

Riverbeds in urban environment and risks of water-related diseases spreading in developing and developed countries

THE ECOSYSTEM SERVICES OF URBAN RIVERS

April 19th – 22th 2016 – Chateau Křtiny, Czech Republic

Not known ecology of the most microorganisms

The Netherlands

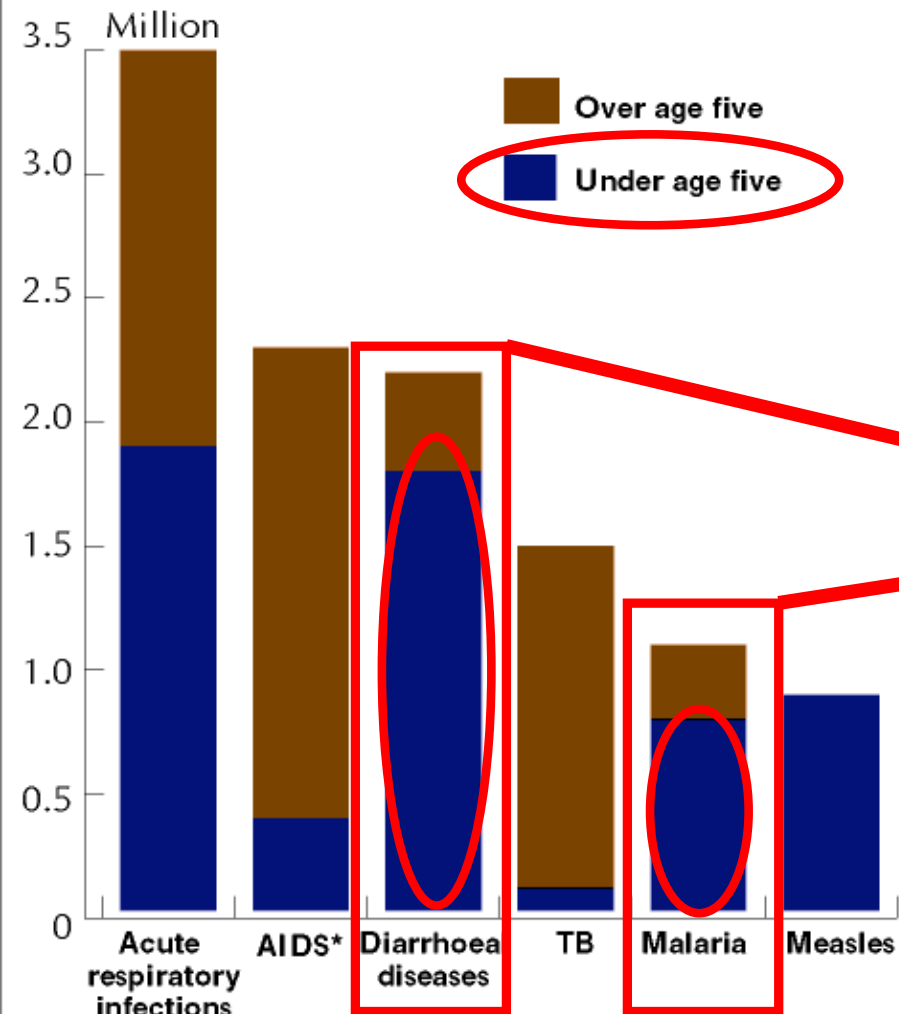


Nicaragua



LEADING INFECTIOUS KILLERS

Six high-burden diseases cause 90% of total disease deaths

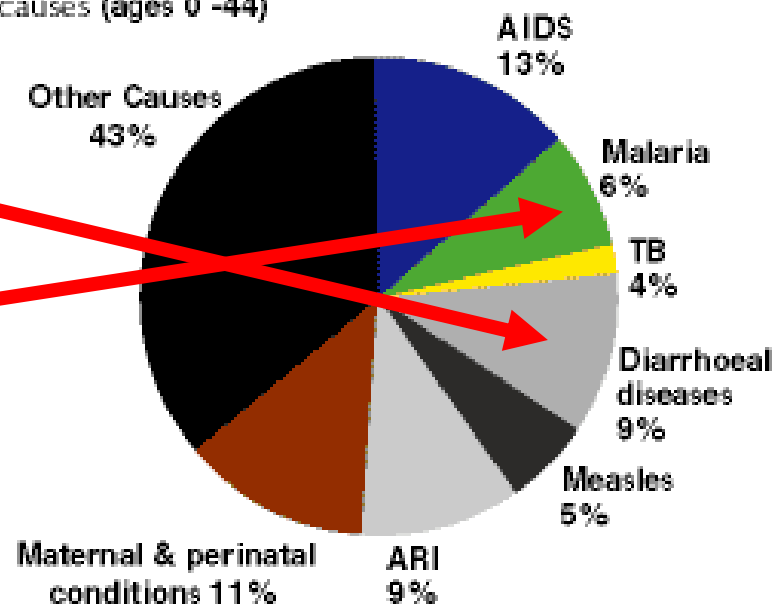


*HIV-positive people who have died with TB have been included among AIDS deaths

Source: World Health Organization/CDS 1999

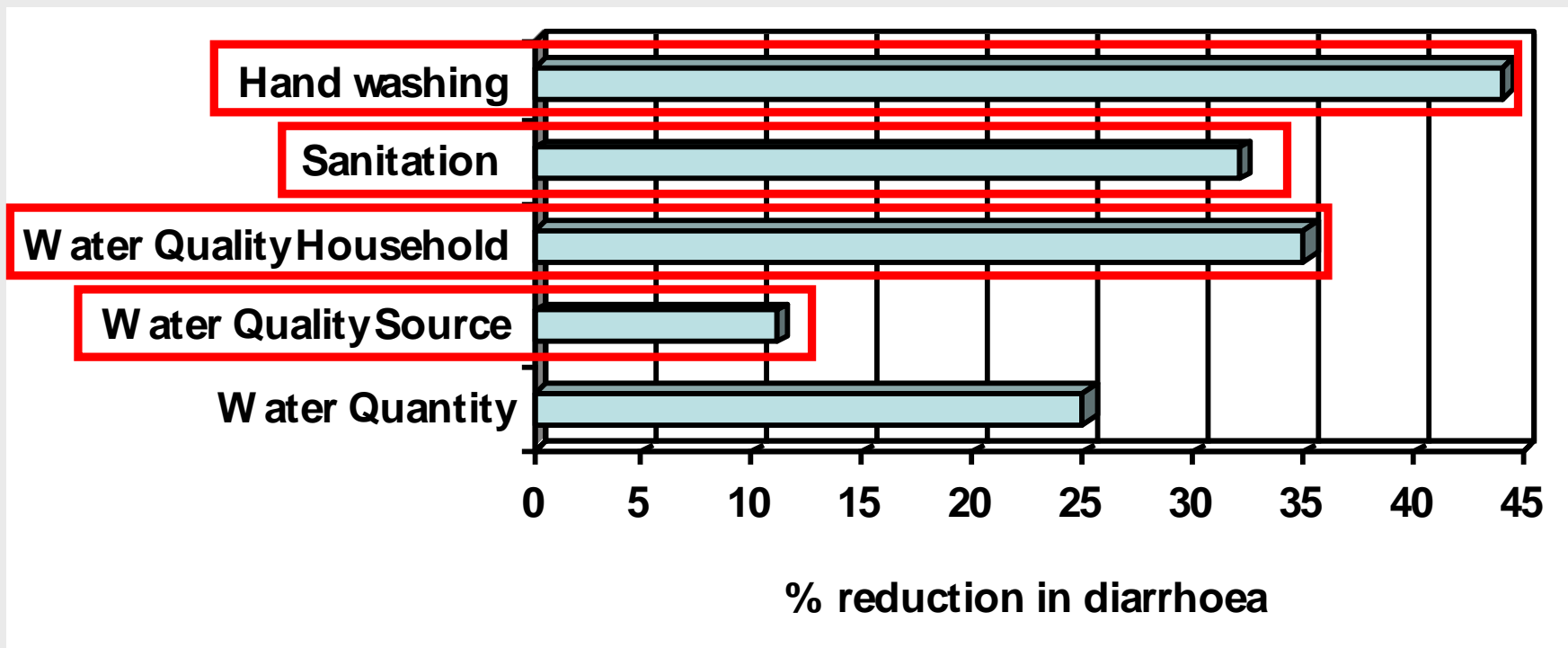
DEATHS IN DEVELOPING COUNTRIES

Two out of three deaths among children and young adults in Africa and Southeast Asia are due to seven causes (ages 0 -44)



Source: World Health Organization/CDS

Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis, Fewtrell et al (2005)



Safe Drinking Water

- Free from pathogenic agents
- Free from harmful chemicals
- Pleasant to taste
- Usable for domestic purposes



Safe Water for International Travelers (SWIT)

1 Drop Countries

Madagascar, Nepal, Yemen, Angola, Iraq, Laos

2 Drops Countries

Egypt, Zimbabwe, Morocco, India, Kenya, Dominican Republic

3 Drops Countries

Turkey, Saudi Arabia, Cuba, Indonesia, Vietnam, South Africa, Tunisia, Thailand

Safe Water for International Travelers (SWIT)

4 Drops Countries



Slovakia, Bulgaria, Croatia, Hungary, Kuwait

5 Drops Countries



Czech Republic, Austria, USA, Spain, Greece,
The Netherlands, Israel

1. **Water-borne diseases** (microbial contamination of drinking water) – infectious agent ingested
2. **Water-washed (water-scared) diseases** (sufficient water quantities) – person to person
3. **Water-based diseases** (infection through contact with water) – intermediate host in water
4. **Water-associated vector-borne diseases** (ecosystems conducive to vector breeding) – insect breeding or biting near water

1. Water-borne diseases - ECOLOGY

(microbial contamination of drinking water)

- Developing countries



Nicaragua

Photo I. Pavlik



Nicaragua

Photo I. Pavlik

Ometepe Lake, Nicaragua

Rivas



Photo I. Pavlik

Ometepe Lake, Nicaragua

Rivas



Photo I. Pavlik

Somoto River, Nicaragua



Photo I. Pavlik



Somoto River, Nicaragua



Photo I. Pavlik

Dolores, Nicaragua



Nicaragua



Photo I. Pavlik



Nicaragua



Photo I. Pavlik

Ice represents critical factor (vehiculum)!



Granada, Nicaragua

Managua, Nicaragua



Water contamination, Mexico



Photo I. Pavlik

Water contamination, Brazil



1. Water-borne diseases - ingested (microbial contamination of drinking water)



Infectious water-borne diseases

- Water-borne diseases are caused by pathogens that can be directly spread through contaminated water.
- Most cause diarrheal illness spread through the fecal-oral route.
- **Viruses:** Hepatitis A, E, Rotaviruses, noroviruses
- **Bacteria:** Cholera, Shigellosis and Typhoid Fever
- **Protozoa:** Cryptosporidiosis, Giardiasis
- **Helminths:** Guinea Worm, Schistosomiasis (Bilharzia)

Examples from Nicaragua - rotaviruses

Journal of Clinical Virology 46 (2009) 391–393



Contents lists available at ScienceDirect

Journal of Clinical Virology

journal homepage: www.elsevier.com/locate/jcv



Letter to the Editor

Zoonotic bovine rotavirus strain in a diarrheic child, Nicaragua

Other group A rotaviruses representing various genotype specificities. Using phylogenetic analysis,⁷ the most likely ancestors



Ometepe Lake, Nicaragua

Photo I. Pavlik

Rotaviruses – seasonal variations (raining...)

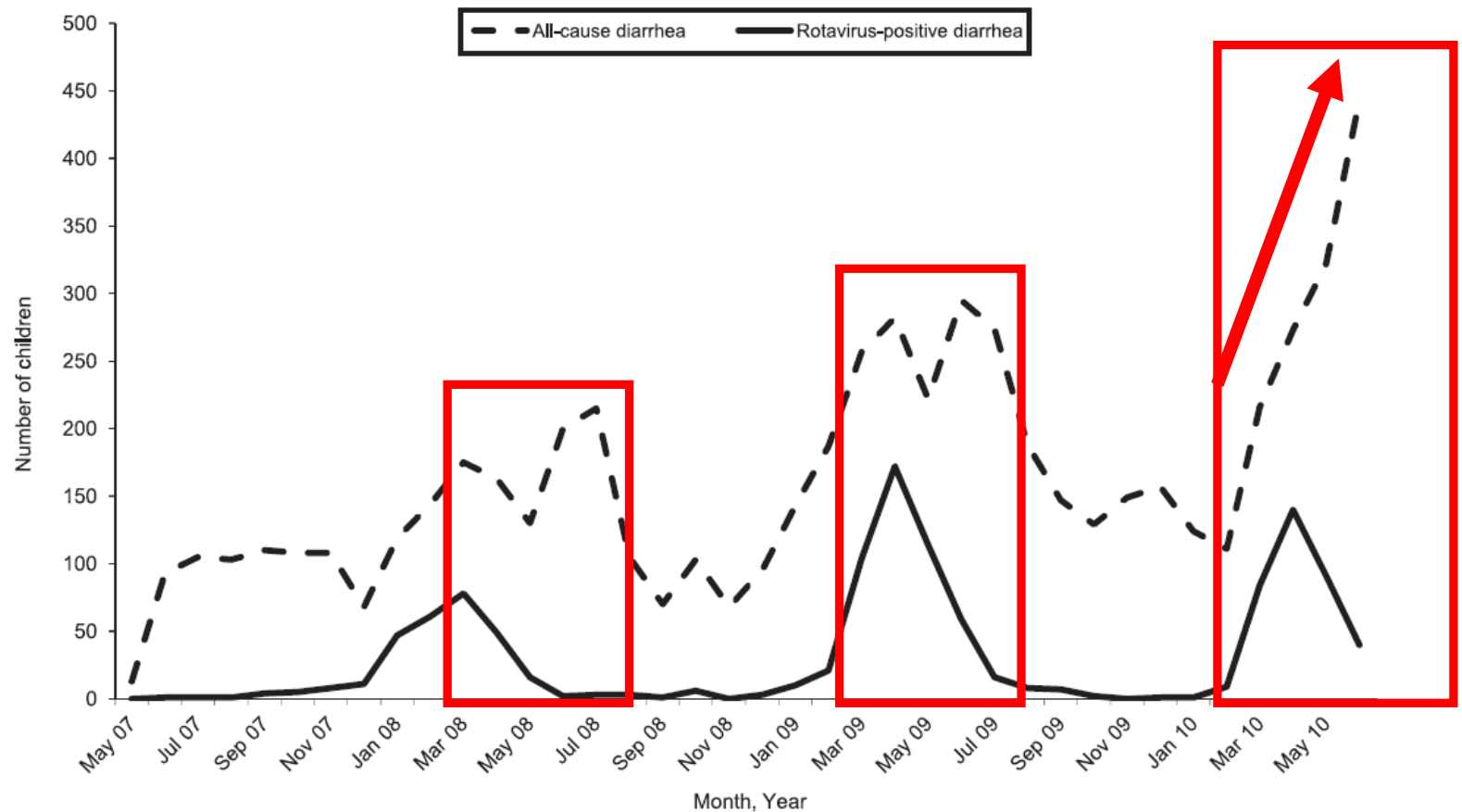


FIGURE 1

Monthly number of vaccine age-eligible children with severe diarrhea and rotavirus positive diarrhea, 4 hospitals, Nicaragua, July 2007 through June 2010.

Community Diarrhea Incidence Before and After Rotavirus Vaccine Introduction in Nicaragua

Sylvia Becker-Dreps,* Marlon Meléndez, Lan Liu, Luis Enrique Zambrana, Margarita Paniagua, David J. Weber, Michael G. Hudgens, Mercedes Cáceres, Carina Källestål, Douglas R. Morgan, Félix Espinoza, and Rodolfo Peña

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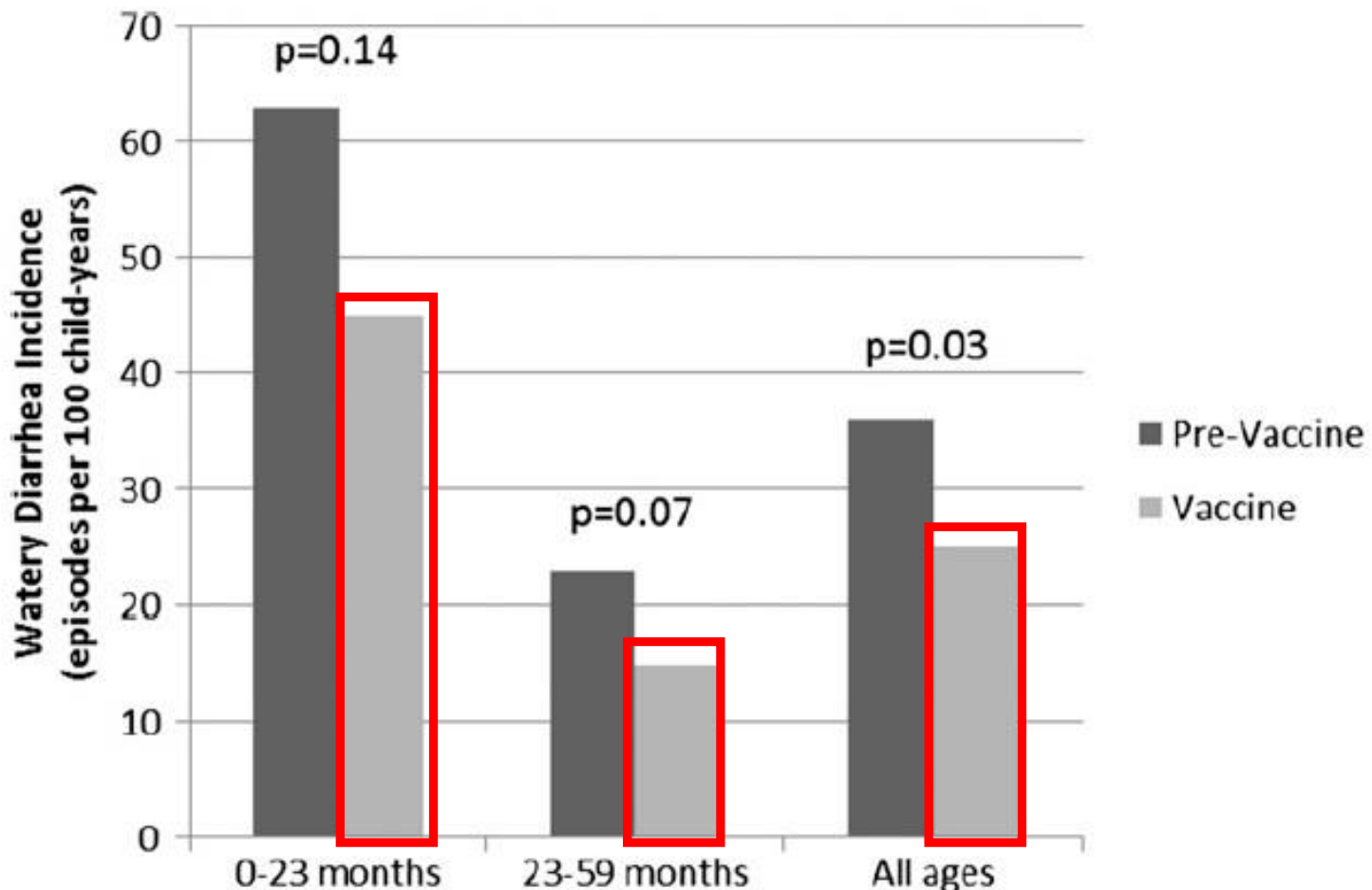


FIGURE 2. Watery diarrhea incidence by age group.

Hepatitis A

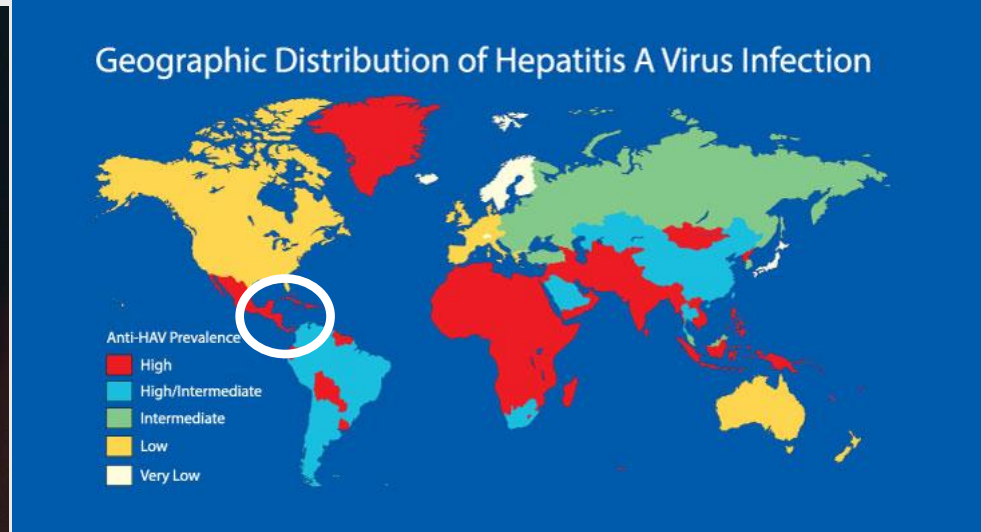
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Decreasing Risk of Hepatitis A Infection in León, Nicaragua: Evidence from Cross-Sectional and Longitudinal Seroepidemiology Studies

Orlando Mayorga Perez¹, Martin W. G. Brinkhof^{2a}, Matthias Egger², Gert Frösner³, Christian Herzog^{4a,b}, Marcel Zwahlen^{2*}

1 Department of Microbiology and Parasitology, Faculty of Medical Sciences, National Autonomous University, León, Nicaragua, 2 Institute of Social & Preventive Medicine (ISPM), University of Berne, Berne, Switzerland, 3 Max von Pettenkofer Institute, Ludwig-Maximilians University, Munich, Germany, 4 Crucell Switzerland AG, Berne, Switzerland



León – touristic center in Nicaragua



Photo I. Pavlik

Sewage management...

León



Water contaminations



Photo I. Pavlik

Risks of infection (humans' expositions)



Hepatitis A virus expositions (Nicaragua)

Photo I. Pavlik



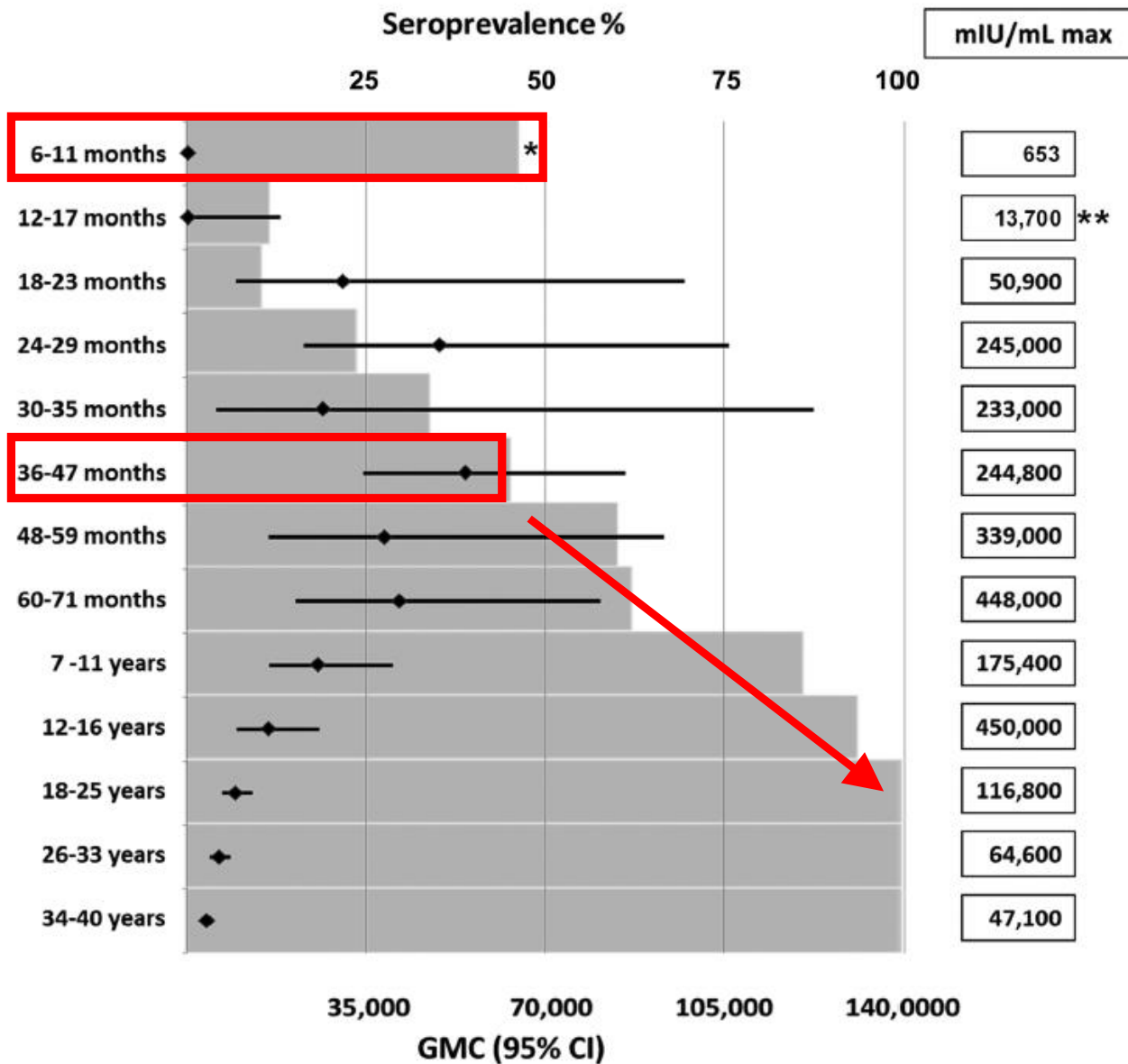
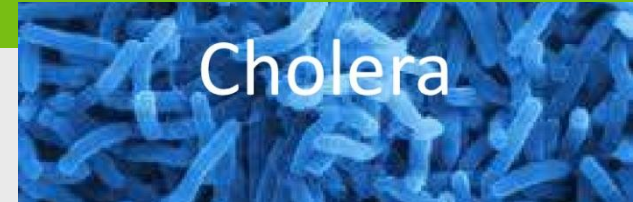
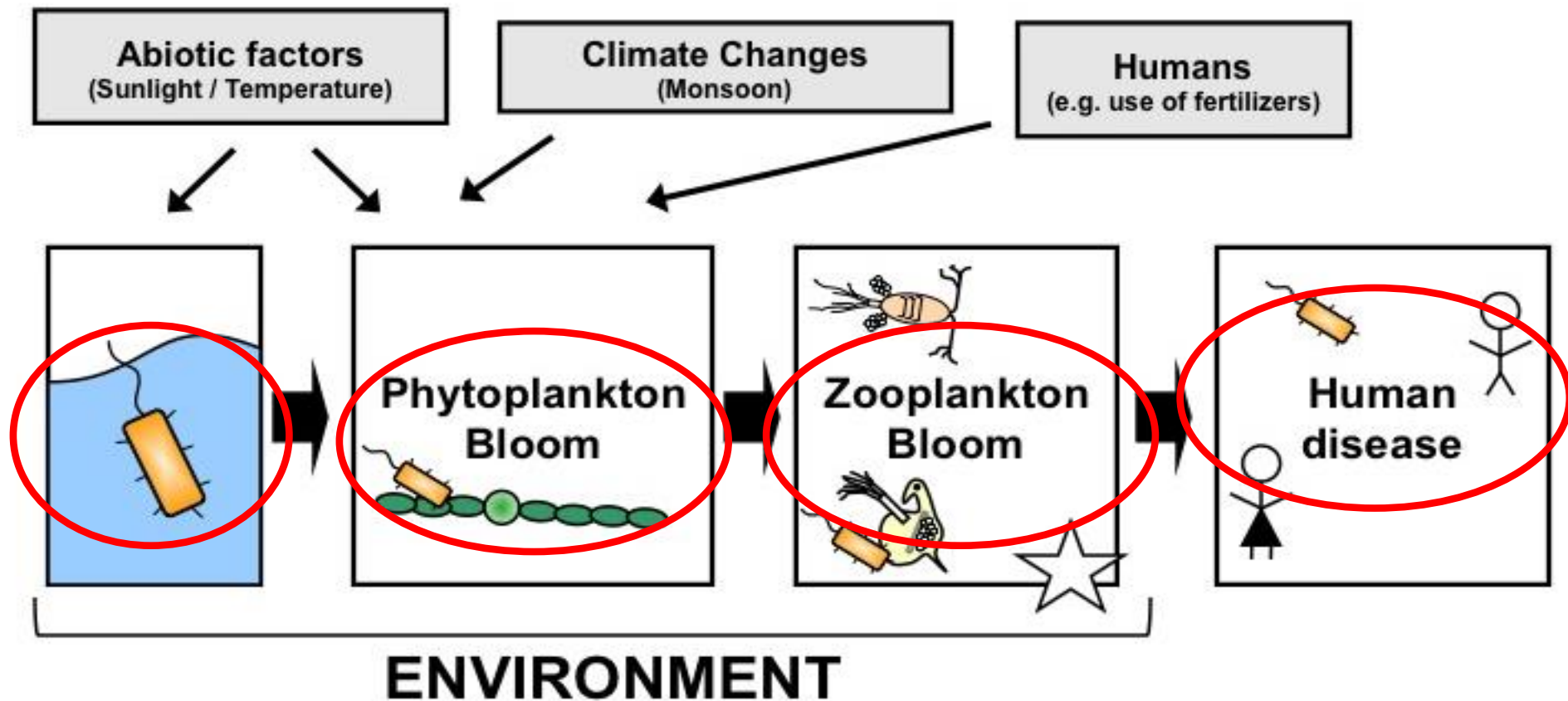


Figure 3. Age-specific seroprevalence, GMC and maximum values of anti-HAV antibodies in the 2003 cross-sectional sample. The shaded bars (upper scale) represent seroprevalence rates; the diamonds (lower scale) indicate GMC with lines representing 95% confidence intervals. * The seroprevalence of the 6–11 months old children is entirely due to maternal anti-HAV antibodies (see Table 2). ** The maximal concentration of 13700 mIU/mL was caused by one recent HAV infection. Three other anti-HAV positive children in this group had maternal anti-HAV with concentrations of 26, 28 and 31 mIU/ml (see Table 2).
doi:10.1371/journal.pone.0087643.g003

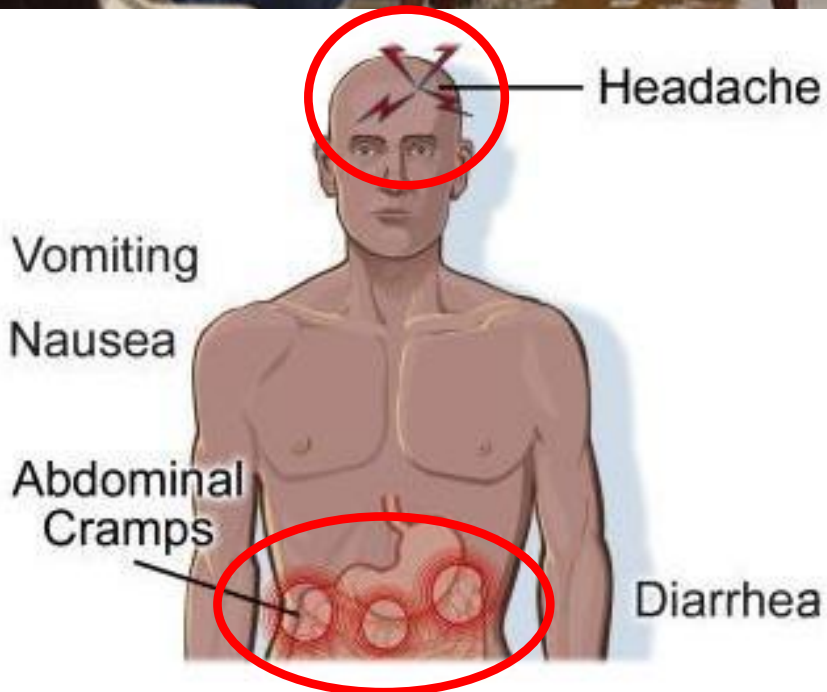
Examples from Nicaragua - bacteria



The Cholera Model – Effects of Global Climate on Infectious Disease



Risks and clinical signs – *Vibrio cholerae*

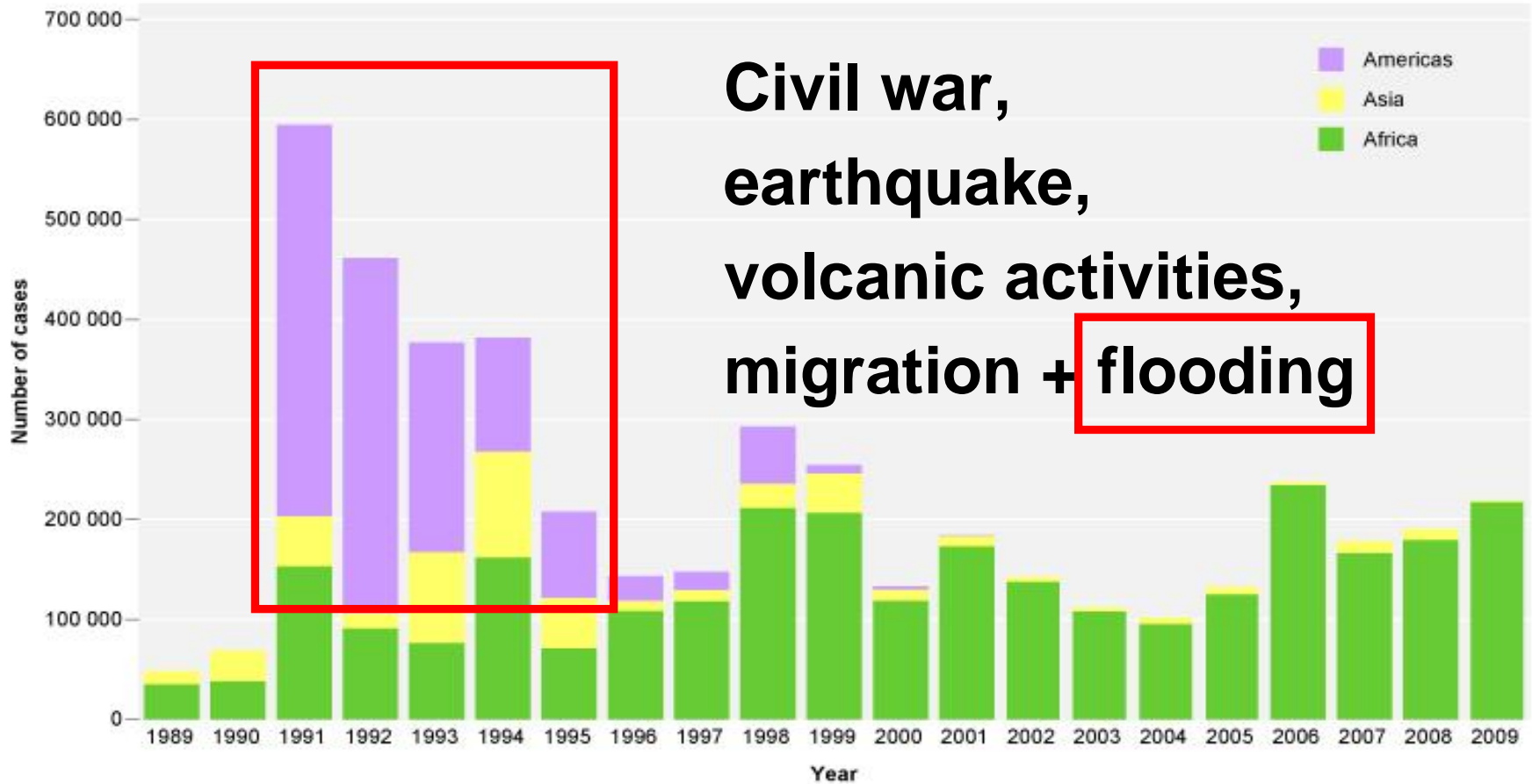


Notifiable disease – Central America epidemic



World Health Organization

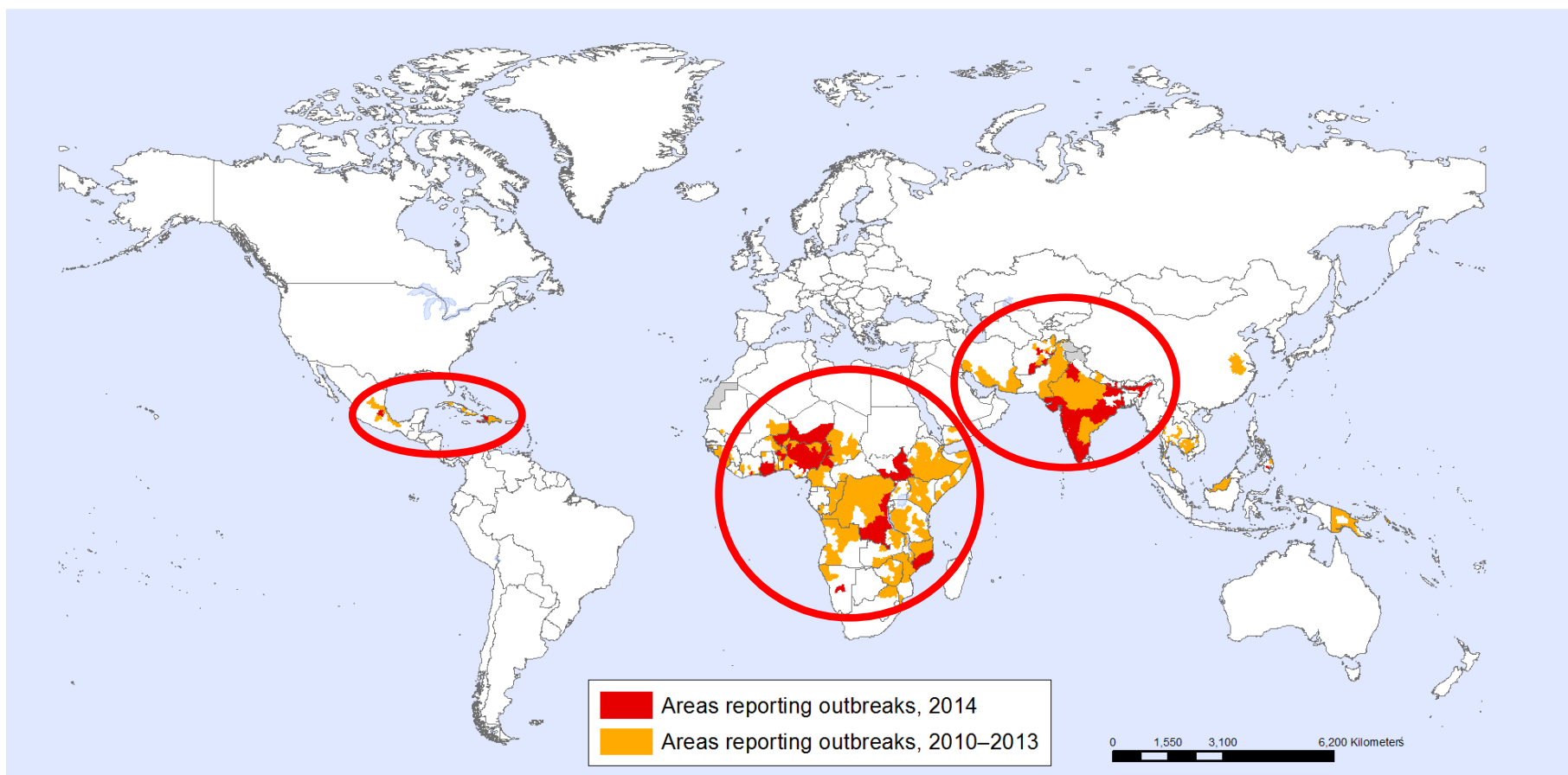
Cholera cases reported to WHO by year and by continent
1989–2009



Source: WHO Weekly Epidemiological Record no. 31, 2010, 85, 293–308

Current cholera outbreaks, 2010-2014

Cholera, areas reporting outbreaks, 2010–2014



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Health Statistics and Information Systems (HSI)
World Health Organization



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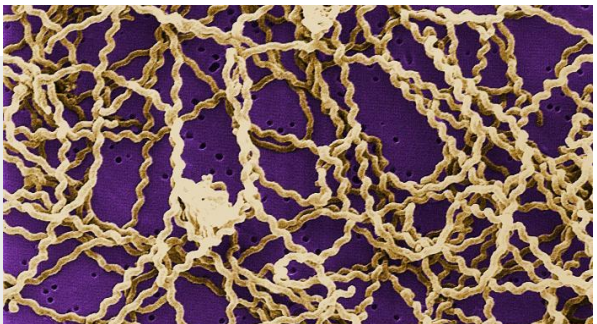
Leptospirosis in Nicaragua – river water

Am. J. Trop. Med. Hyg., 63(5, 6), 2000, pp. 249–254
Copyright © 2000 by The American Society of Tropical Medicine and Hygiene

ASYMPTOMATIC INFECTION AND RISK FACTORS FOR LEPTOSPIROSIS IN NICARAGUA

DAVID A. ASHFORD, ROBYN M. KAISER, RICHARD A. SPIEGEL, BRADLY A. PERKINS, ROBBIN S. WEYANT, SANDRA L. BRAGG, BRIAN PLIKAYTIS, CARLOS JARQUIN, JOSE O. DE LOSE REYES, AND JUAN J. AMADOR

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RISK FACTORS FOR LEPTOSPIROSIS IN NICARAGUA

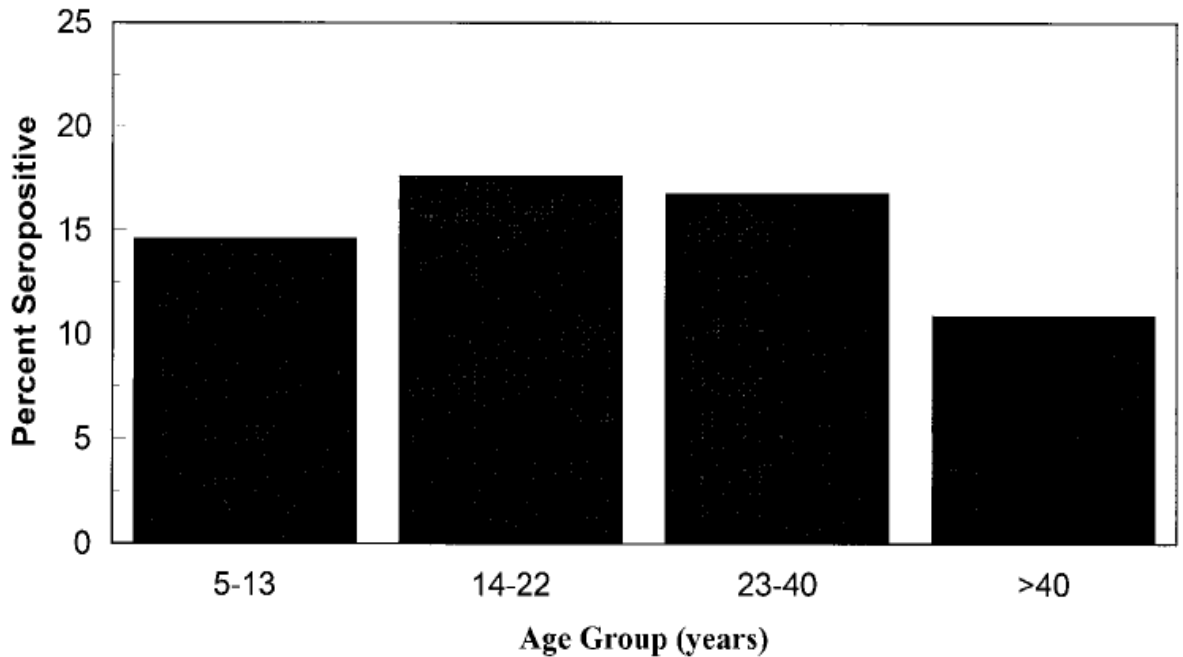


FIGURE 1. Age-specific attack rate for leptospirosis infection in El Sauce, Nicaragua, 1995.

Leptospirosis in Nicaragua – distribution

Int. J. Environ. Res. Public Health 2012, 9, 3883-3910; doi:10.3390/ijerph9113883

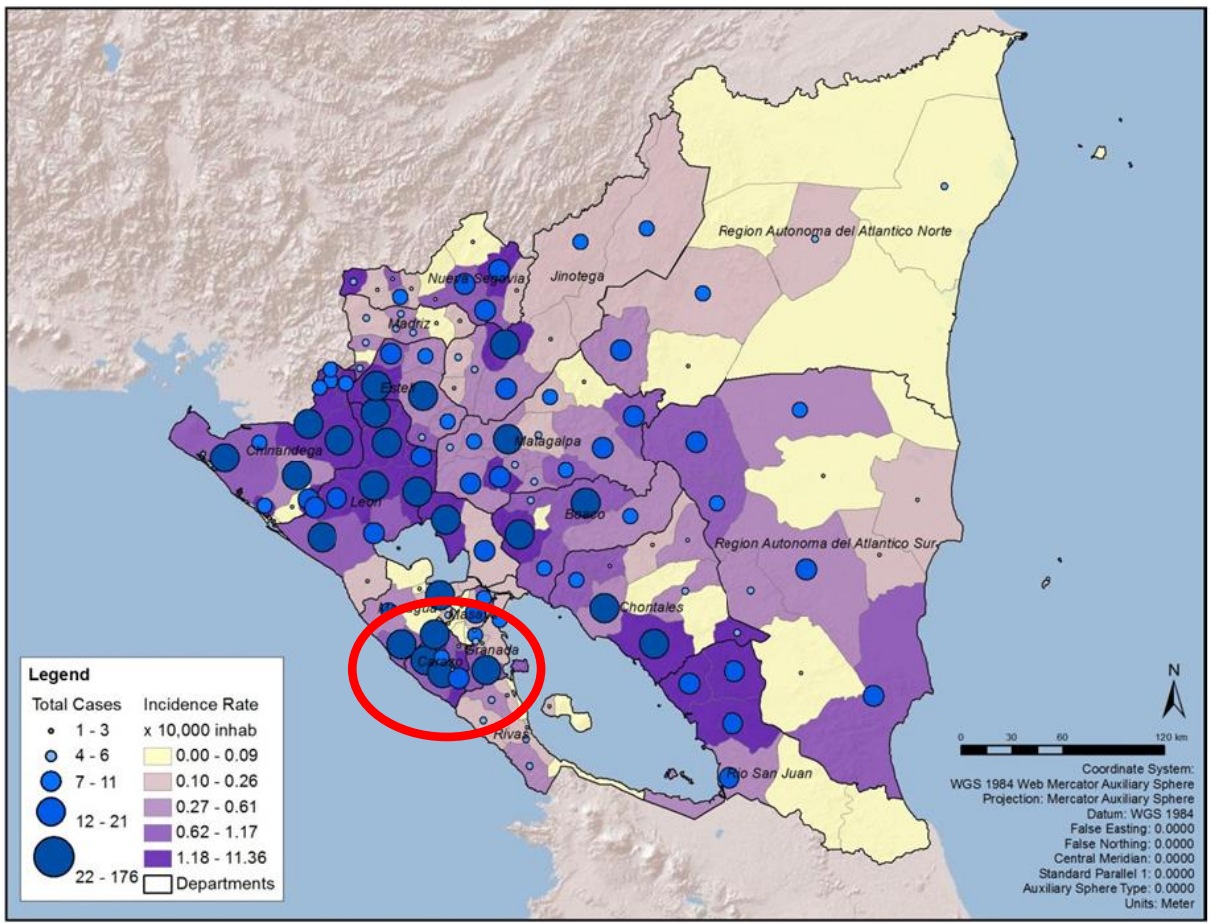
OPEN ACCESS

Figure 2. Total number of cases of leptospirosis, cumulative incidence rate (10,000 populations), by municipality, Nicaragua, 2004–2010.

Article

Leptospirosis Outbreak Areas and Exploring D

Maria Cristina Schneider ^{1,*}, Patr Aida Soto ³, Wilmer Marquino ³, I Eduardo Jimenez ⁴, Matthew Moy



Source: Ministry of Health of Nicaragua [25] and others [26,37]. Analysis was carried out by the authors.

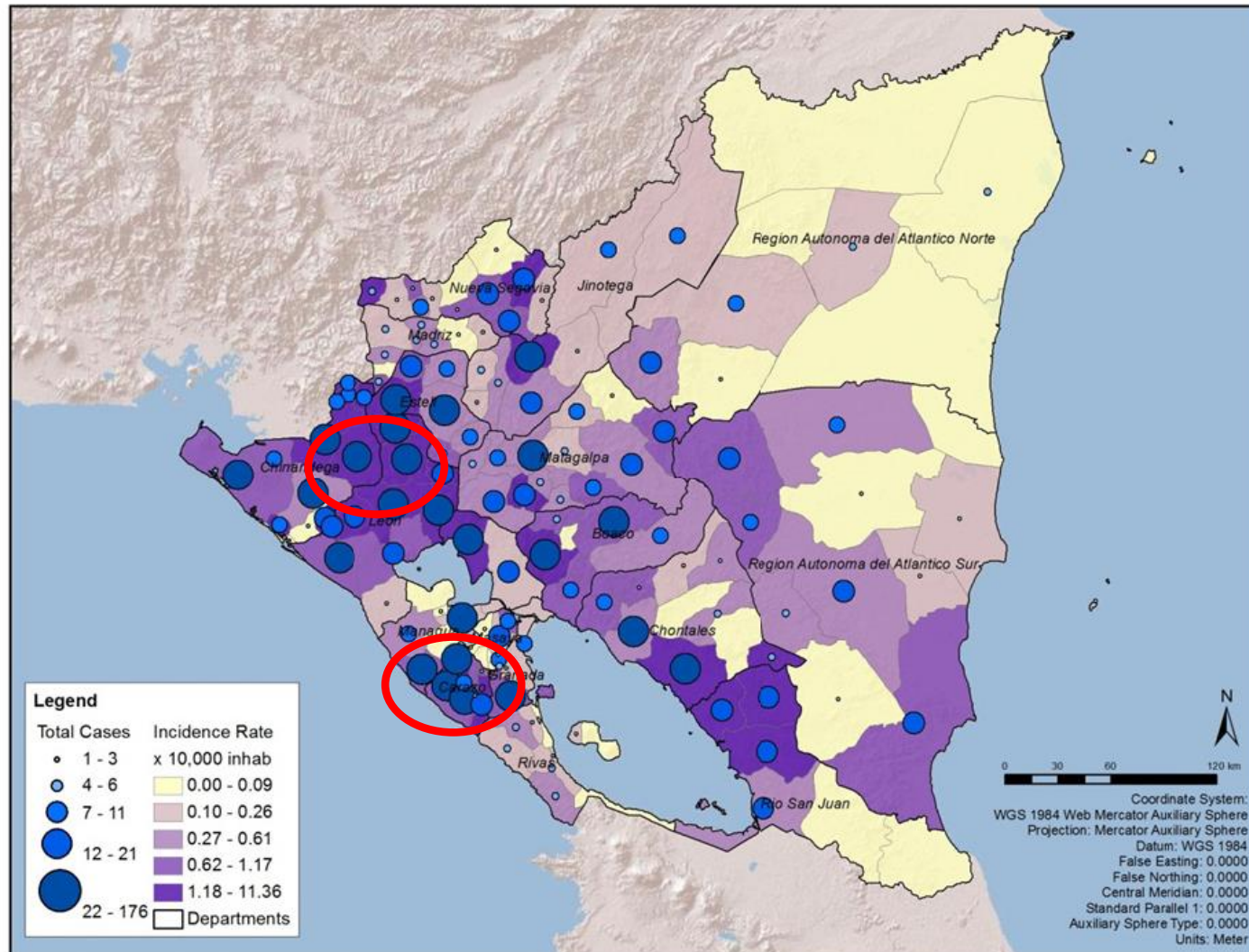
Contaminated surface water „Nicaragua“



Photo I. Pavlik

Irrigation systems: risks in Northern areas

Figure 2. Total number of cases of leptospirosis, cumulative incidence rate (10,000 populations), by municipality, Nicaragua, 2004–2010.



Source: Ministry of Health of Nicaragua [25] and others [26,37]. Analysis was carried out by the authors.

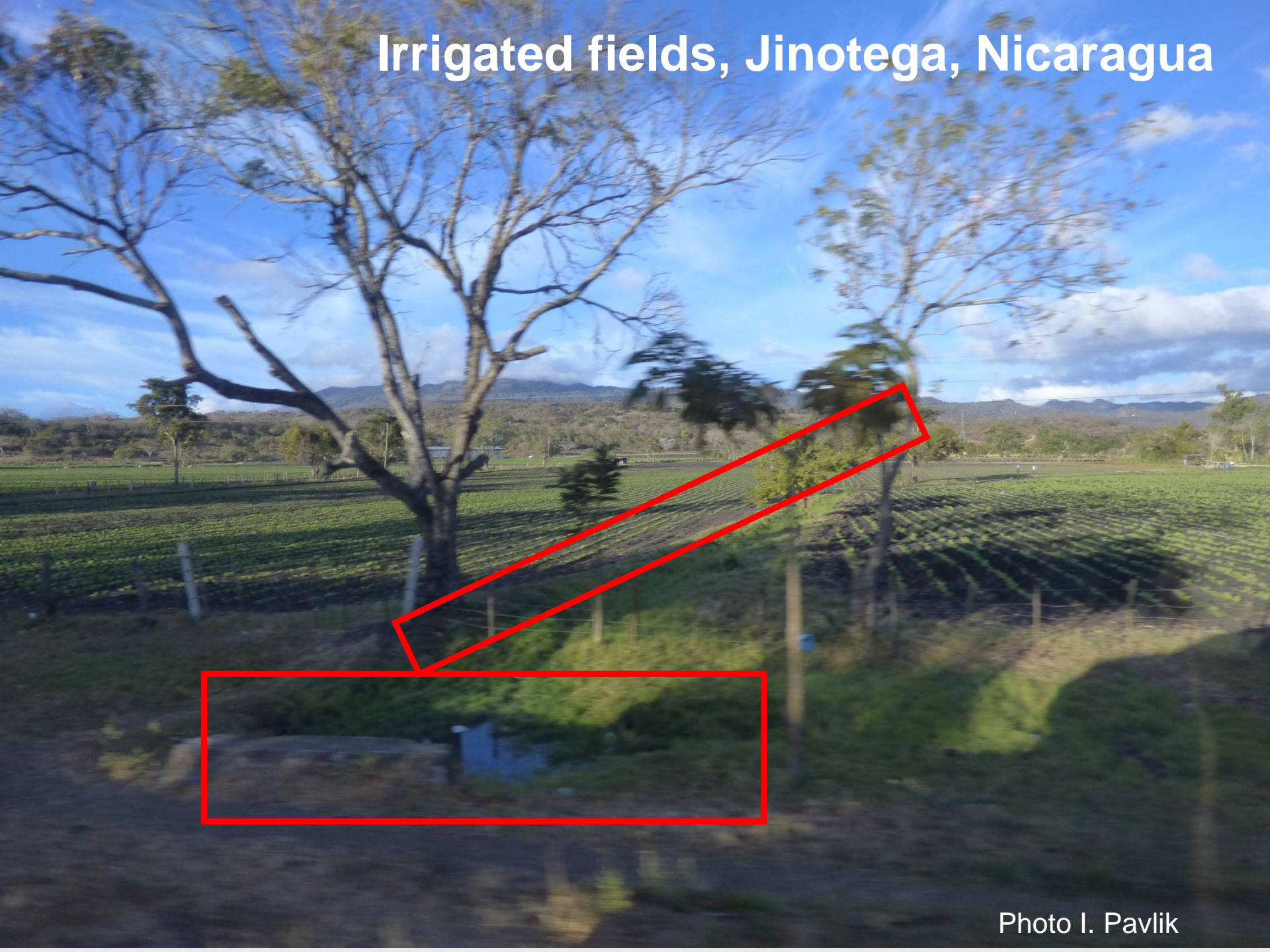
Irrigation systems: vegetable and/or fruit

Nicaragua, León



Google maps;
29.3.2014

Irrigated fields, Jinotega, Nicaragua



Cross-contaminated vegetable by water



Photo I. Pavlik

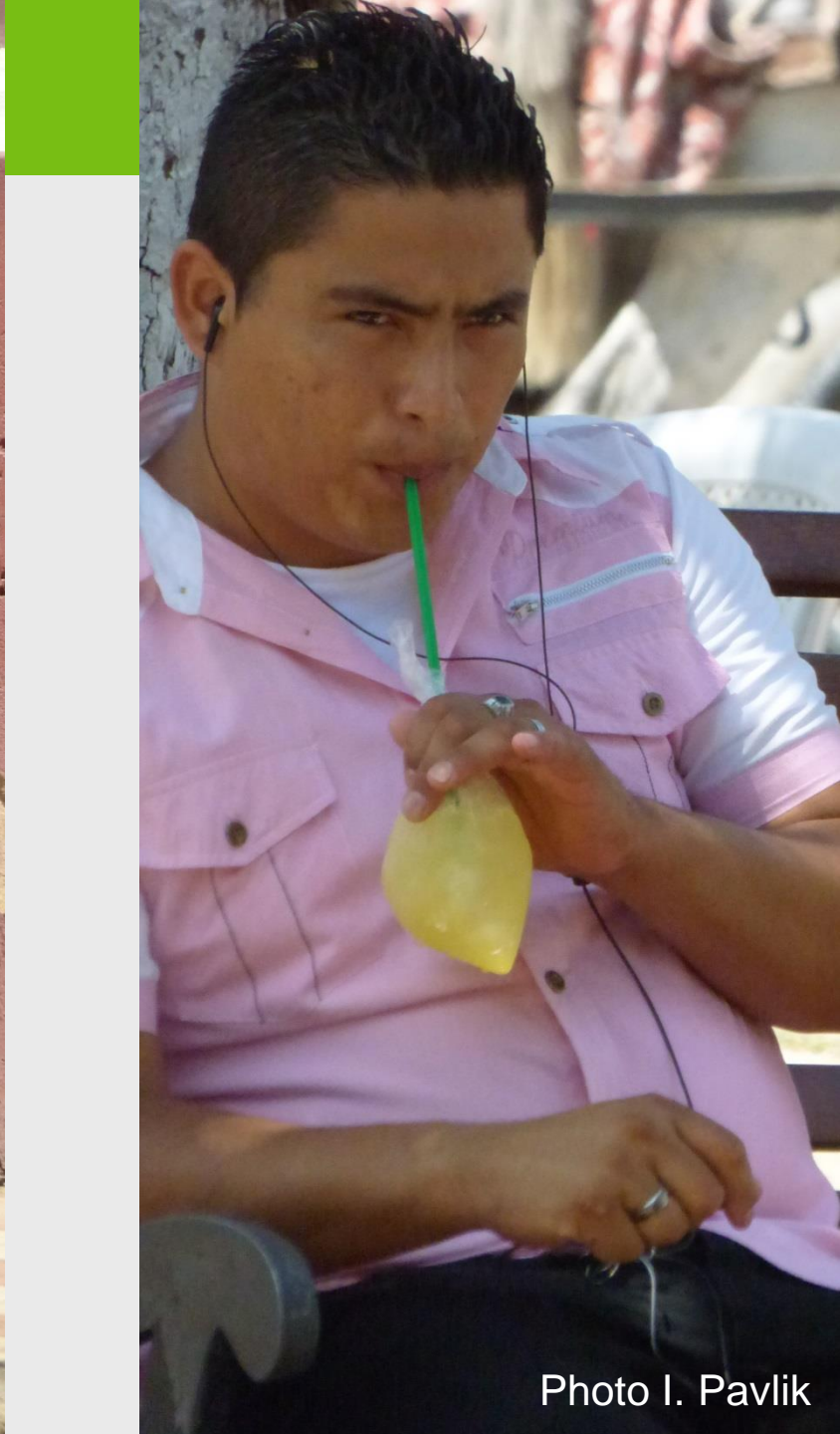


Photo I. Pavlik



Photo I. Pavlik

2. Water-washed diseases – arid areas (Africa)



2. Water-washed diseases – person to person

- Scabies
- Flea
- Lice
- Tick-borne diseases



Photo Google

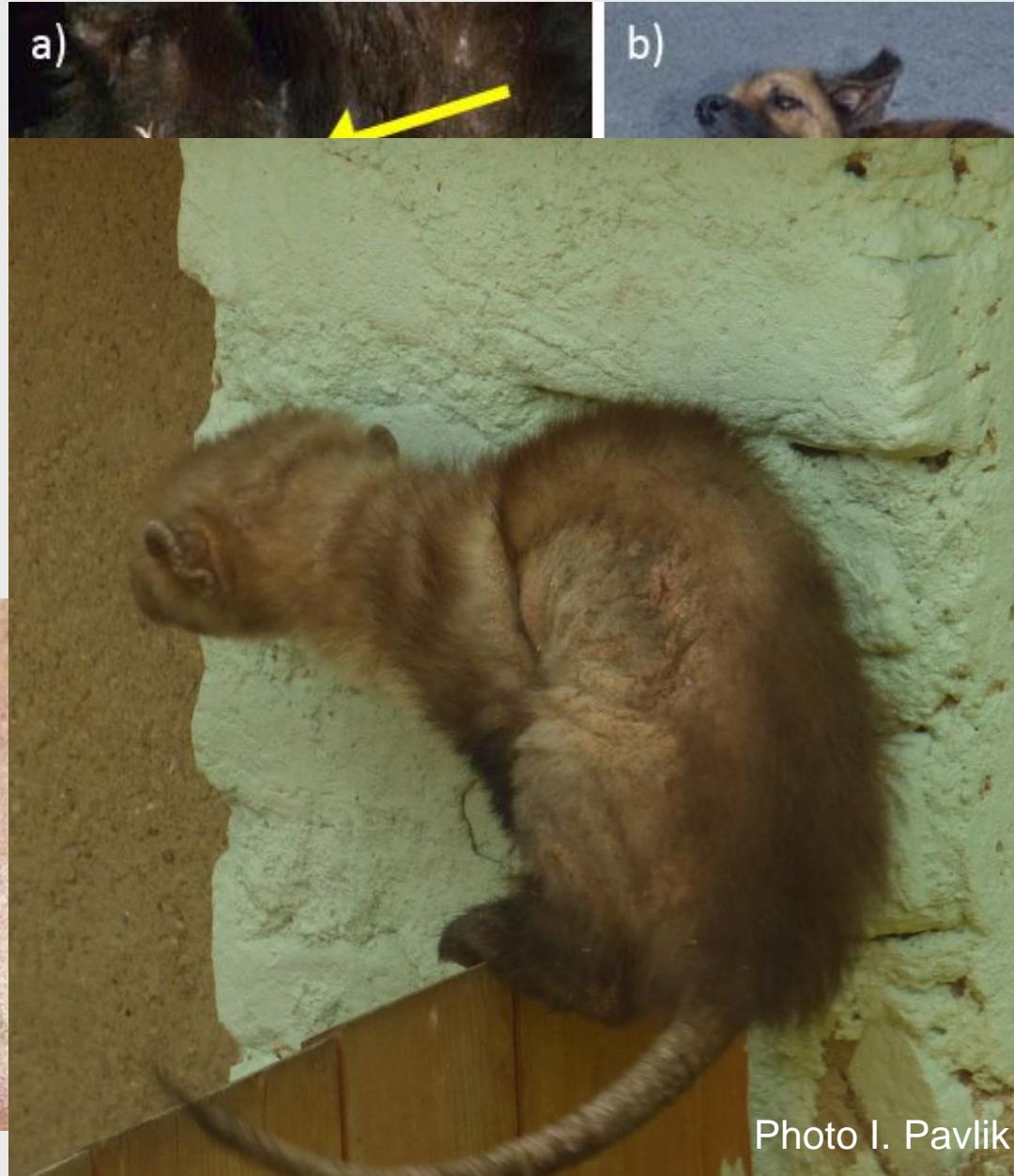
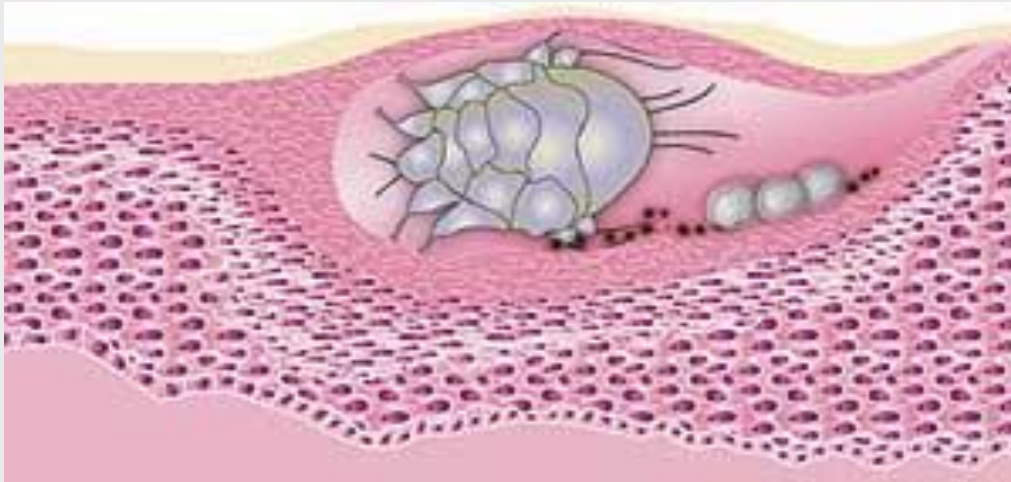
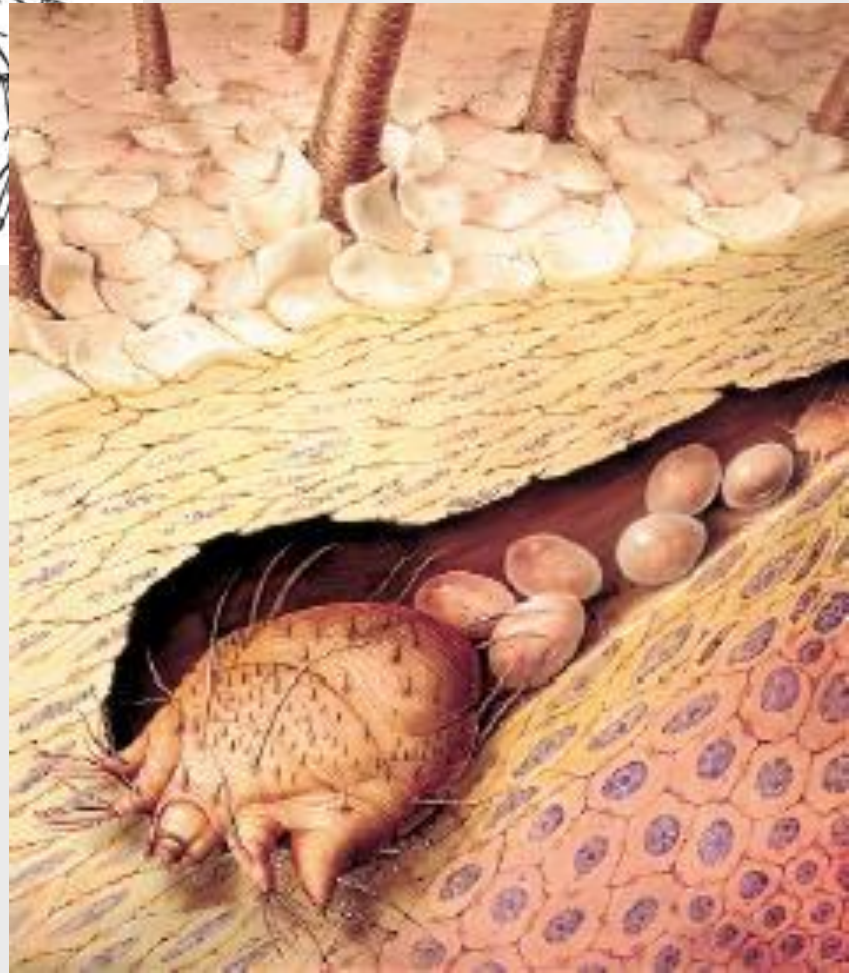
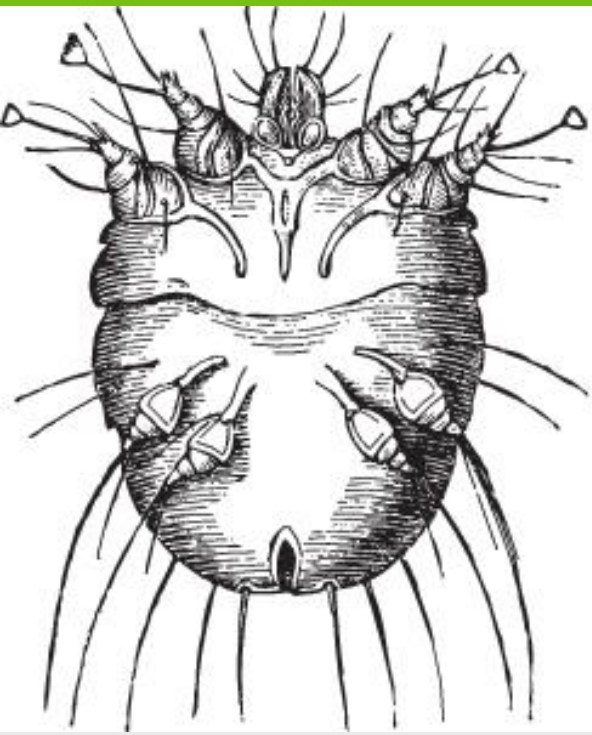


Photo I. Pavlik

Skin infection (not regularly washed)



3. Water-based diseases - intermediate host in water

- **Schistosomiasis (Bilharziasis)**
- **Dracunculiasis**



Status of Certification of Dracunculiasis Eradication Worldwide, 2013



Schistosomiasis-Endemic Areas

- Hepatic-Intestinal
- Very Low Risk for Hepatic-Intestinal
- Very Low Risk Urinary
- Both (Hepatic-Intestinal and Urinary)
- Very Low Risk for Both (Hepatic-Intestinal and Urinary)
- Not Endemic

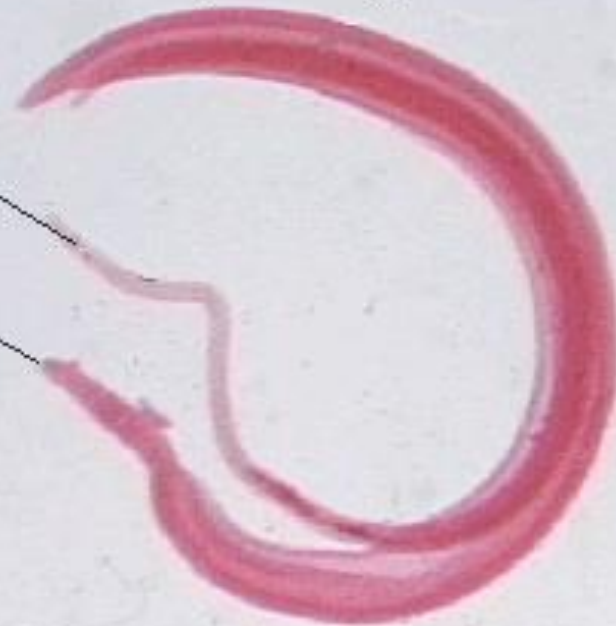
Schistosomiasis (Bilharziasis)



Schistosoma, in copula

female

male



(by P.W. Pappas and S.M. Wardrop)

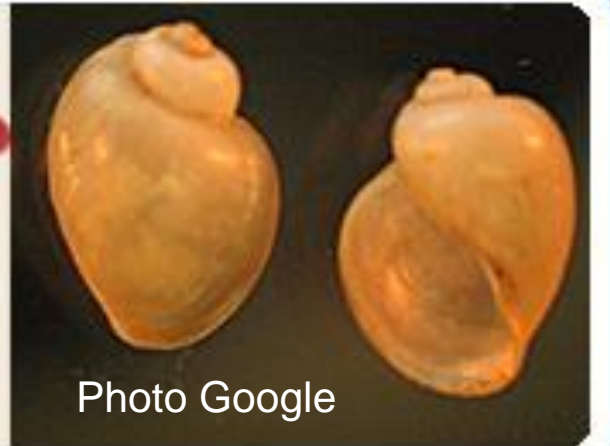
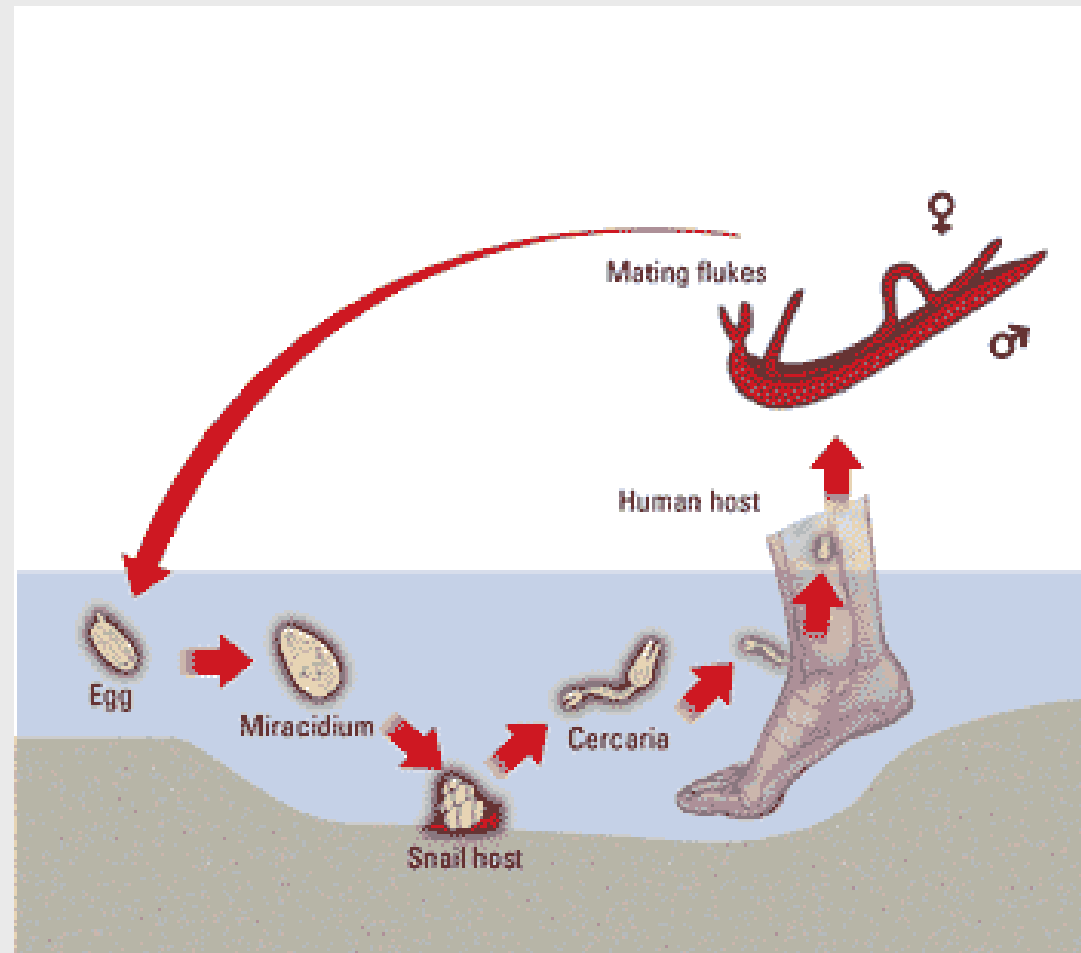
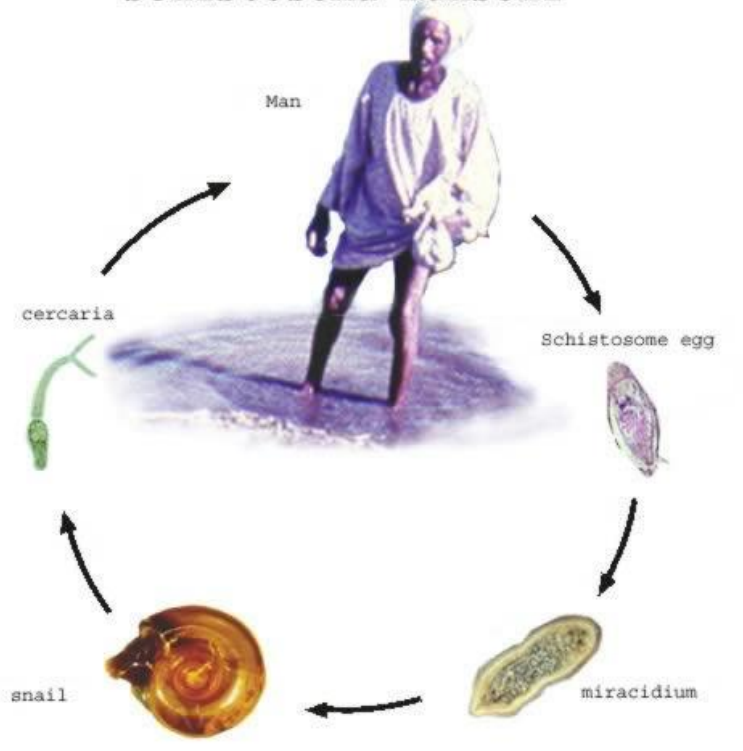


Photo Google

Infection can happen through healthy skin!

The life cycle of *Schistosoma mansoni*

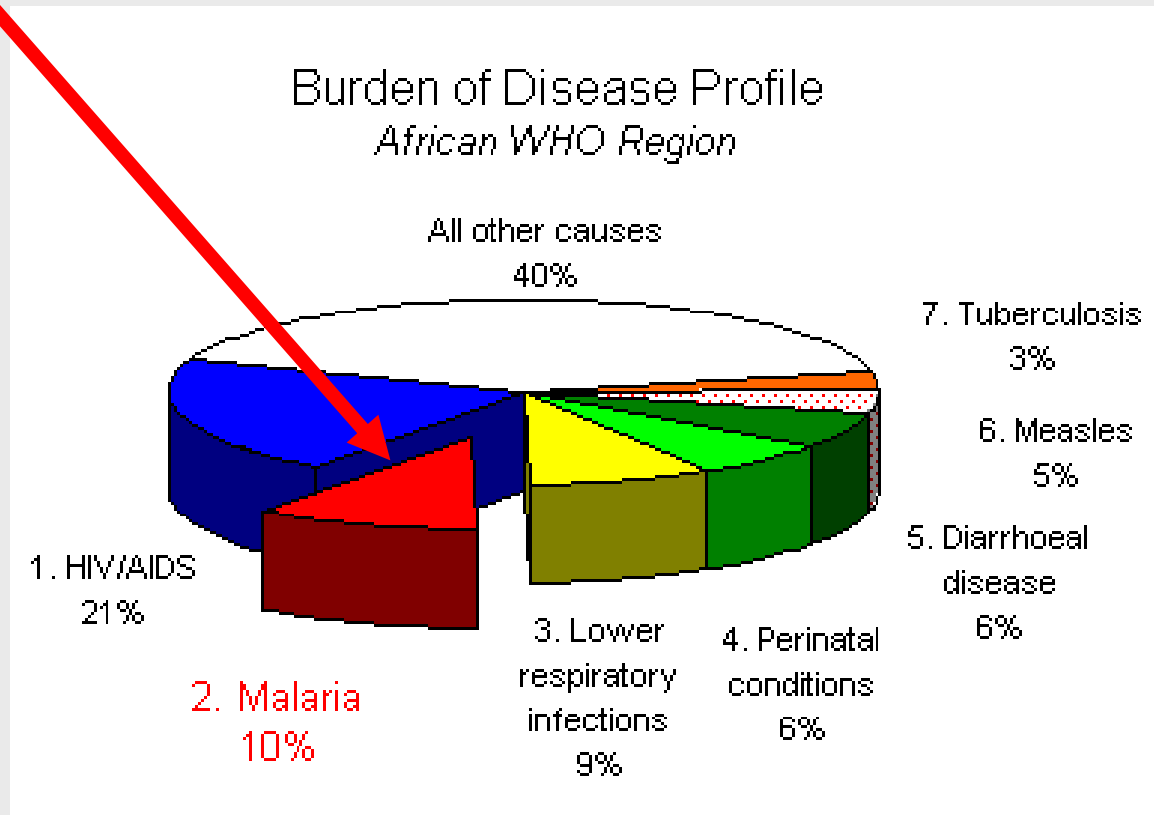


Typical risky behavior



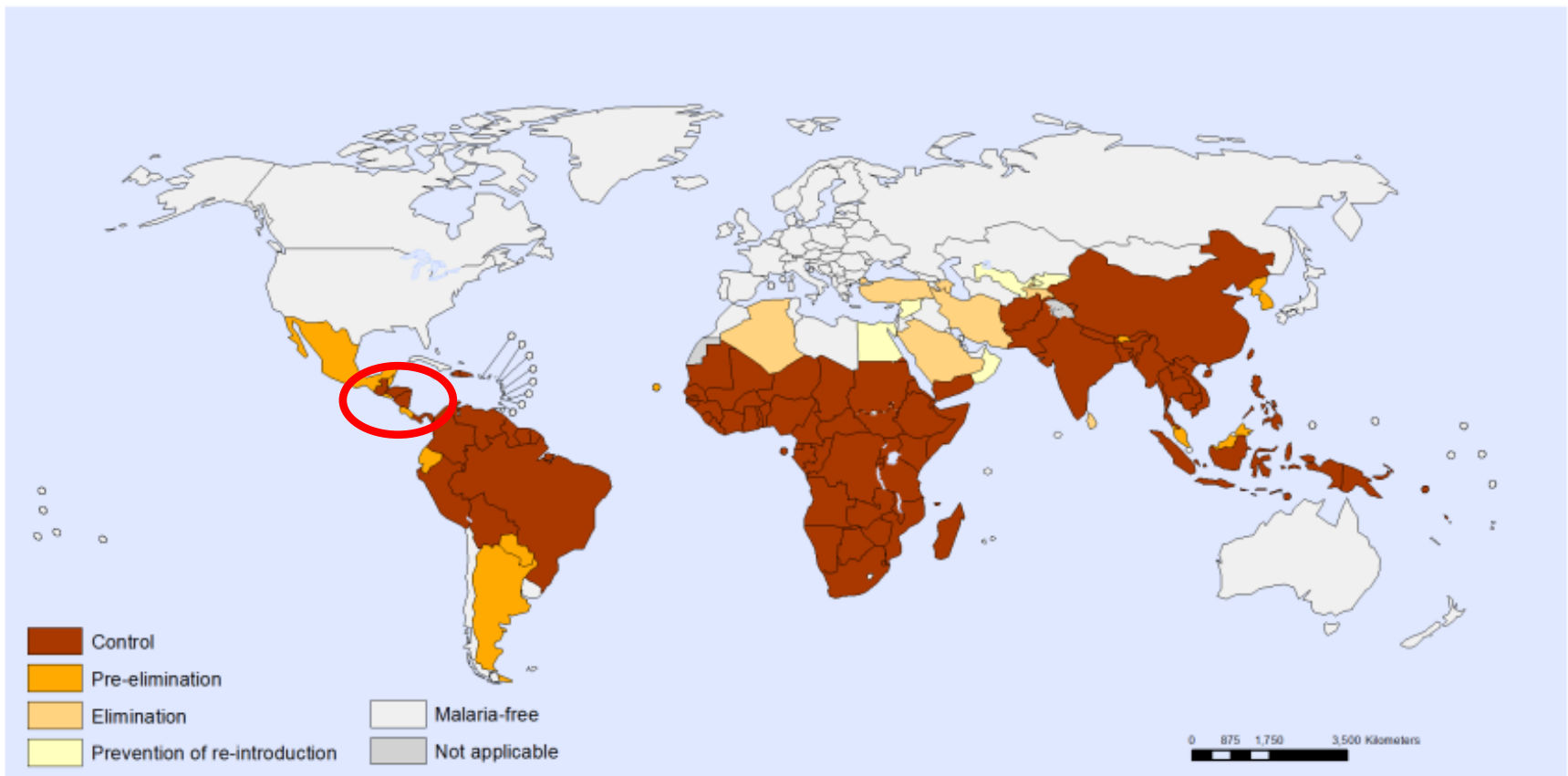
4. Water-associated vector-borne diseases— insect breeding or biting near water

- **Malaria**
- **Filariasis**
- **Onchocerciasis**
- **Trypanosomiasis**
- **Yellow fever**



Malaria—protozoal infection (Central America)

Classification of countries by stage of malaria elimination, as of December 2013



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Data Source: World Health Organization
Map Production: Health Statistics and
Information Systems (HSI)
World Health Organization



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Somoto River, Nicaragua



Photo I. Pavlik



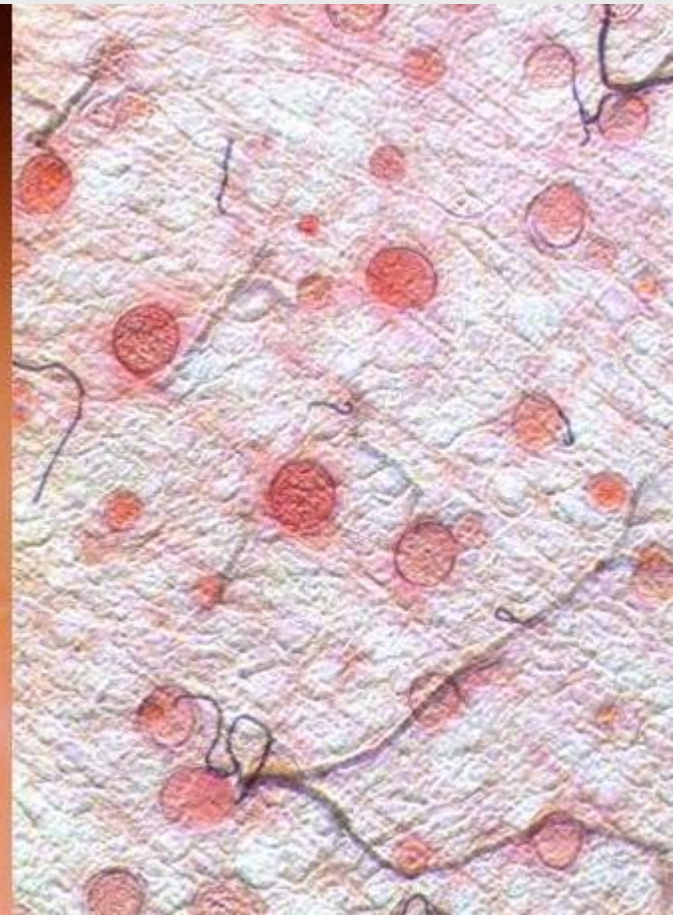
Photo I. Pavlik



Malaria



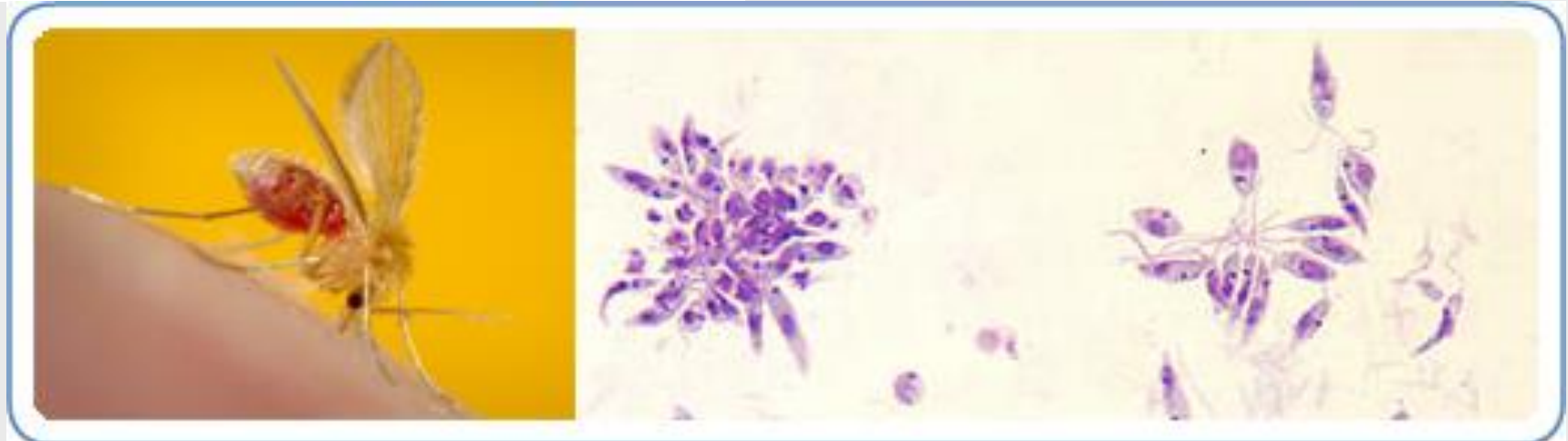
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Leishmania



Phlebotomus dubosci, a sand fly
WHO/TDR/Stammers



Cutaneous Leishmania

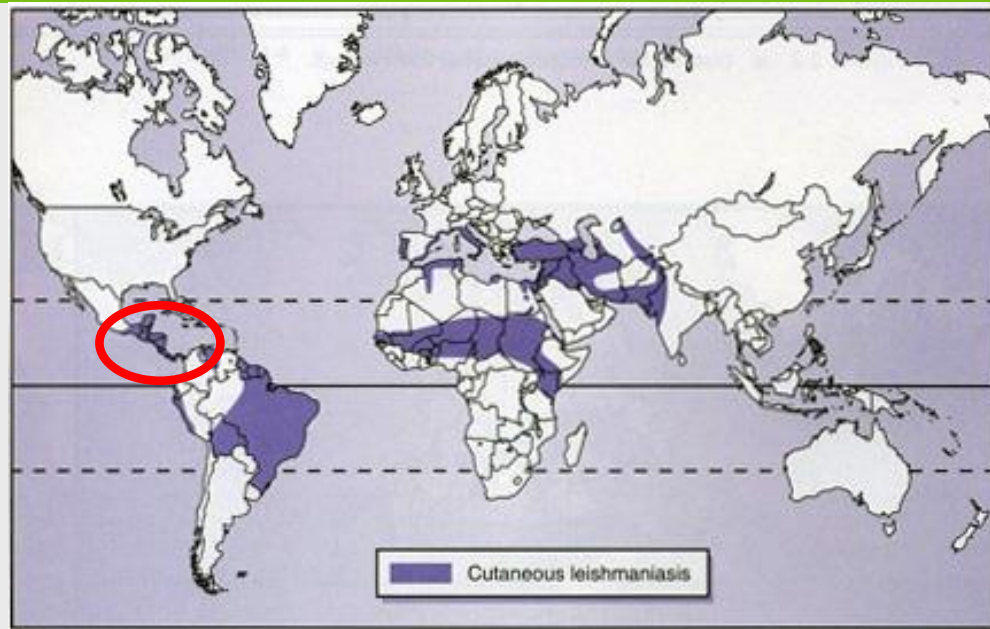


FIGURE 2-1 ■ Distribution of cutaneous leishmaniasis.



Skin lesions in a case of cutaneous leishmaniasis are healed after treatment with herbal extracts.

Ecology of vectors/reservoirs

Leishmania: running water



Malaria: standing water



Mycobacterium ulcerans – Buruli ulcer

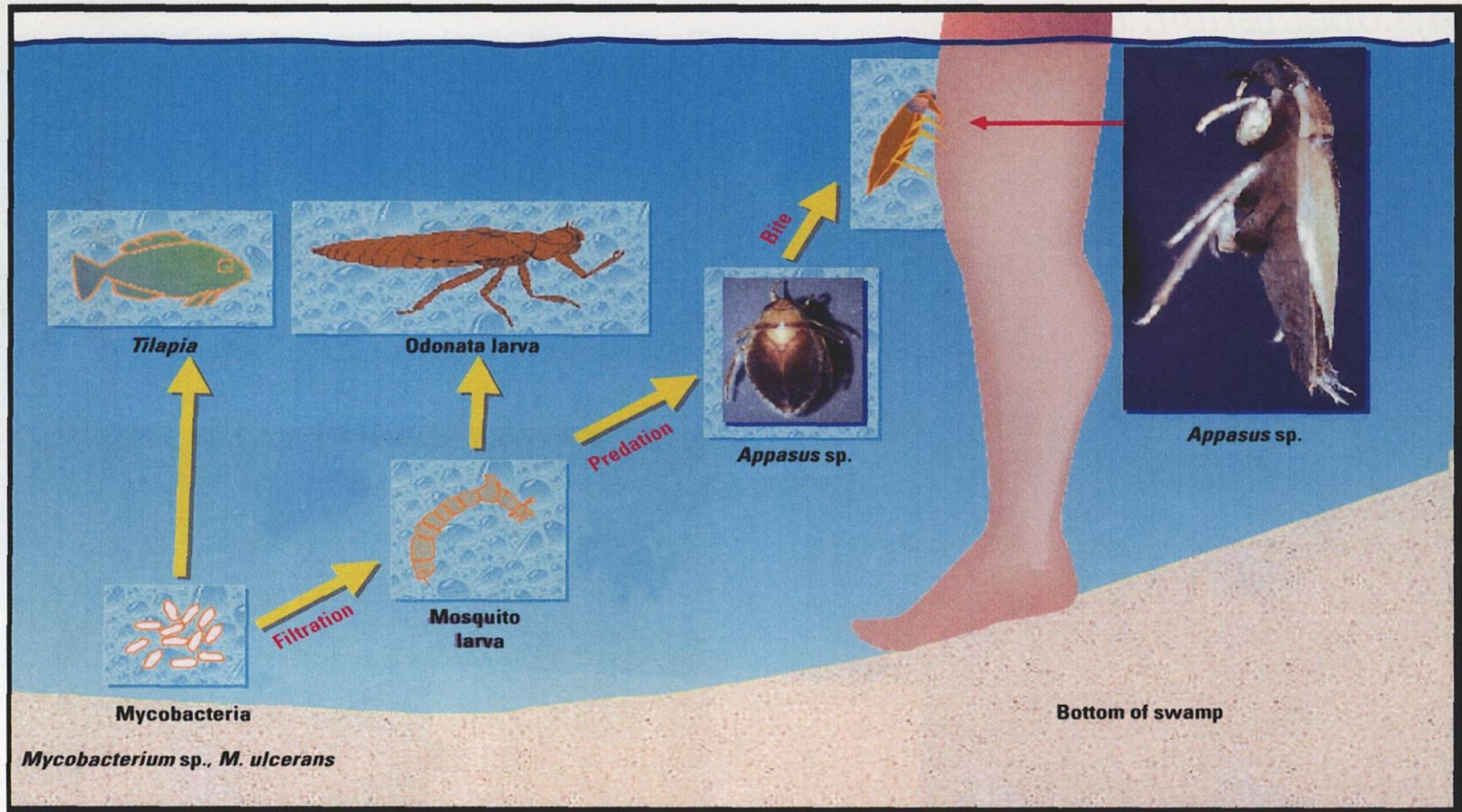
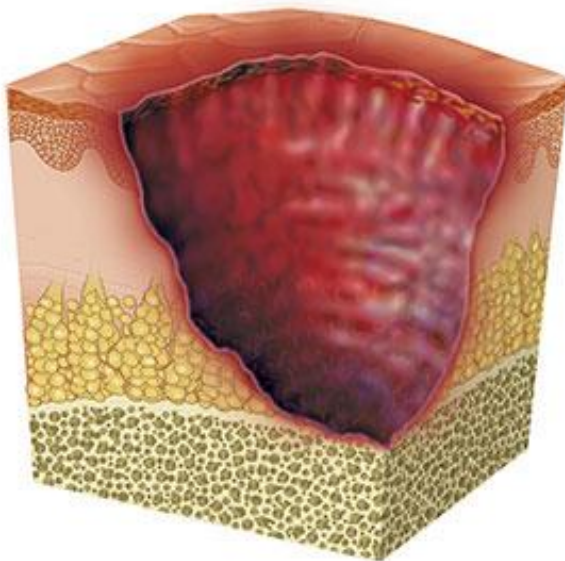


Fig. 3
Environmental sources of *Mycobacterium ulcerans* and possible mode of transmission to animals and humans



An 11 year old girl had extensive arm edema due to *M. ulcerans* and received 8 weeks of treatment. By the end of therapy, an ulcer has developed.



Developed countries – rivers' contamination



Photo I. Pavlik

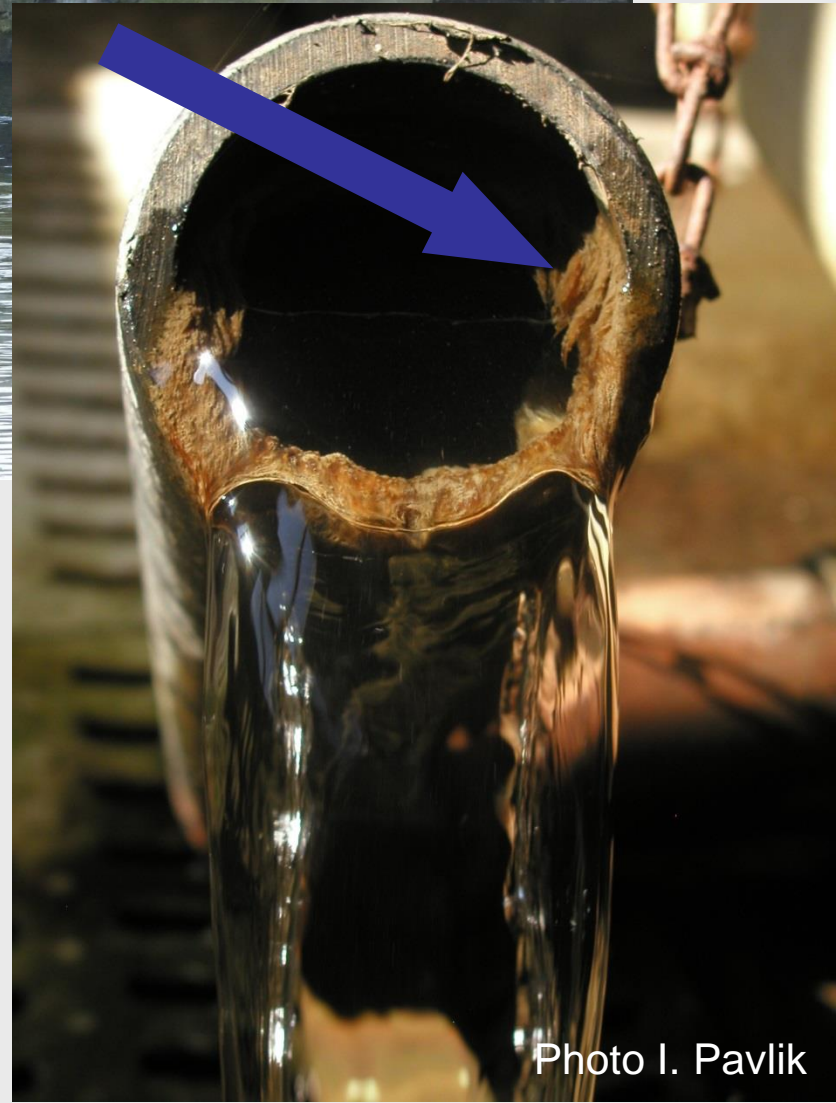
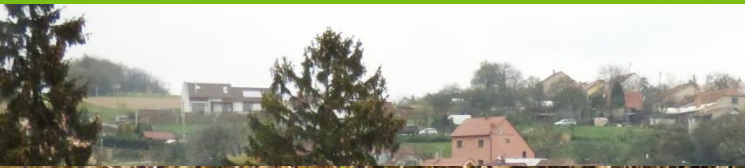
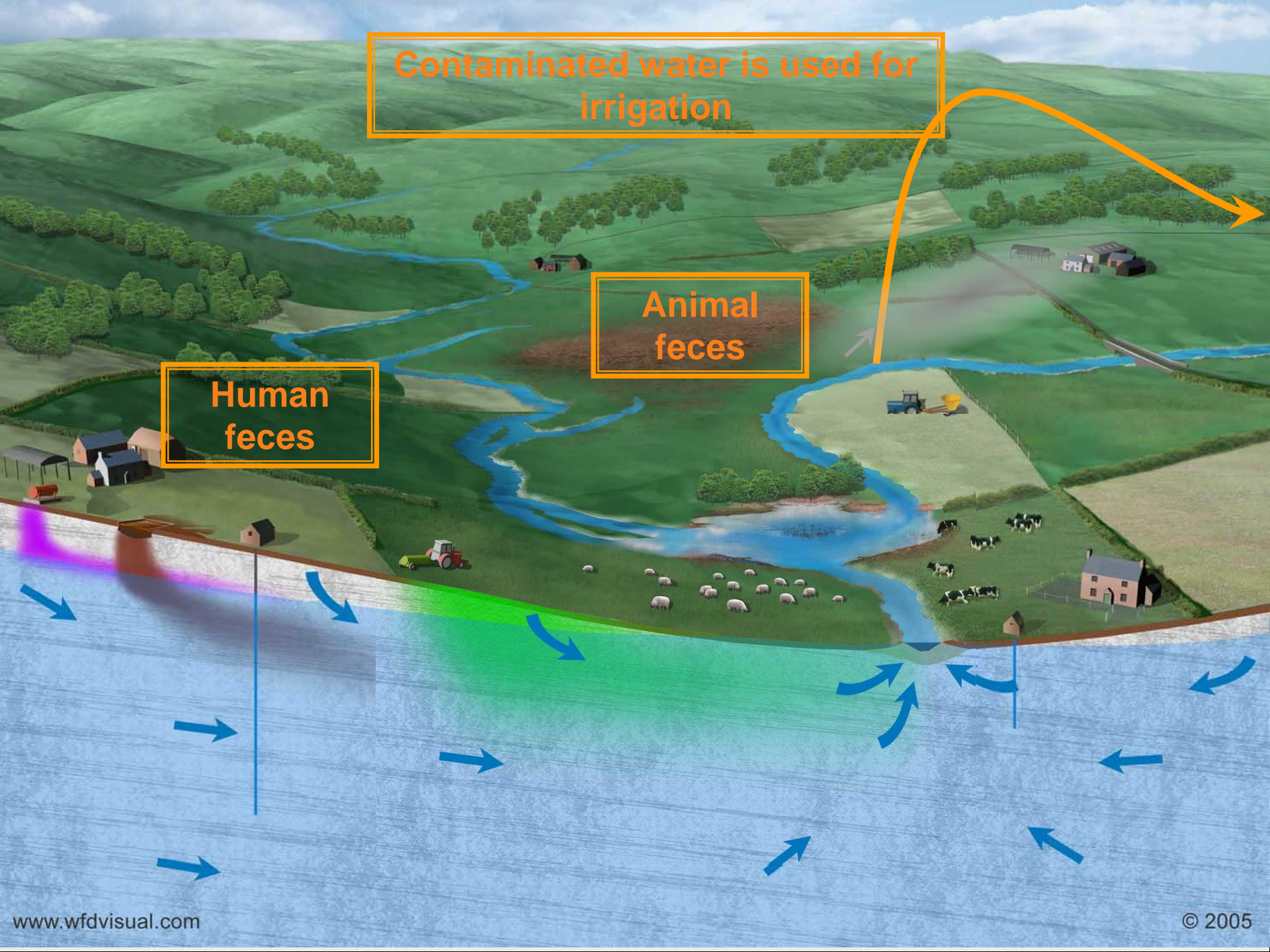


Photo I. Pavlik

Water contamination in villages





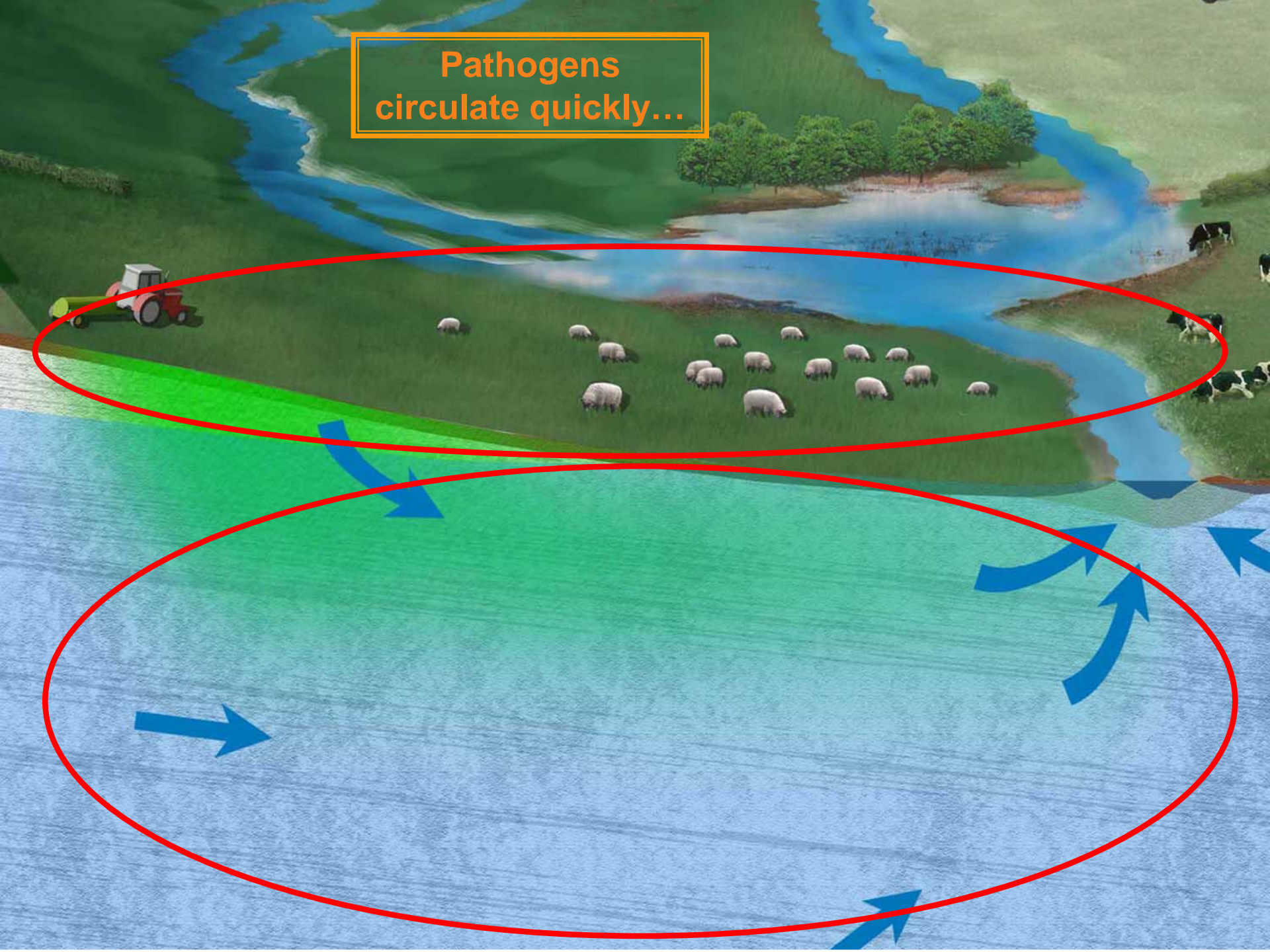


Contaminated water is used for irrigation

Animal feces

Human feces

Pathogens
circulate quickly...



Examples from USA - protozoa

Cryptosporidiosis

Cause: *cryptosporidium muris* is found in infected water

Prevention: Boiling water for 5-10 minutes will destroy organism

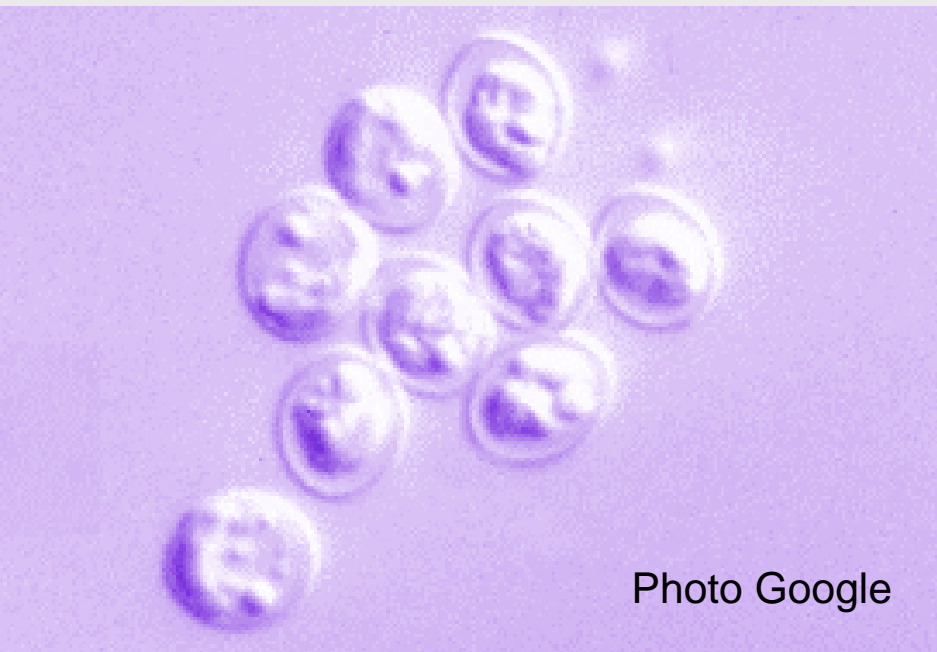
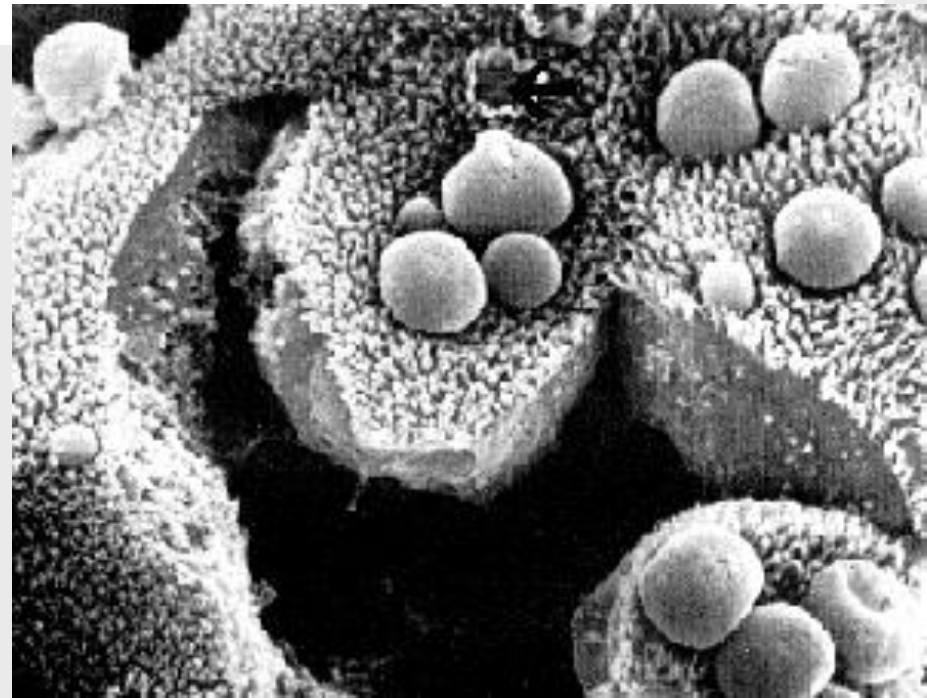
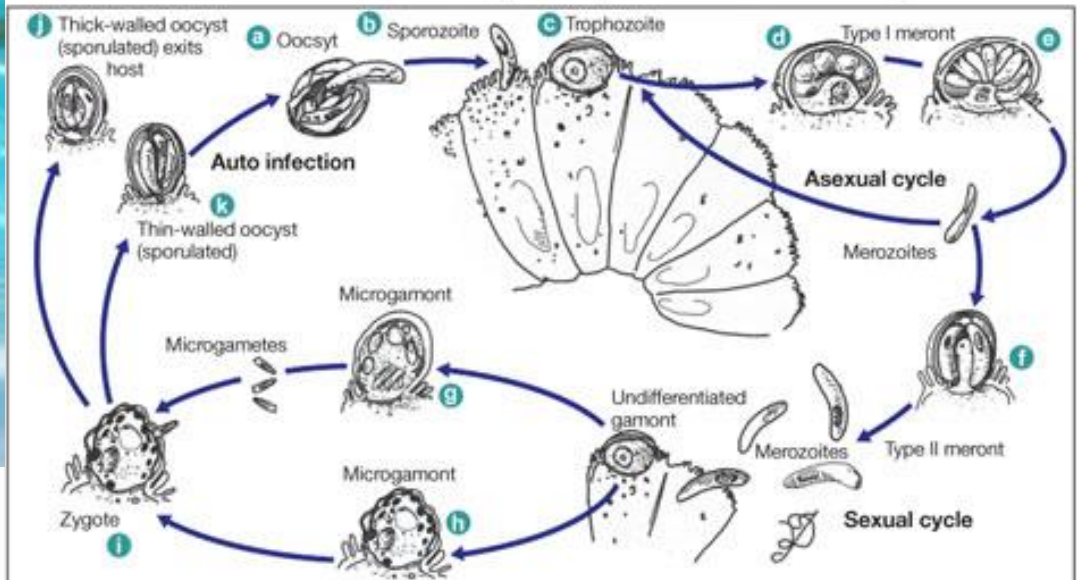
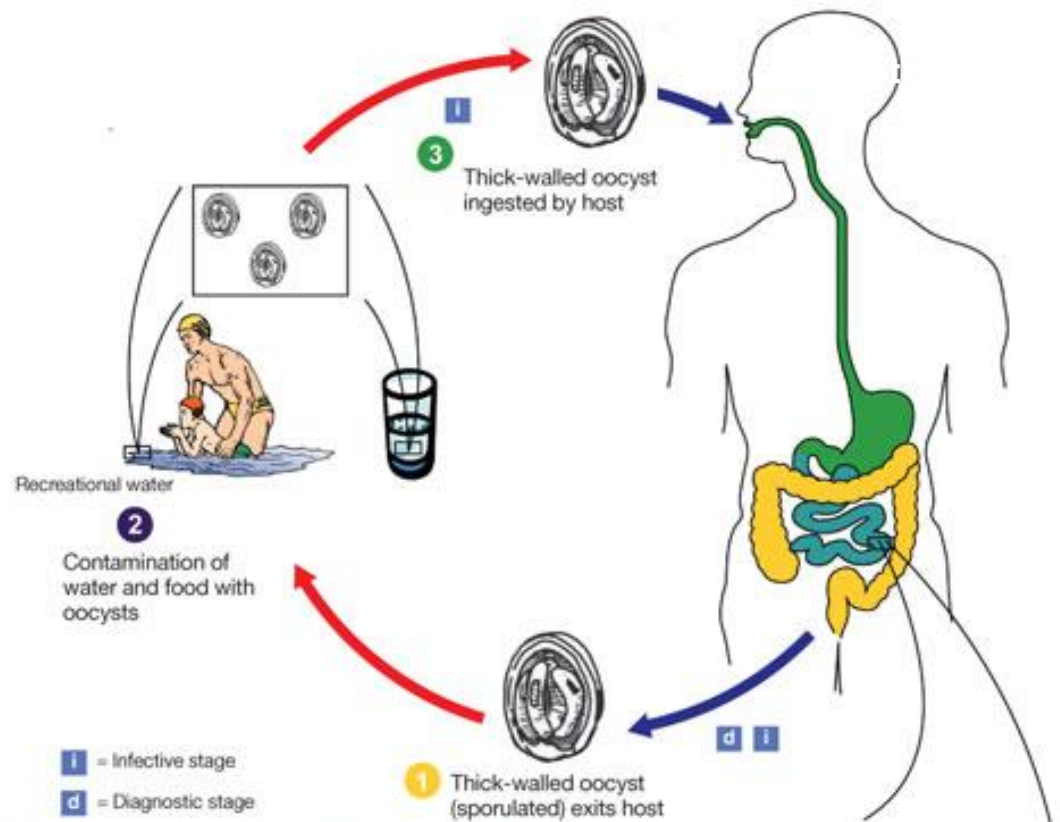


Photo Google



Water contamination!



Difficult to treat (toxic drugs are used)



- Avoid exposure to **contaminated surface water** (with sewage)
- Do not drink or swallow **water from recreational sources** (lakes, streams, pools etc.)
- **Ice, fountain beverages and water fountains** are risky (avoid contact with your mucous in mouth)

Drinking water treatment process

The Milwaukee Water Works provides drinking water from two treatment plants to Milwaukee and 15 suburban communities. Inside each plant, water from Lake Michigan passes through several treatment steps to kill potentially harmful microbes and remove even microscopic particles before being distributed to the public.

1 Ozone disinfection: Ozone gas is bubbled through the incoming lake water. Ozone destroys disease-causing microorganisms including *giardia* and *Cryptosporidium*, controls taste and odor, and reduces chlorinated disinfection byproducts.

2 Coagulation: Very fine particles in the water adhere together to form larger particles as the coagulant alum is mixed into the water. Large particles are removed more effectively during the settling and filtering processes.

3 Settling: Settling is the process in which solid particles settle out and are removed from the water.

4 Biologically active filtration: The water is slowly filtered through 24 inches of anthracite coal and 12 inches of crushed sand to remove very small particles.

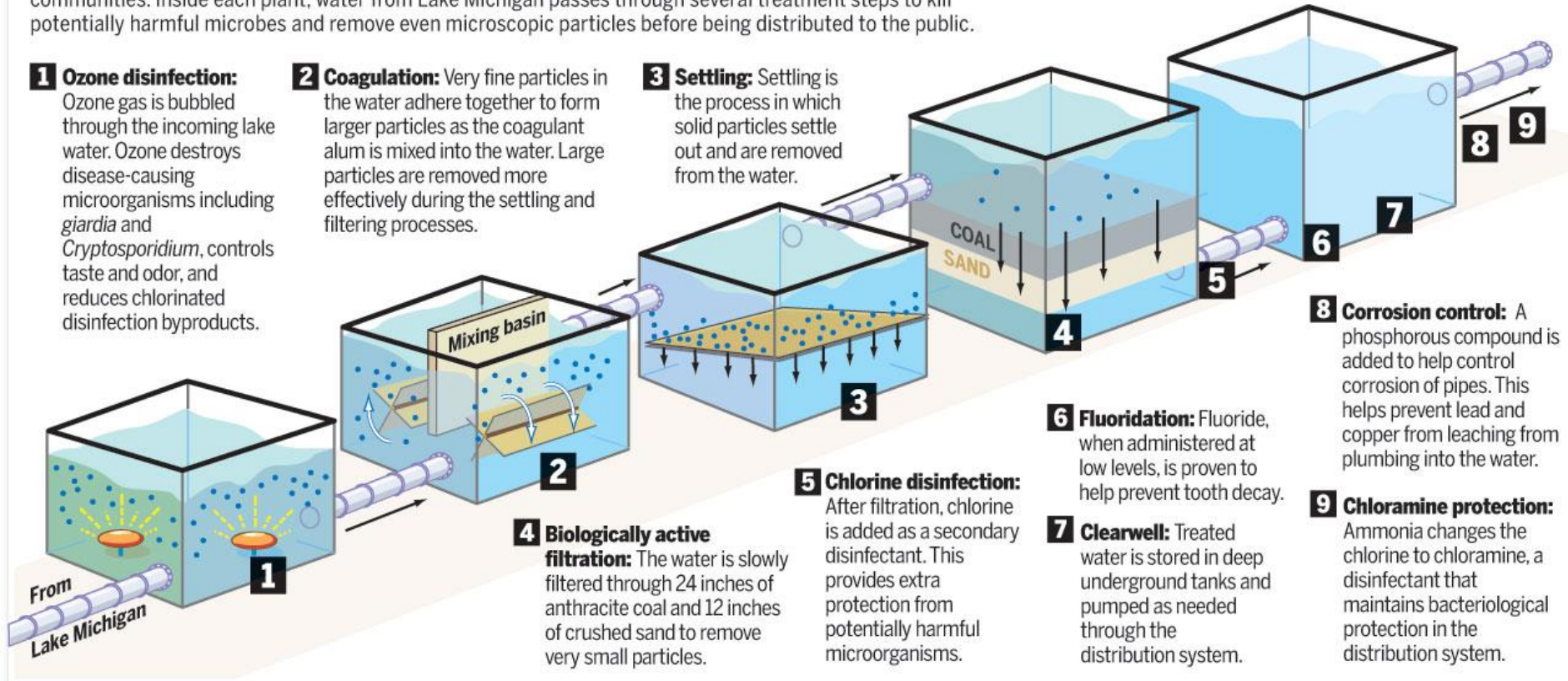
5 Chlorine disinfection: After filtration, chlorine is added as a secondary disinfectant. This provides extra protection from potentially harmful microorganisms.

6 Fluoridation: Fluoride, when administered at low levels, is proven to help prevent tooth decay.

7 Clearwell: Treated water is stored in deep underground tanks and pumped as needed through the distribution system.

8 Corrosion control: A phosphorous compound is added to help control corrosion of pipes. This helps prevent lead and copper from leaching from plumbing into the water.

9 Chloramine protection: Ammonia changes the chlorine to chloramine, a disinfectant that maintains bacteriological protection in the distribution system.



Drinking water from Římov, Czech Republic



Photo I. Pavlik



OPERATOR
TERB_OT_V
12:13:08
9/27/2011
Energo

Usazovací nádrž 3

Výběr nádrže

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14

Ovředání LN
Odkalování

Stav LN: **ODSTAVEN**

Odkalovací Slab
Náložový Slab

Zadní rolt
Přední rolt

Mikrovlákn
Kanárové žláby

Usazovací nádrž	
Celkem hodin	0 h
Zbývá do odkalování	16 h
Nastavená doba	71 h
Čas odkalování	4 h 20 min

M49 AUT B
Čas otevření: 10 min

M50 AUT B
Čas otevření: 10 min

M51 AUT B
Čas otevření: 4 min

M52 AUT B
Čas otevření: 4 min

Poruchy ventilů	
M49	neotevřel
M49	pleščen
M50	neotevřel
M50	pleščen
M51	neotevřel
M51	pleščen
M52	neotevřel
M52	pleščen

Výzvatky a poruchy
Přístup k ovládacím

Trendy
Obědy
Servisy
Provoz



Photo I. Pavlik

Drinking water distribution system (safety)



Photo I. Pavlik

Accidents – contamination with sewage



Case from the Czech Republic - 2015

Aktuálně.cz DOMÁČÍ ZAHRANIČÍ EKONOMIKA SPORT NÁZORY MAGAZÍN AUTO VIDEO

POLICISTA NABOURAL 51 AUT ČSSD PROHRÁLA SOUD O 300 MILIONŮ NÁVŠTĚVA ČÍNSKÉHO PREZIDENTA ČAPÍ HNÍZDO UPRCHLICKÁ KRIZE DĚNÍ V KRAJÍCH

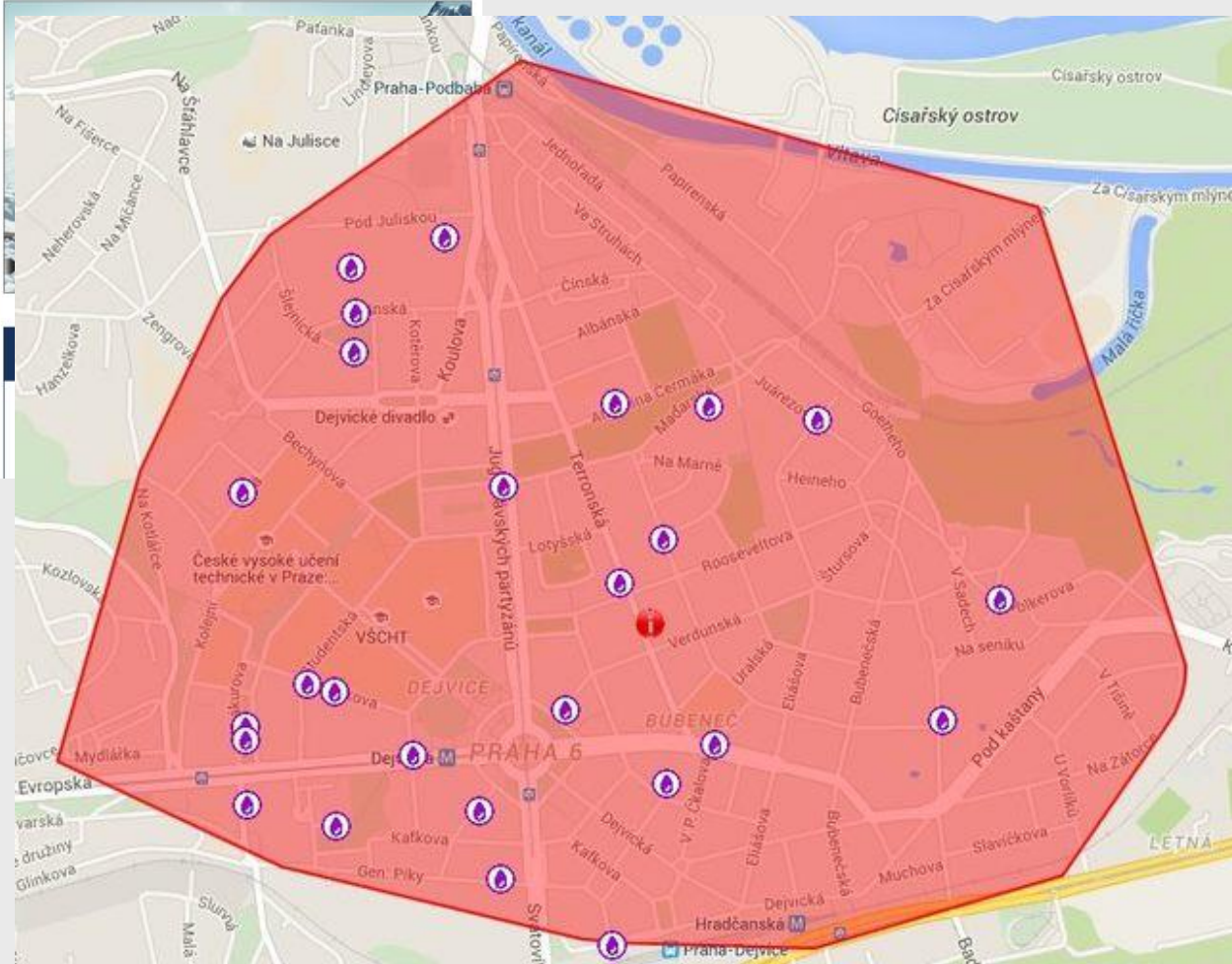
Problém s pitnou vodou v Praze. Stovky lidí trpí průjmy

AKTUALIZOVÁNO 24. 5. 2015



ilustrační foto. | Foto: Michal Štárek

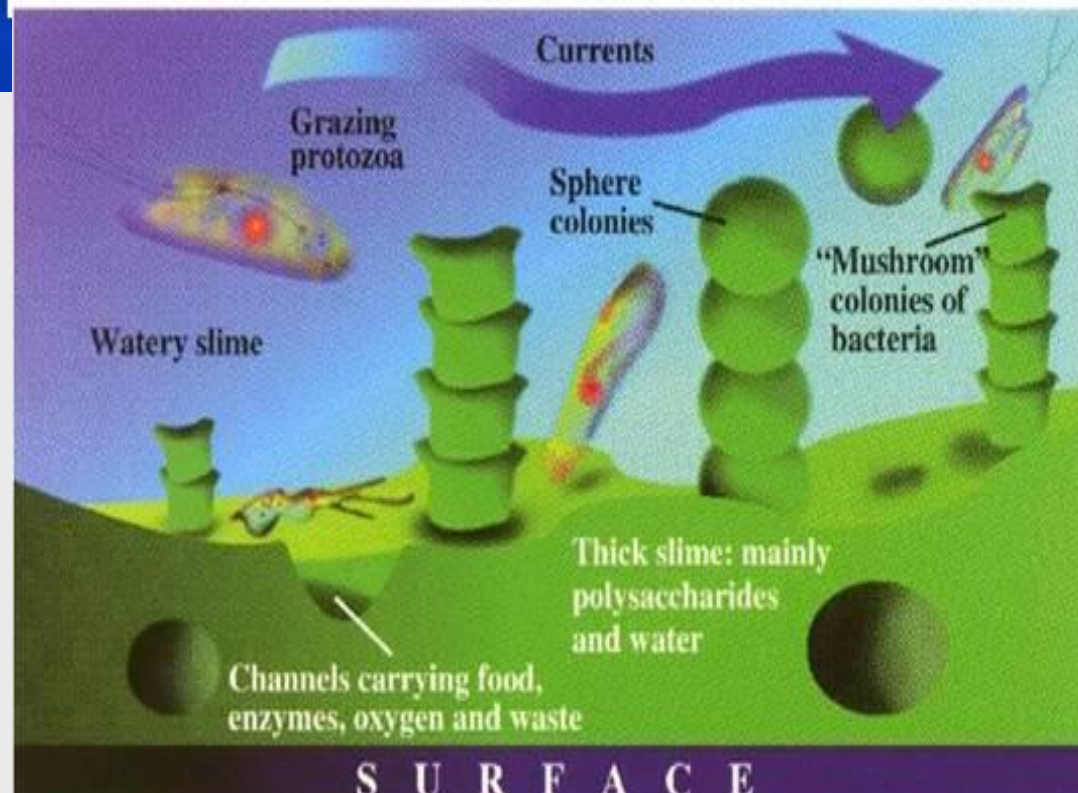
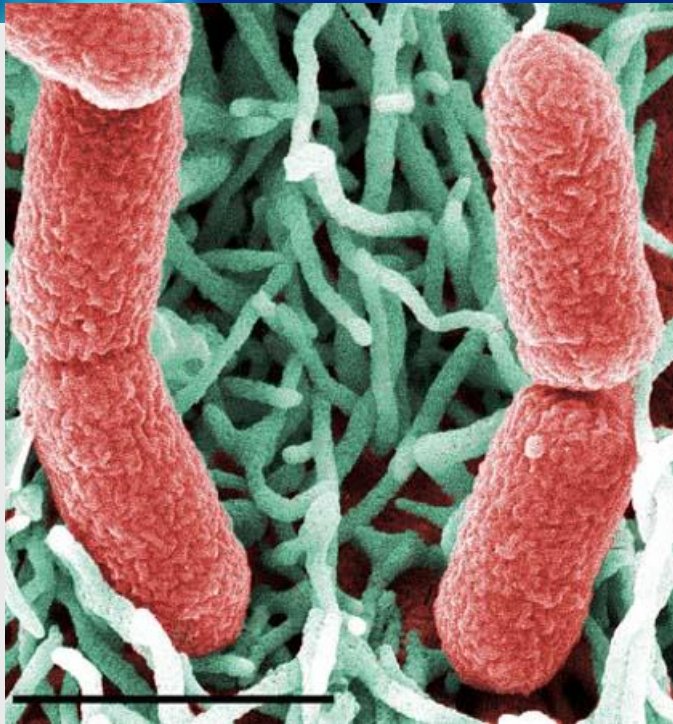
32 tisíc lidí v Dejvicích a Bubenči musí pro vodu do cisteren. Podle hygieniků se do vodovodů zřejmě dostalo zvýšené množství bakterií, které jsou běžné v zaživacím traktu člověka.



- 32 th. people without pipe water
- 130 patients hospitalized
- 550 suspected cases

Biophilm – phenomenon in bacterial ecology

What is
Legionella?



Recreational surface water

Emerging Issues in Water and Infectious Disease

Water Recreation and Disease

Plausibility of Associated Infections
Acute Effects, Sequelae and Mortality



Kathy Pond



6

Disease surveillance and water outbreaks

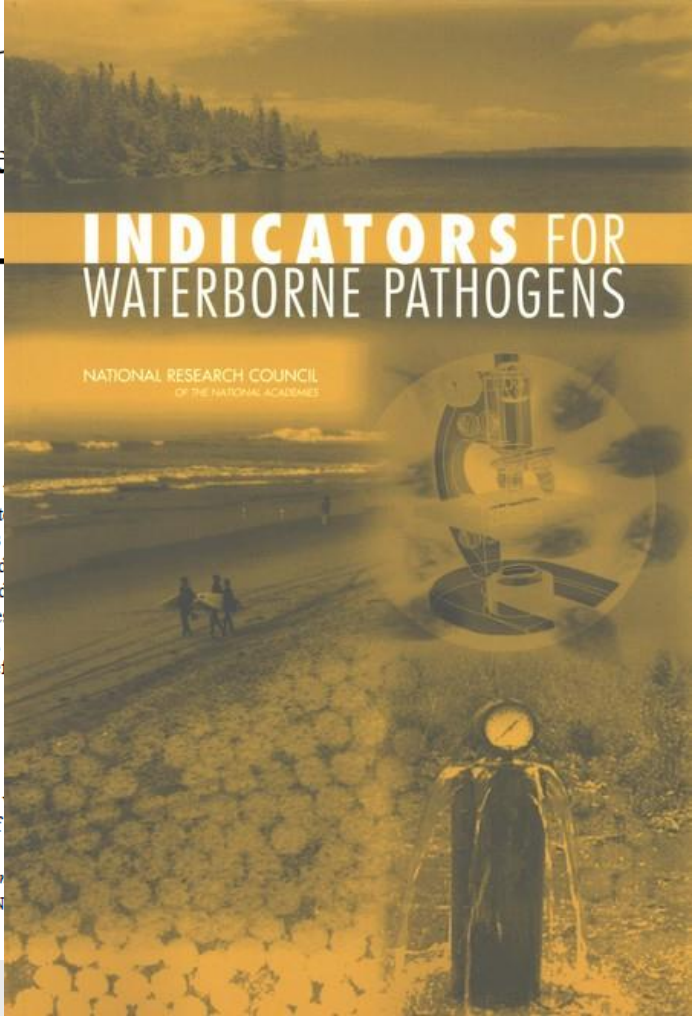
Yvonne Andersson and Patrick Bohan

Outbreaks are both a demonstration of a breakdown or failure in by acting as a 'natural experiment', present an opportunity to insights into disease transmission and, perhaps, improvements This chapter outlines in detail the surveillance systems in Sweden that are designed to detect waterborne disease outbreaks, and actions taken upon suspecting an outbreak. It also examines outbreaks that have occurred, principally from drinking water, that can be learnt from well-conducted investigations, and brief worldwide situation.

6.1 THE SWEDISH SITUATION

Sweden has a long history of communicable disease awareness, dating back to 1875. The regulations are based on a selection of

© 2001 World Health Organization (WHO). *Water Quality: Guidelines, Standards and* Loma Fewtrell and Jamie Bartram. Published by IWA Publishing, London, UK. ISBN



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Thank you for your attention!

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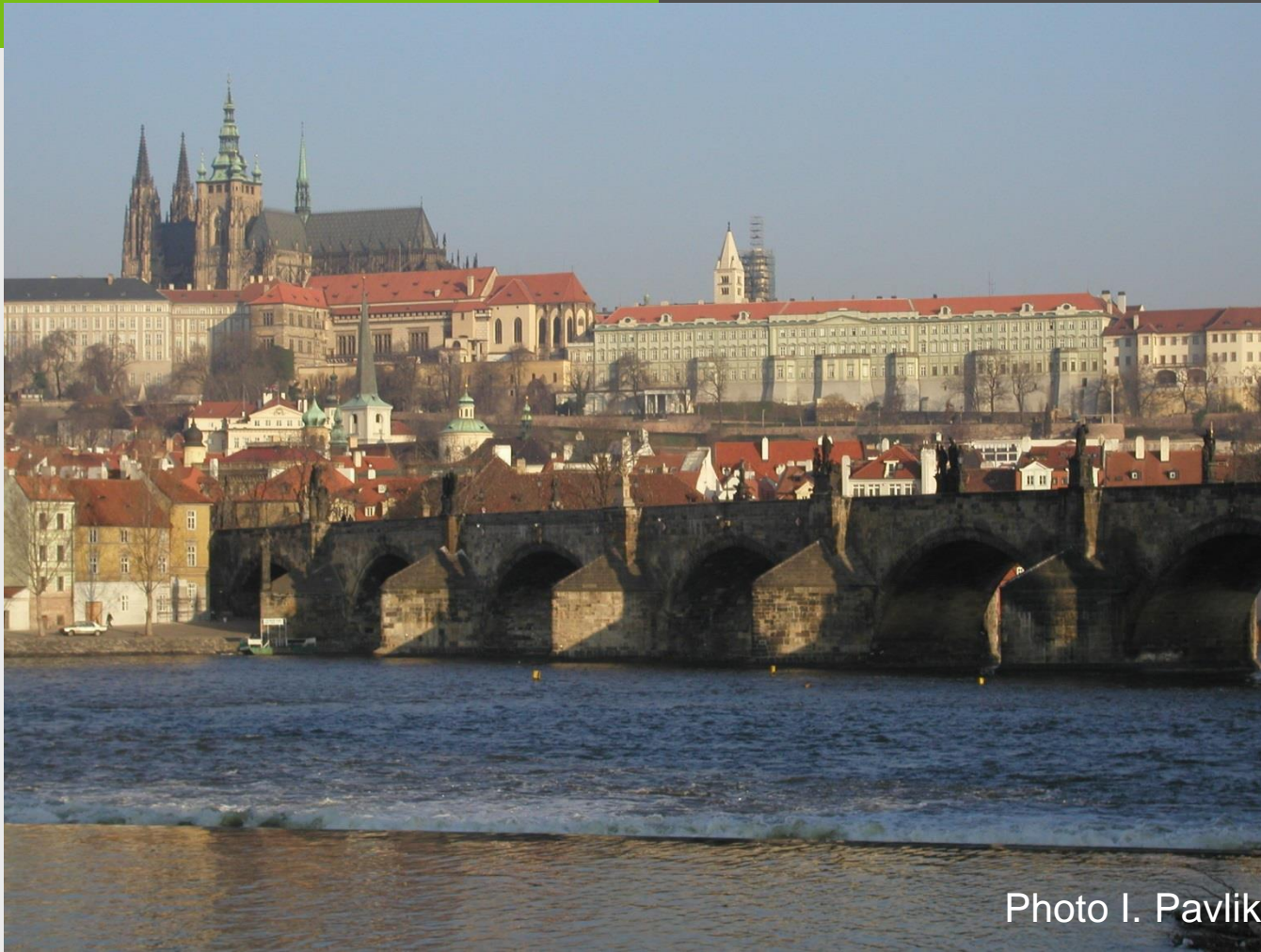


Photo I. Pavlik