Mosquito	450	more than 5 000 cases per year	Tropical South America Africa	

1. Top three entries are population-prorated projections, based on 1989 estimates.
2. WHO, 1994.
3. Michael and Bundy, 1995.
4. WHO, 1994.
5. Ranque, personal communication.
6. Annual incidence of visceral leishmaniasis; annual incidence of cutaneous leishmaniasis is 1-1.5 million cases/yr (PAHO, 1994).
7. WHO, 1995.

Highly likely · Very likely · Likely · Unknown

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GRAPHIC DESIGN : PHILIPPE REKACEWICZ

Source: Climate change 1995, Impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

Three examples

- Malaria
- Dengue fever
- Cholera

HEALTH PROFESSIONALS AND SCIENTISTS WARN OF SPREADING INFECTIOUS DISEASES.

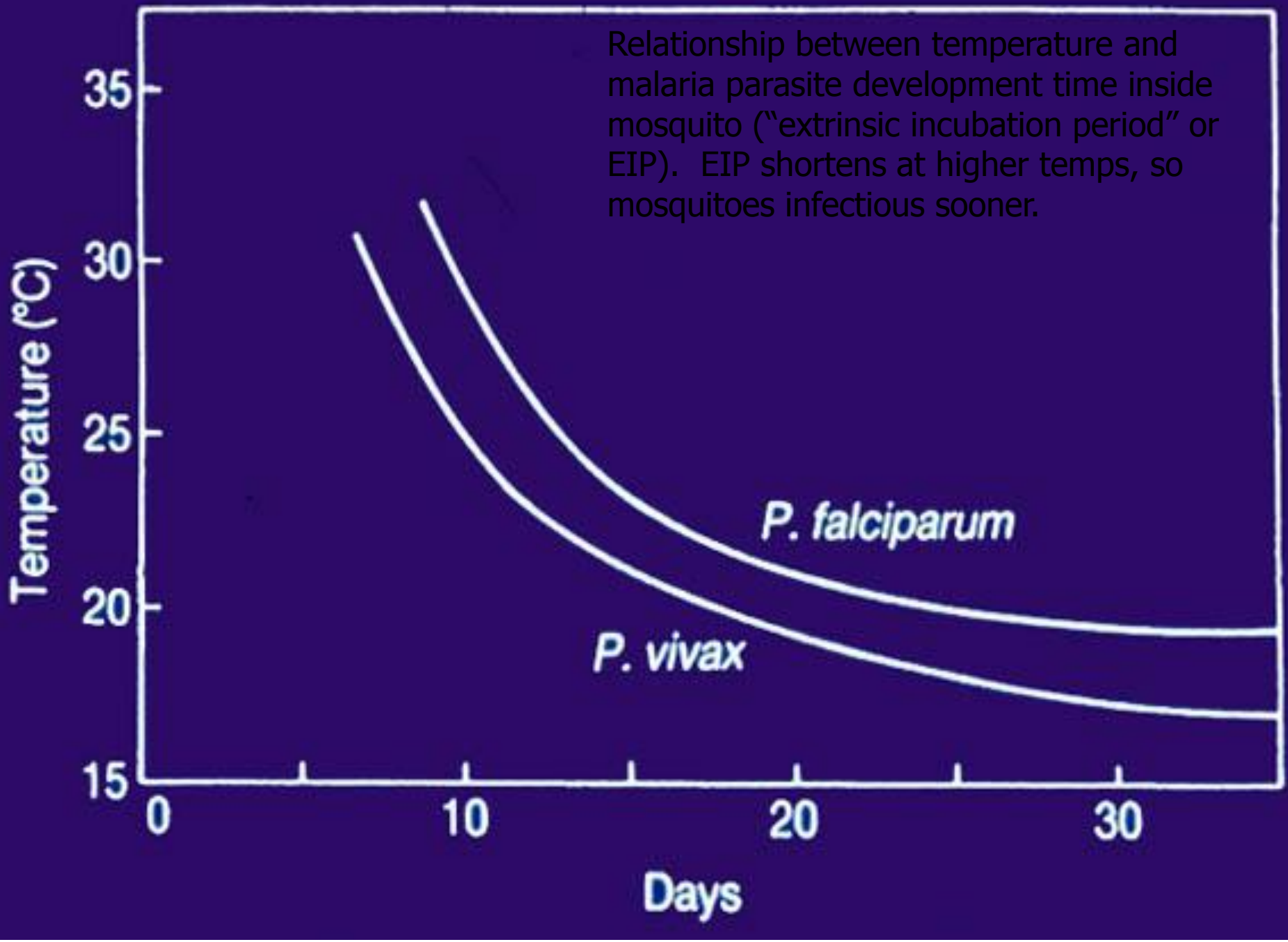
Global Warming's **greatest** threat may also be the **smallest.**

Malaria

- Caused by four species of the protozoan *Plasmodium:* falciparum, vivax, ovale, malariae.
- Transmitted by *anopheline* mosquitoes.
- Most extensive tropical disease in the world.
  - 300-500 million active cases/year
- Major gains in control over the last 50 years, but these gains are threatened.
  - Changes in land use
  - Erosion of clinical services
  - Antibiotic resistance
  - Refugee and war crises

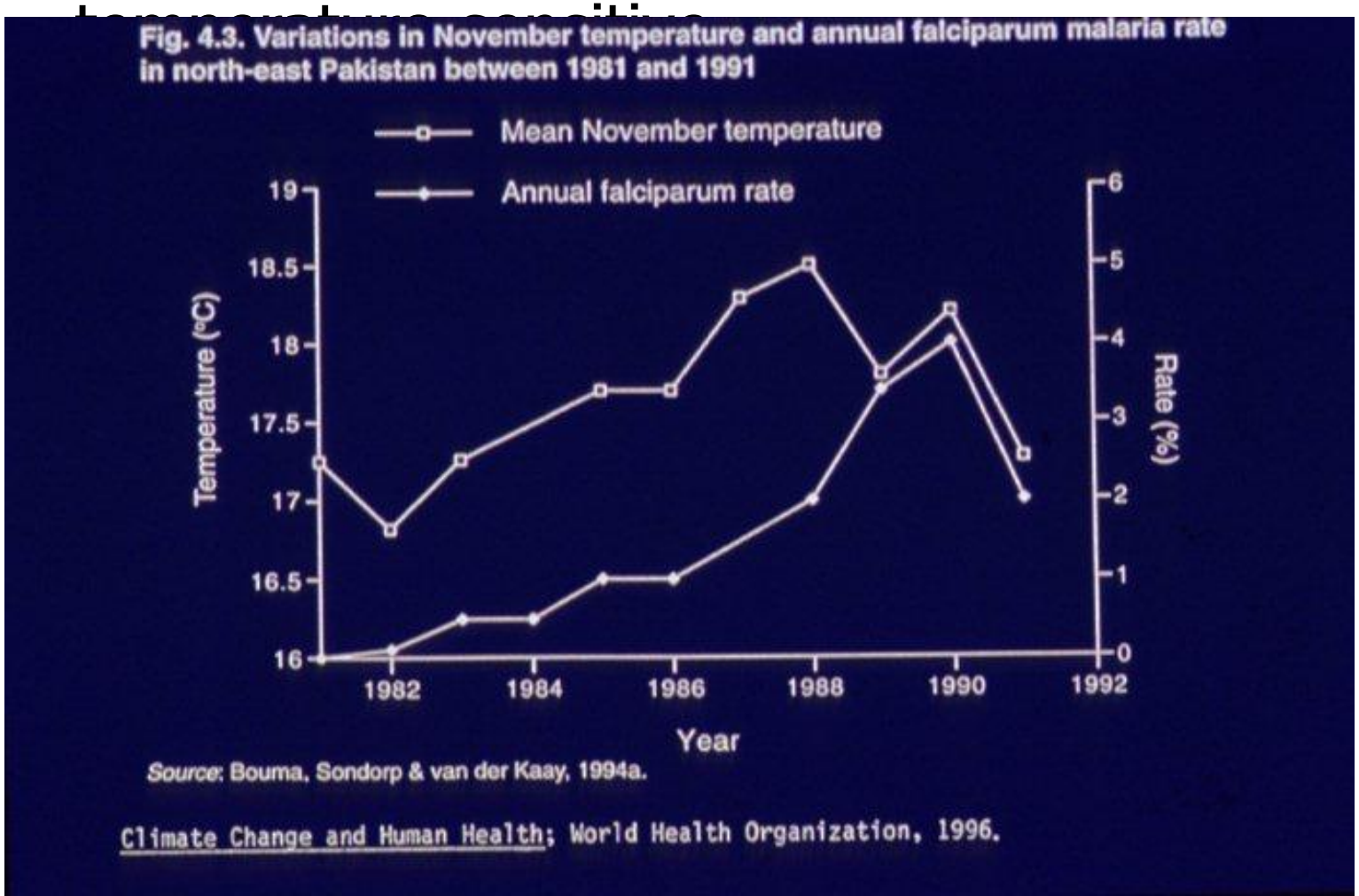
Malaria

- Symptoms: fever, shivering, joint pain, headache, vomiting, seizures, coma. Severe anemia may occur. Death may occur.
- Risk groups:
  - children
  - poor
  - pregnant women
- Outbreaks with severe weather events.
- Both plasmodium and anopheline mosquitoes are temperature-sensitive.


Relationship between temperature and malaria parasite development time inside mosquito ("extrinsic incubation period" or EIP). EIP shortens at higher temps, so mosquitoes infectious sooner.
Temperature (°C)
35
30
25
20
15
0
10
20
30
Days
P. falciparum
P. vivax

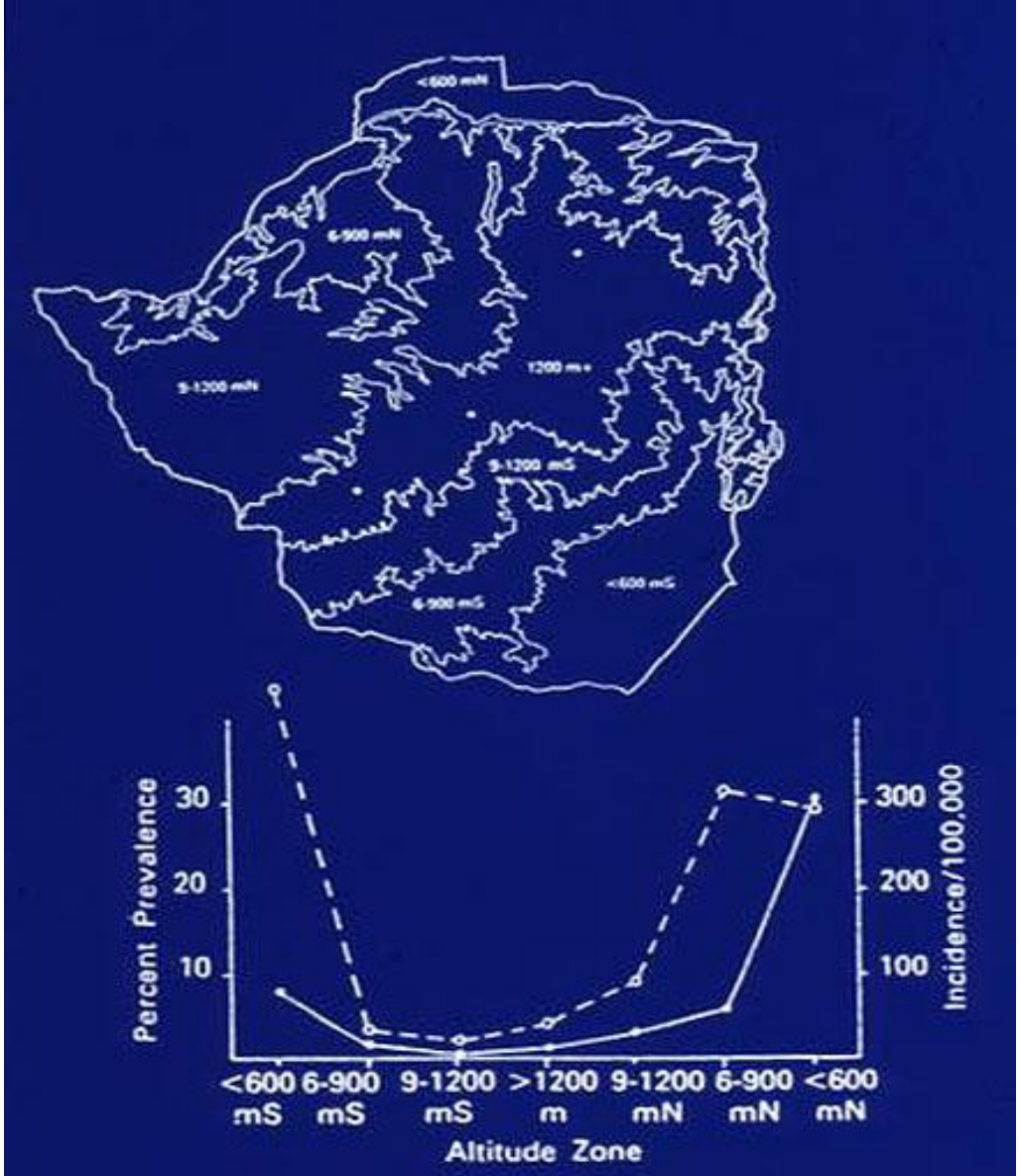
Malaria

- Pathogen (*plasmodium)* transmitted by *anopheline* mosquitoes; both are



Relationship between malaria and altitude, Zimbabwe.

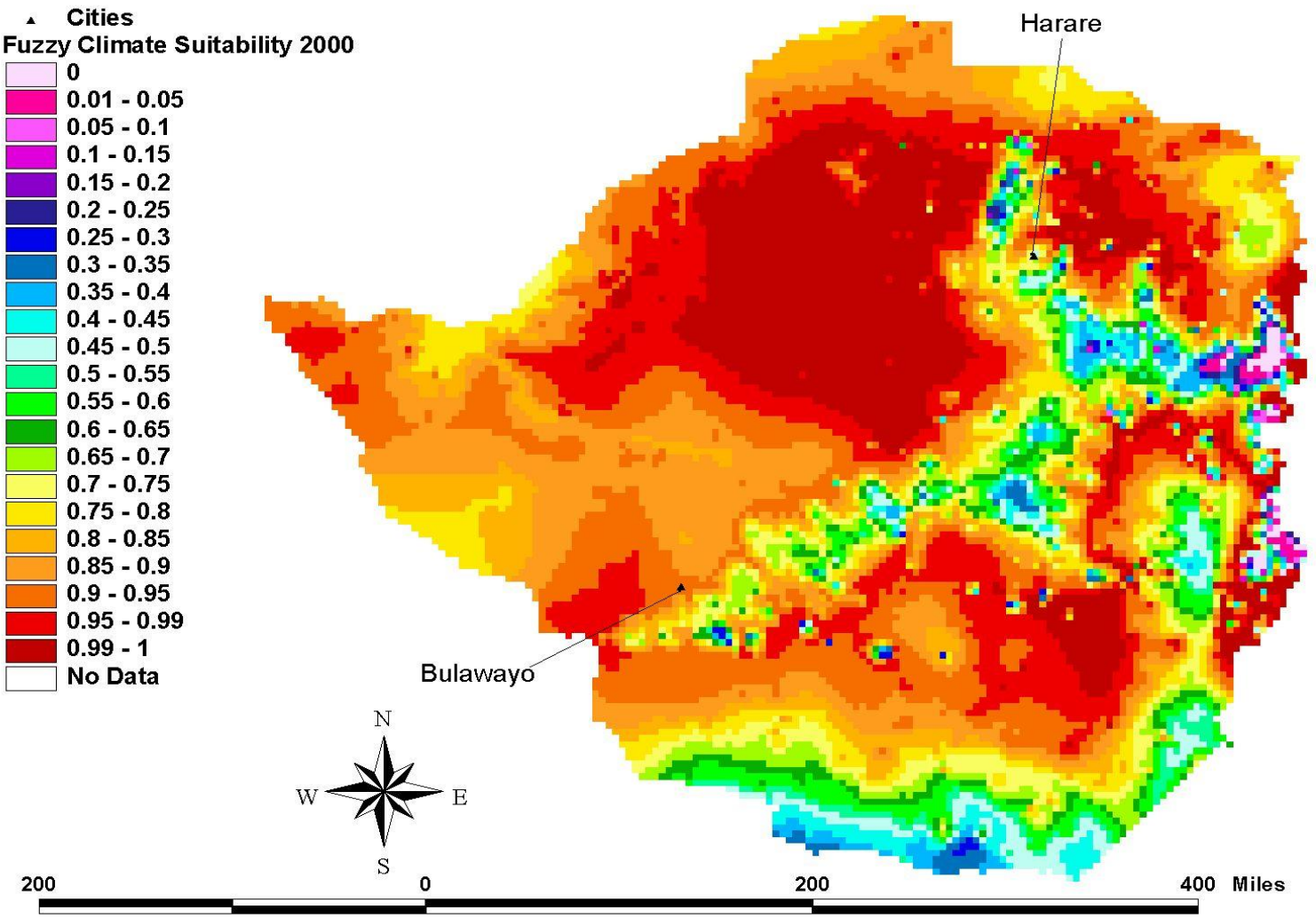
Altitude a good surrogate for temperature: the average temperature decrease with height = **6°C per 1000 meters**



Average annual prevalence and incidence/100,000 population of malaria by altitude zone for the years 1969-1981 and 1972-1981, respectively (Taylor & Mutambu, *Trans. Royal Soc.Trop. Med. & Hyg.*, 1986; 80: 12-19).

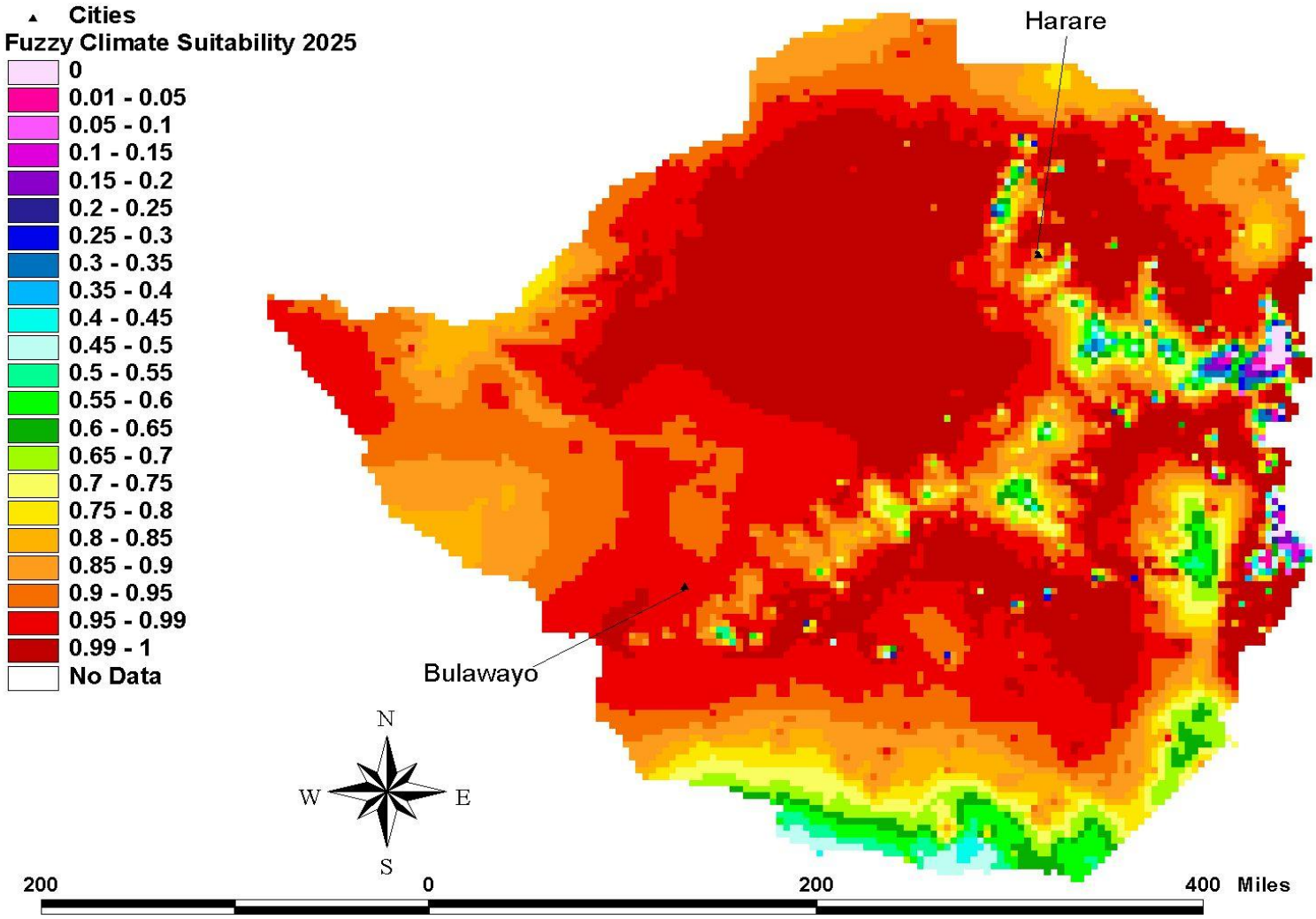
Source: Taylor and Mutambu, 1986

2000 2025 2050 2075



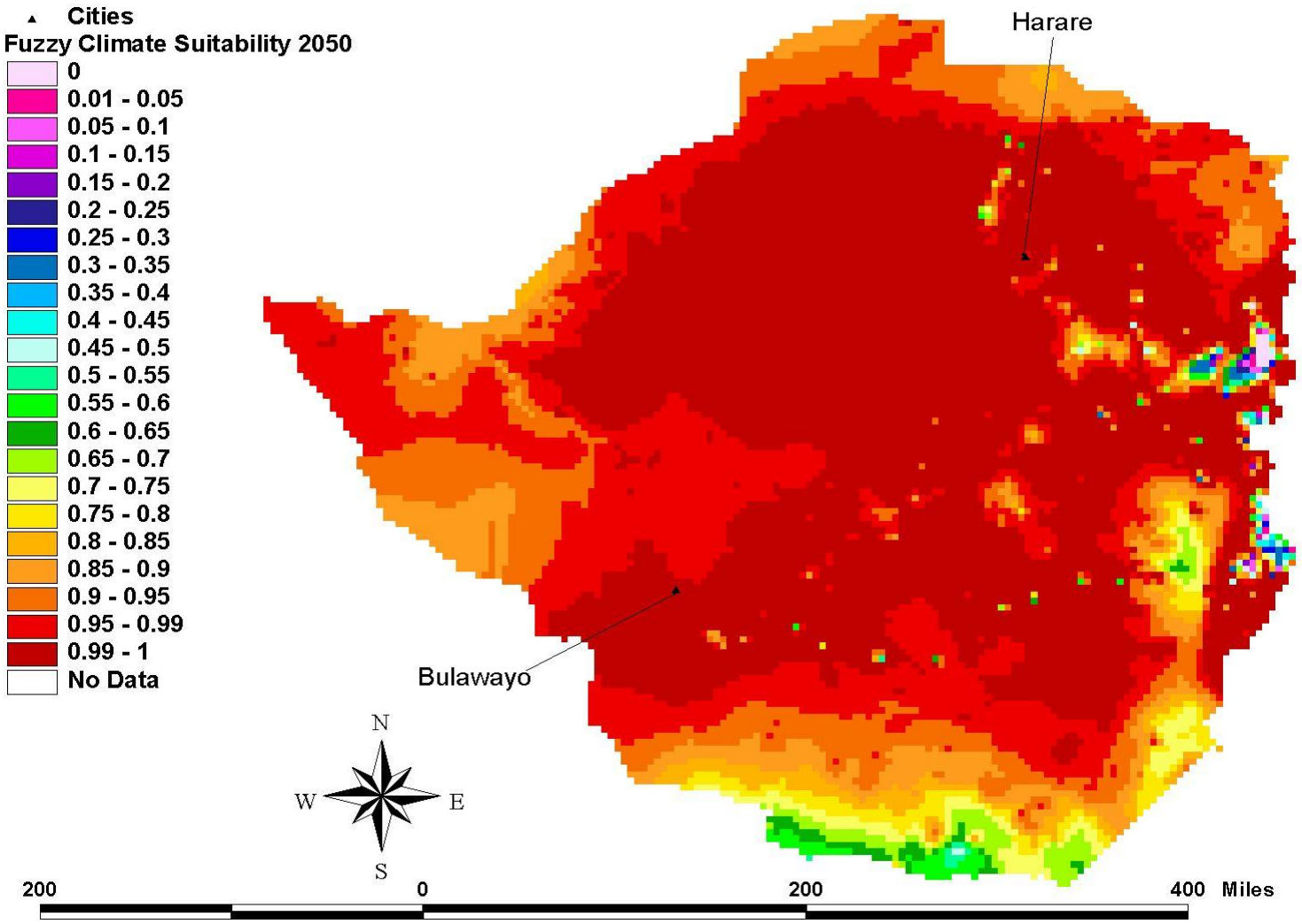
Source: Hartman, Ebi, et al., 2001

2025 2050 2075



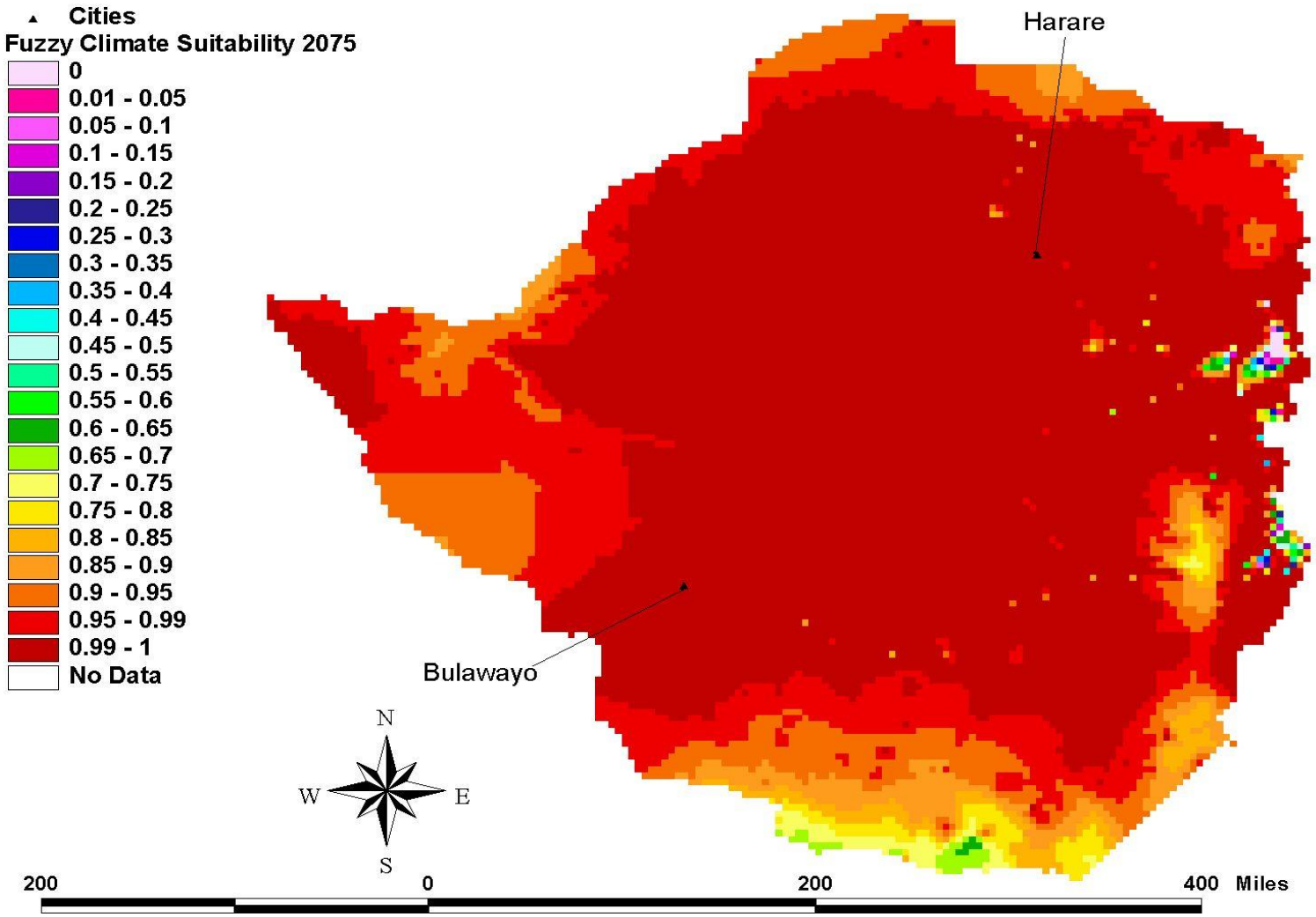
Source: Hartman, Ebi, et al., 2001

2050 2075



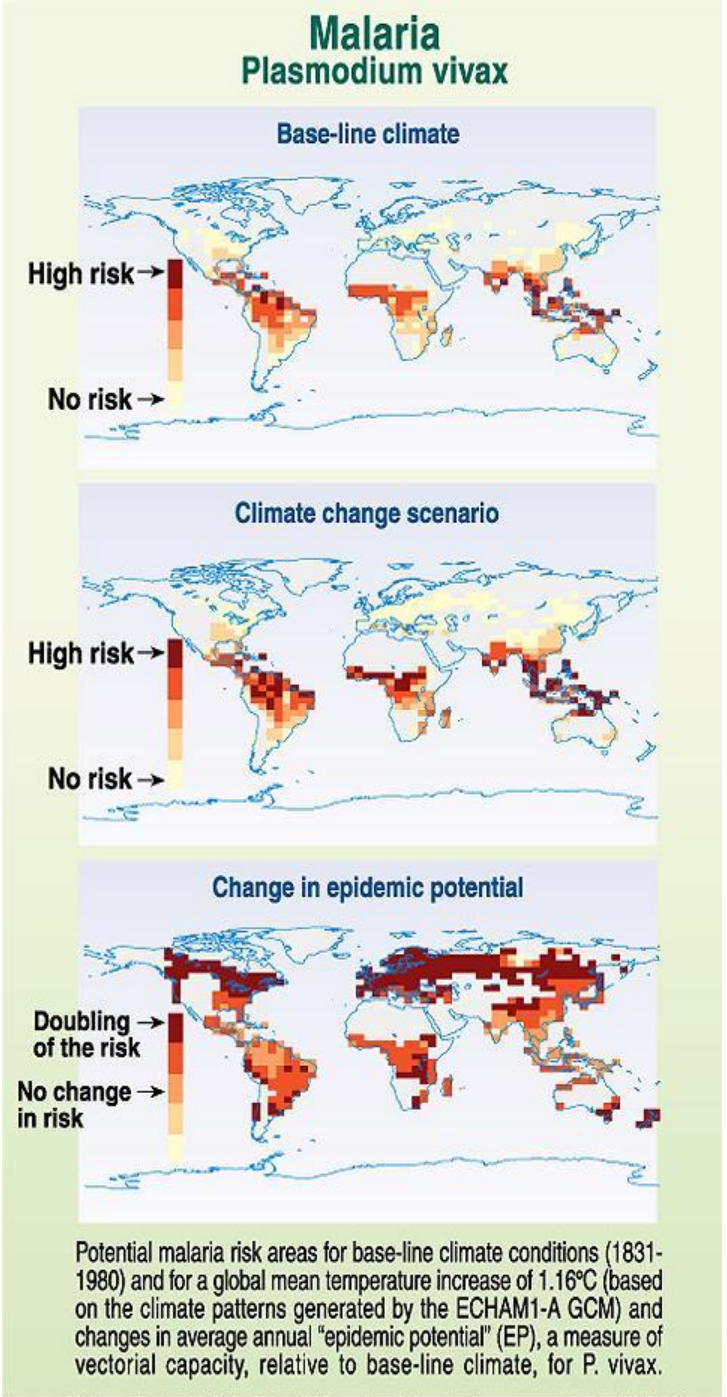
Source: Hartman, Ebi, et al., 2001

Baseline 2000 2025 2050 *2075*



Source: Hartman, Ebi, et al., 2001

Potential malaria risk areas with climate change

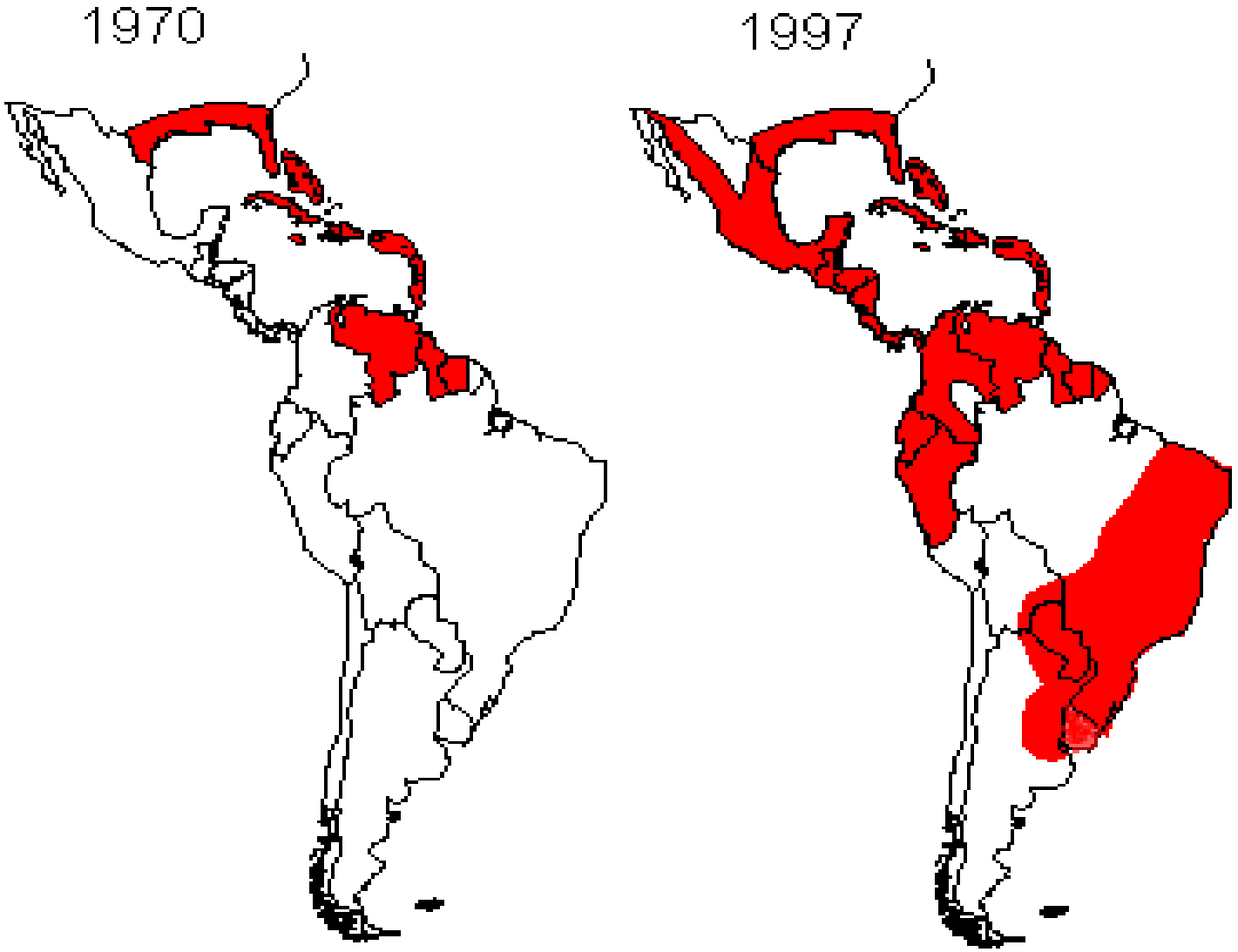


Potential malaria risk areas for base-line climate conditions (1831-1980) and for a global mean temperature increase of 1.16°C (based on the climate patterns generated by the ECHAM1-A GCM) and changes in average annual "epidemic potential" (EP), a measure of vectorial capacity, relative to base-line climate, for P. vivax.

Source: Martens, P. et al. (1995). Potential impacts of climate change on malaria risk. Environme Health Perspectives, 103(5), 458-464.

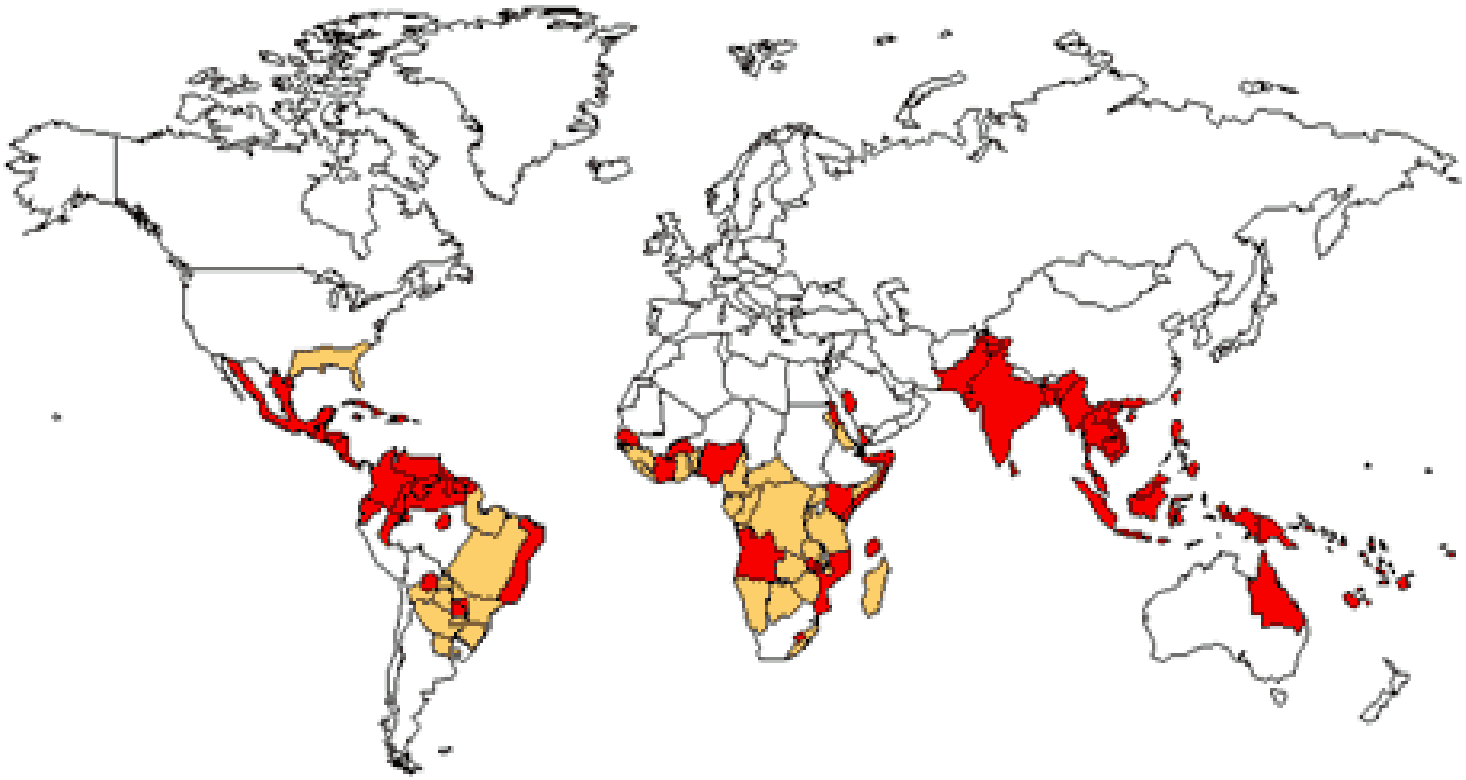
Dengue/ Dengue Hemorrhagic Fever

- Caused by one of four distinct flavivirus serotypes
- No vaccine or treatment available (vaccine trials currently underway)
- DHF average case fatality rate: 5%
- Estimated 50 to 100 million cases each year of dengue, several hundred thousand cases of DHF
  - Spread by *Aedes* mosquito; *Ae. Aegypti* does not survive below 50 °F (10 °C), epidemic transmission unlikely below 68 °F (20 °C)
  - Range is expanding



Distribution of *Ae. Aegypti* mosquito in the Americas in 1970 (at the end of the mosquito eradication program) and in 1997

World Distribution of Dengue - 2000



CDC

Ae. aegypti sensitivity to temperature

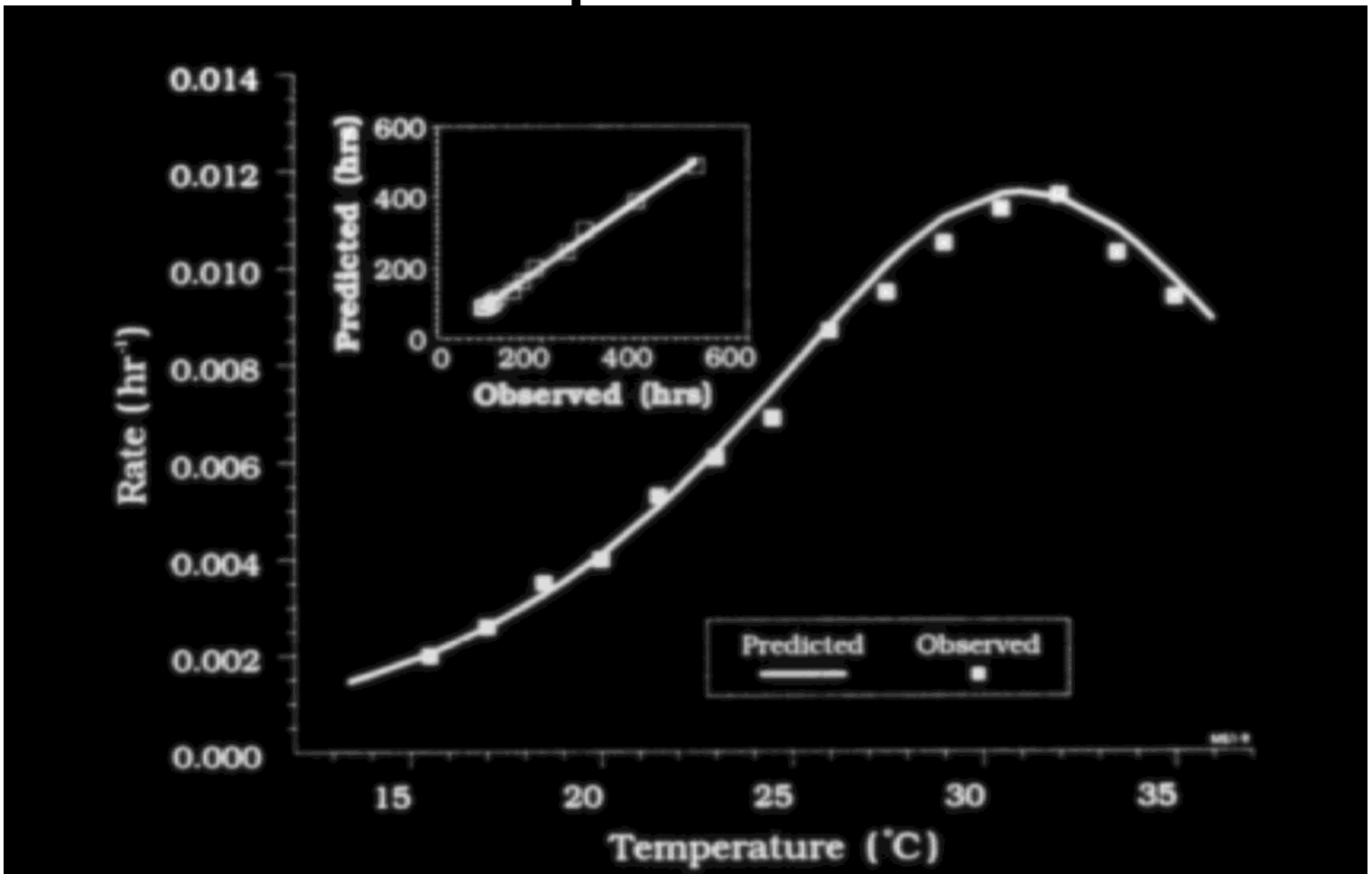


Fig. 5. Developmental rate per hour of *Ae. aegypti* larvae to median pupation (data from Fig. 1 in Gilpin & McClelland 1979) as a function of temperature.

Cholera

- First described over 2,000 years ago
- Modern pandemics began in 1817
- Seventh pandemic began in 1961 in Indonesia, struck South America in 1991
- *V. cholera* was recognized to survive in marine phytoplankton
- Phytoplankton respond to temperature and other factors.

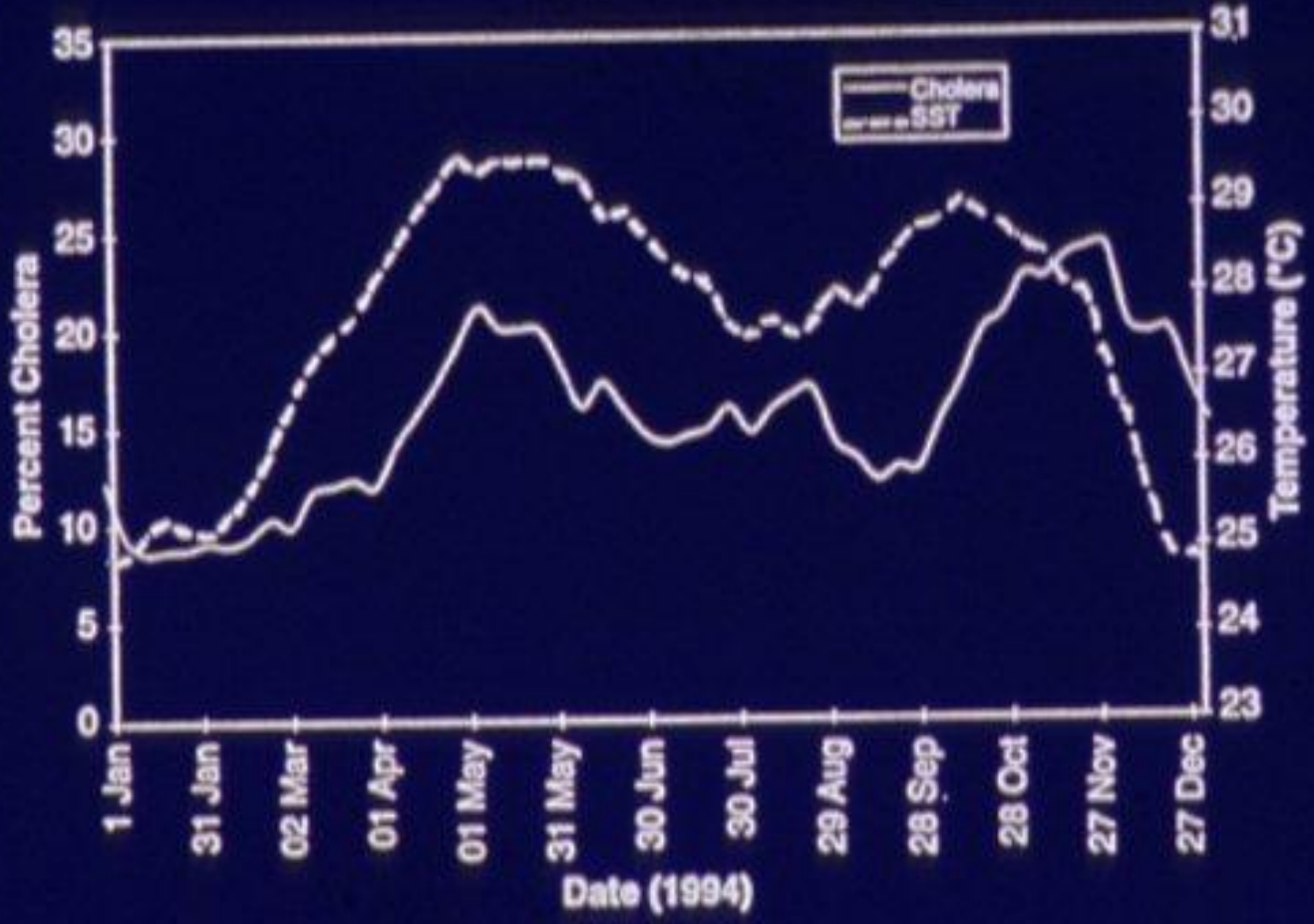


Fig. 1. Relationship between sea surface temperature and cholera case data in Bangladesh from January to December 1994.

Solutions (Water)

Solutions include treatment which has the following main steps:

- Sedimentation
- Coagulation-flocculation,
- Filtration, and
- Disinfection.

Water Treatment

- **Water treatment should reduce to acceptable levels or remove entirely all contaminants present in the water.**
- **Techniques utilized are:**
  - **Sedimentation**
  - **Coagulation-flocculation**
  - **Filtration**
  - **Disinfection**
  - **Conditioning**
  - **Softening**
  - **Fluoridation**
  - **Removal of tastes and odors**
  - **Corrosion control**
  - **Algae control**
  - **Aeration**

Sedimentation

- **Sedimentation is the settling out of comparatively heavy suspended material in water because of gravity**

Coagulation

- **Coagulation is the forming of flocculent particles in a liquid by adding chemicals. Alum (hydrated aluminum sulfate) is mixed with turbid water and then allowed to remain quiet.**

Filtration

- **Filtration is the removal of suspended material from water as it passes through beds of porous material.**

- **The amount of removal depends on character and size of filter media, the thickness of the porous media, and the size and quantity of suspended solids**

- **Use of various layers of sand is quite helpful in rural areas.**

Disinfection

- **Disinfecting the water is the most important water treatment process utilized to destroy all pathogenic bacteria or harmful organisms.**
- **However, proper disinfection will not occur unless the organic material and other materials are removed prior to the disinfecting process.**
- **Disinfecting agents may consist of chlorine, ultraviolet light, or iodine.**
- **The most frequent treatment agent is chlorine.**

Impact of Water Supply and Sanitation on Diarrheal Morbidity among Young Children in the Socioeconomic and Cultural Context of Rwanda *[Environmental Research Section A 90, 76-88 (2002)]*

- **The contamination, first thought to be only a function of rainfall, turned out to be a very complex phenomenon.**
- **Water in homes was contaminated (43.4%) with more than 1100 total coliforms/100 ml due to the use of unclean utensils to transport and store water.**
- **This socio-economic and cultural problem should be addressed with health education about sanitation.**
- **The latrines (found in 43.8% of families) presented a double-edge problem.**
- **The extremely high population density reduced the surface area of land per family, which resulted in a severe nutritional deficit (15% of the children) affecting mainly young children, rendering them more susceptible to diarrhea (three episodes/child/year).**

- The results of the study showed that using an artificial drinking water treatment system decreased the concentration of coliforms from 4 to 1100 total coliforms per 100/mi to 3 - 5 total coliforms per 100/ml.
- The density of the population determined the frequency of contamination.
- Rainfall played a contributory role to the contamination of water.
- Personal sanitation was another determining factor for the increase in contamination (hygiene practices, storage of the water, latrines (43.8% of population had no latrines)).
- Socioeconomic status played a contributing role to the poor standard of living (substandard housing, agricultural subsistence, and a low educational level of 2.8 years on average).

- Poor nutritional status increased the sus-ceptibility to diarrheal diseases (on average, three episodes per child per year).
- Malnutrition increases the severity and duration of diarrhea, and diarrhea may cause malnutrition.
- Water provision is seen by a large sector of people as the most fundamental means of survival.
- However, with regard to health challenges facing the developing countries, sanitation is an area that is not being adequately addressed, primarily because of a lack of demand.
- This problem is being exacerbated by some development organizations that provide ‘free” sanitation without people appreciating the need for sanitation.

• The control of diarrheal diseases must be a comprehensive program including the water supply, excreta disposal, health education, and improvement of the standard of living.

• ***There is no best way to achieve health improvements, except that it must be by people themselves***.

•Interventions in water supply and sanitation infrastructure, together with hygiene education and the extension of primary health care services in Rwanda, need to be implemented within an integrated multidisciplinary framework.

•This should result in a significant reduction in the incidence of diarrheal disease and its severity (including death), which may be associated with a reallocation of health care resources to other pressing health and social needs.