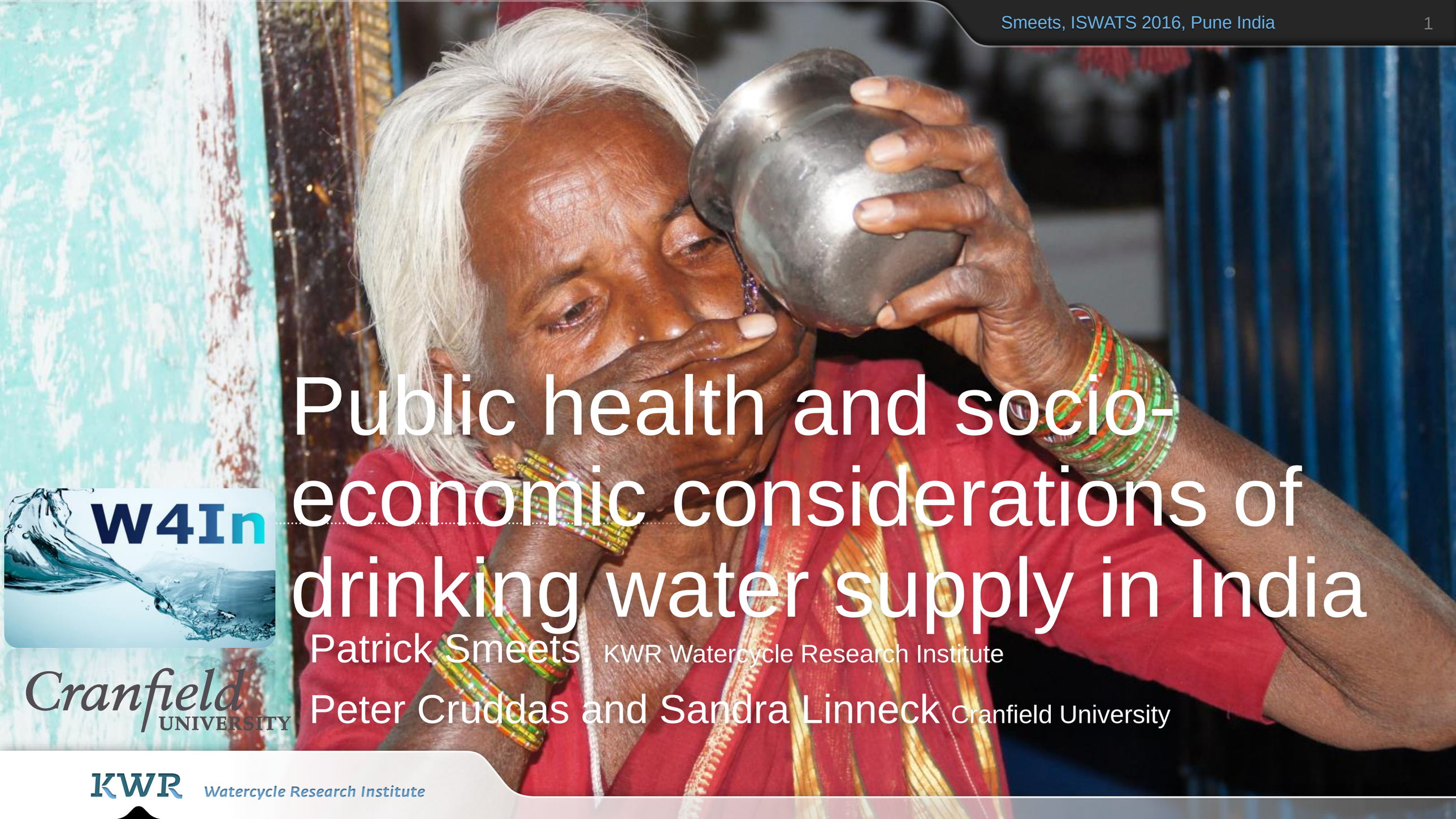


Public health and socio-economic considerations of drinking water supply in India

Patrick Smeets, KWR Watercycle Research Institute

Peter Cruddas and Sandra Linneck Cranfield University

KWR Watercycle Research Institute

Rural India water supply

A range of sources is used to cover water demand
Choice is based on availability and socio-economic aspects

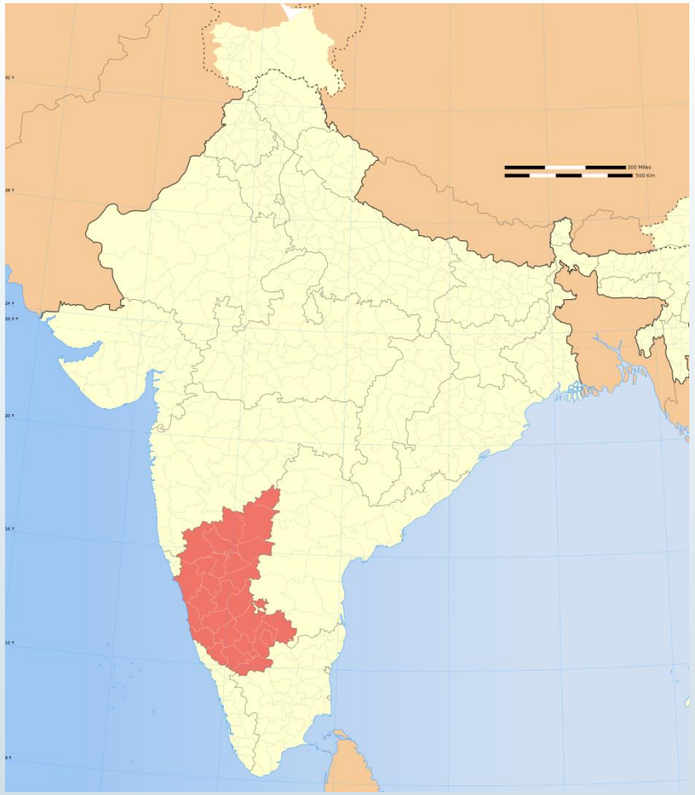
Study:

- Why do people choose a source?
- How do they handle and treat the water?
- What is the impact on health?
- How can safety be improved?

Focus: Microbiological health risks (accute issue)

Study approach

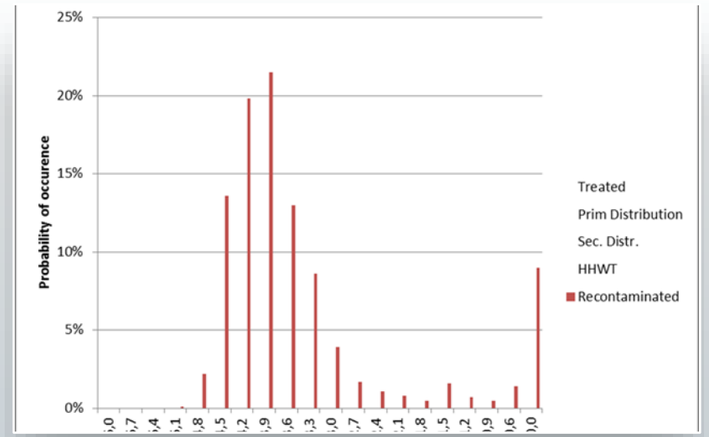
SCOPING STUDY RURAL KARNATAKA



INTERVIEW PEOPLE, NGO'S, LEADERS, DOCTORS….

PARTICIPATORY OBSERVATION

DEVELOP MULTI-ROUTE QMRA MODEL



LITERATURE+DATA STUDY FOR INPUT VALUES

Motivation for water source and treatment

Some examples

Open wells preferred:

- forseeable availability
- natural, spirutual, in the sunlight

No treatment, boiling, candle filtration (status)

Willing to pay for comfort or quality

- tap in the house
- water vendors of high quality water (e.g. RO)

Water source and treatment varies seasonally

Water not cause of diarrhoea (boiling for guests)

Personal behaviour has impact on safety!

INTERVIEW OF WOMEN GROUP

Contamination can occur at many stages of water supply












Disease causing micro-organisms in feces: PATHOGENS

Variation in occurence, persistence, fate, treatment and health effect

Pathogen type	Source	Characteristics	
Indicators *E. coli, TherTolColi*	Human, Animal	Bacteria, high numbers in feces, Water quality monitoring	

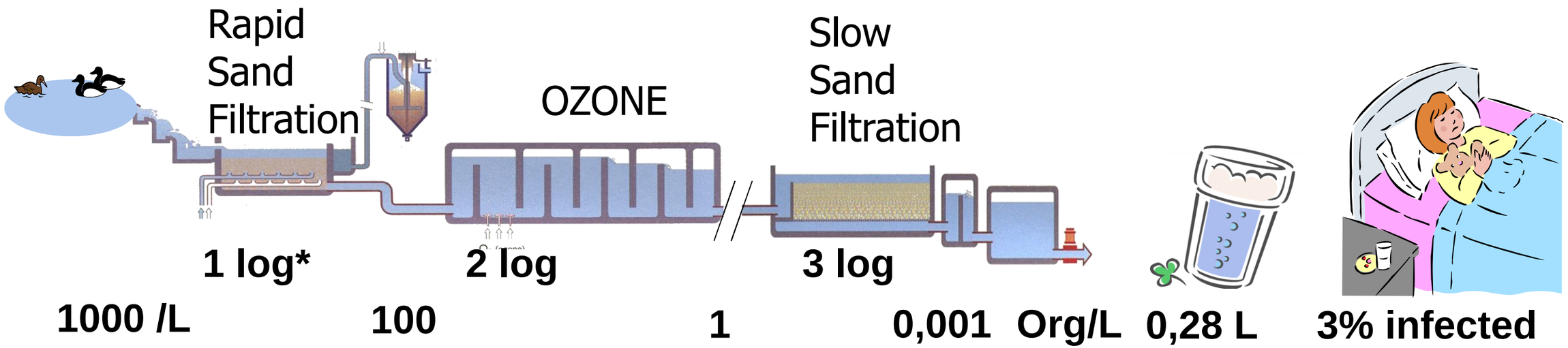
Routine water quality analysis for pathogens too expensive
Therefore risk assessment through modelling:

QMRA

Quantitative Microbial Risk Assessment

QMRA: Calculate health risk

Quantitative Microbial Risk Assessment



WHO: 10^{-6} DALY ≈ 1 infection per 1,000 persons per year
Netherlands + US-EPA: 1 infection per 10,000 persons per year
Absence of pathogenic microorganism in 100,000 to **1,000,000 L**

*1 log=90% removal 2 log=99% removal etc.

Data and estimates for surface water to standpipe and home:









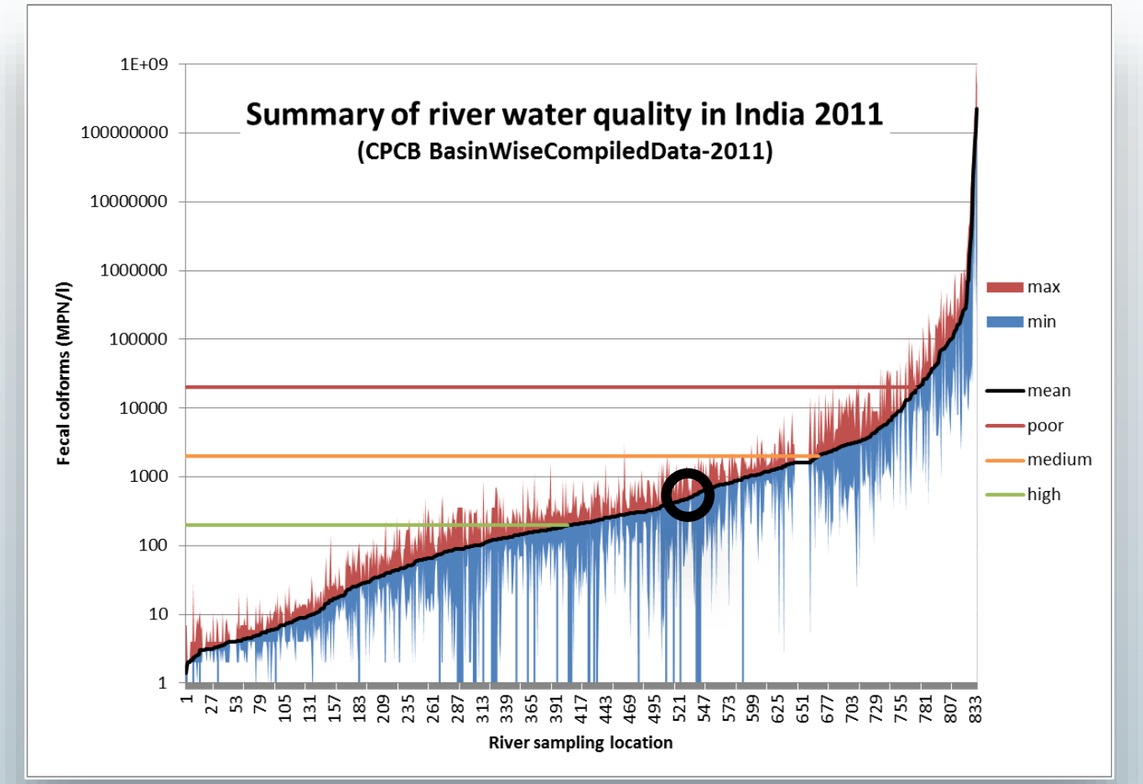

Local and literature data combined
Monte Carlo simulation to assess uncertainties

	Local data/information	Literature / estimates
Pathogens in Tunga River water	Data thermotolerant coliforms	Ratios THCOL-pathogens in EU rivers and sewage
Pathogen removal by treatment	Treatment scheme (conventional)	Watershare treatment calculator (literature review)
Recontamination		
- Pathogens in feces	-	Literature values
- Amount of feces	-	Estimate
- Contaminated water volume	Unit sizes	
- Frequency of contamination	Intermediate supply	Estimate
Water consumed	Observations	Literature, hot climate
Dose-response	-	Literature (QMRAspot)

Pathogens in source water: river

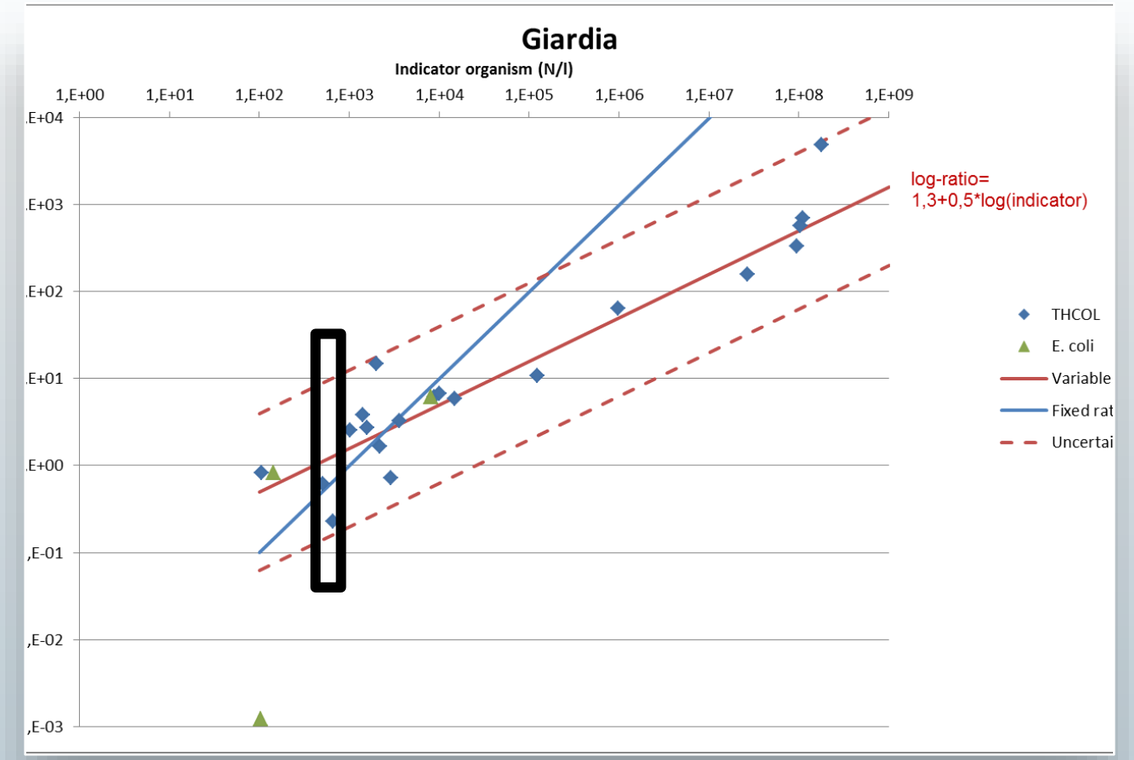
Indian indicator data + ratio indicator:pathogen from EU database

INDIAN MONITORING DATA OF FECAL COLIFORMS



Tunga river mean FC: 600 MPN/l

RELATION BETWEEN INDICATORS AND PATHOGENS IN EU-WATERS

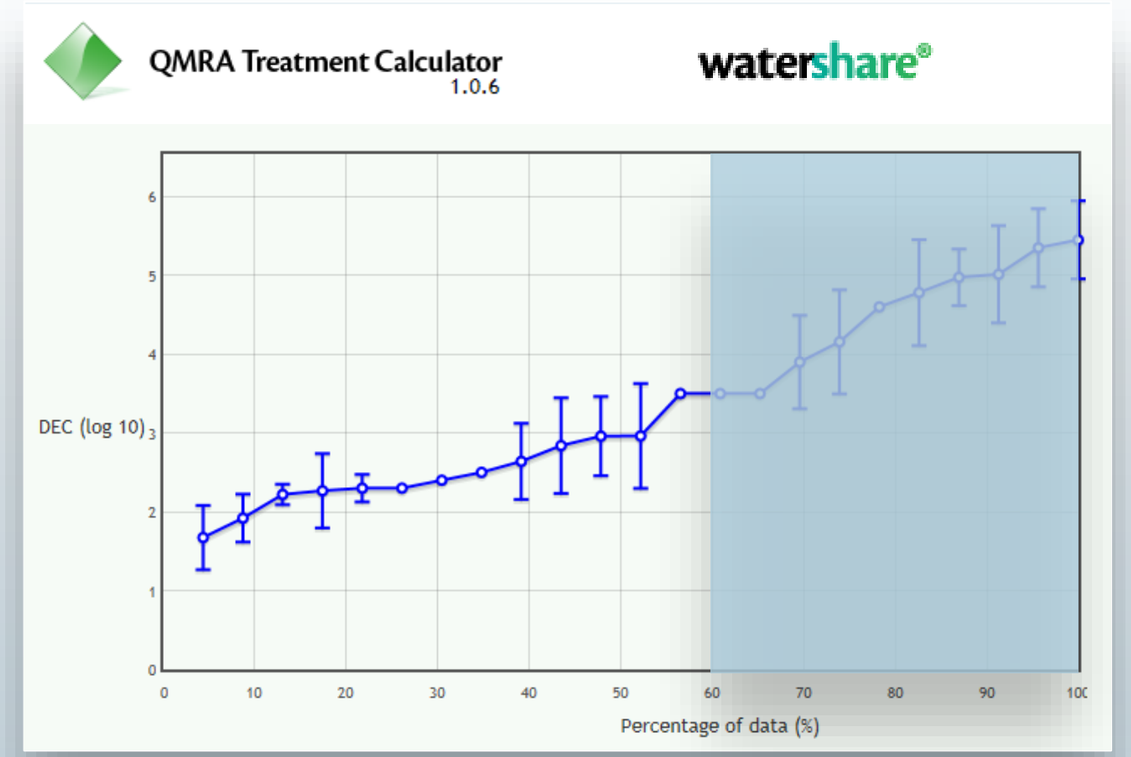


Tunga river mean Giardia: 1.2 cysts/l
uncertainty about mean: 0.15-9.7

Centralised treatment:

Literature data, consider local conditions

WATERSHARE TREATMENT CALCULATOR (LITERATURE VALUES)



www.watershare.eu

LOW EFFICACY DUE TO DISCONTINUOUS OPERATION AND ISSUES E.G. MISSING RAPID MIXER

Treatment: 1.6 – 3.3 log removal
0-0.4 log inactivation

Centralised storage and intermittent distribution

Recontamination with animal or human feces, lack of hydraulic integrity

STORAGE OPEN, ROAMING ANIMALS, LEAKAGE

Once per year, 10 g bird feces, 1 cyst/l

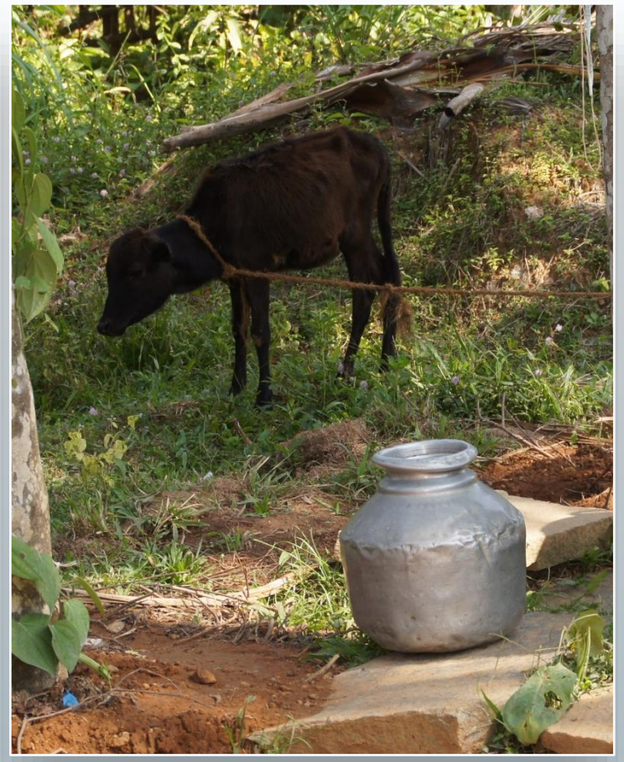
NO PHYSICAL AND HYDRAULIC INTEGRITY

Once per month, 1g cow feces, 10 cyst/l

Secondary distribution and home storage

Risk of contamination from human or animal feces

COLLECTION AND STORAGE IN OPEN VESSELS (CODA'S), ANIMALS NEAR HANDPUMP, STANDPIPE AND STORAGE

Monthly, 0.01g human feces or 1 g cow feces, 100 cysts/l (0.01-1,000,000)

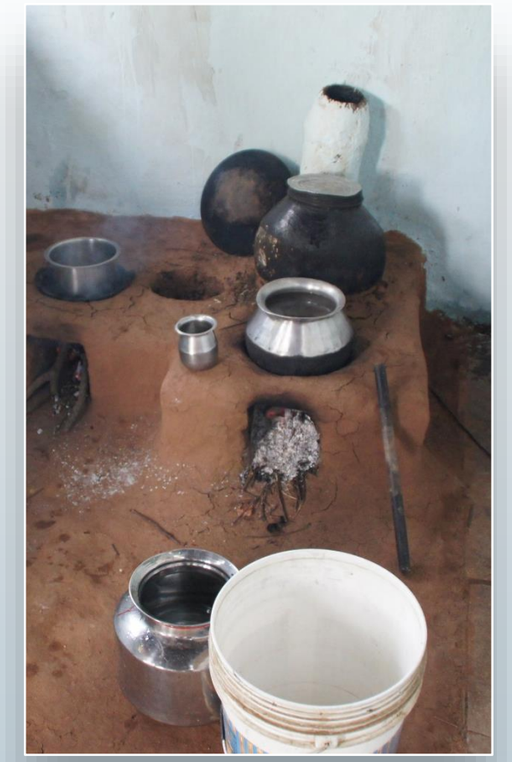
Household water treatment

No certification of household water treatment systems

’FILTRATION’

0 log

BOILING



9 log

CANDLE FILTER

3 log

RO SYSTEM

5 log

Results QMRA risk estimation

Theoretical health risk based on available data and assumptions

Scenario	Theoretical annual risk infection /persons
Current treated surface water (Cryptosporidium, Giardia)	1/20
Optimized treated surface water	1/6000
Contamination intermittent distribution + tapstand	1/10
Good household water treatment	1/400
Open well	1/5
Rainwater	1/1

300X more safe!

Conclusions from interviews and QMRA

Potential impovement treated water

- training staff
- risk-based operation and maintenance
- requires cost recovery

Only effective if contamination is prevented

- hydraulic integrity distribution
- taps in homes

HHWT important role for all water sources

- Awareness of people
- Availability of affordable certified products

HYGENE EDUCATION IN PRE-SCHOOL

Research needs

- Presence of PATHOGENS (esp. protozoa, viruses) in INDIAN environment
- How often does contamination occur in intermittent supply and home?
- Relative importance of exposure routes (drinking water)
- Effect of barriers
  - Potential effect of centralised supply (optimized operation)
  - How to introduce mandatory certification of household water treatment systems
- Extensive study on effect of hygene education and behaviour change

Many thanks to

Basavaraj Honnapa, Vrutti NGO, Gulbarga
Channappa, Chintana Foundation, Shimoga
and the people of India teaching us about their water

Acknowledgements
Water4India European Commission project308496
Joint Research Program of the Drinking Water Companies in the Netherlands

SEVENTH FRAMEWORK PROGRAMME