52 ND

Session of the Codex Committee on

FOOD HYGIENE

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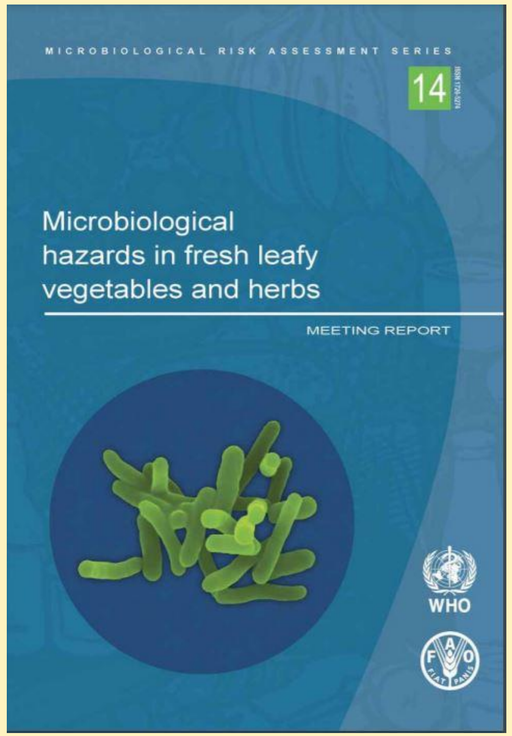
JEMRA work on safety and quality of water used in food

Food and Agriculture Organization of the United Nations

World Health Organization

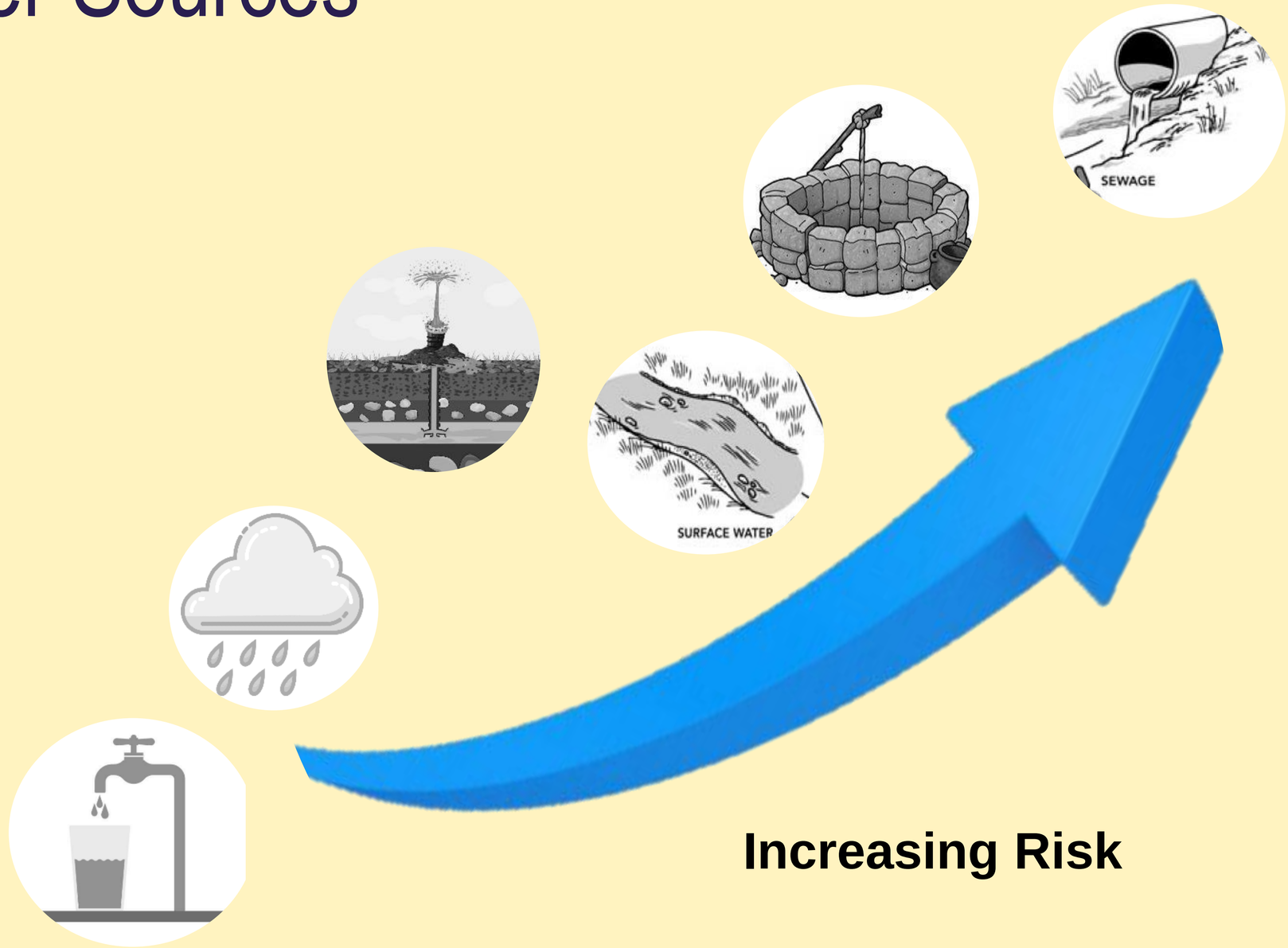
Early Work



2008

- **Characterized and ranked different types and uses of water sources in vegetable production**
- **Described mitigation strategies to prevent waterborne contamination of fruits and vegetables**
- **Outlined microbiological criteria currently in use for different agricultural water sources and how effective are the application of criteria are for mitigating the risks**
- **Emphasized the lack of evidence associating indicators with pathogens and efficacy of adhering to microbial water criteria to reduce risk**

Water Sources



CCFH Request to JEMRA

- to provide guidance on processing water, in particular,

  1)“clean water” for irrigation water,

  2) clean seawater, and

  3) on the safe reuse of water.

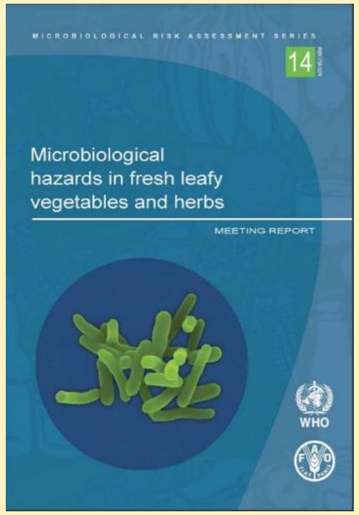
- sector-specific applications and case studies for determining appropriate and fit-for-purpose microbiological criteria for water sourcing, use and re-use in:

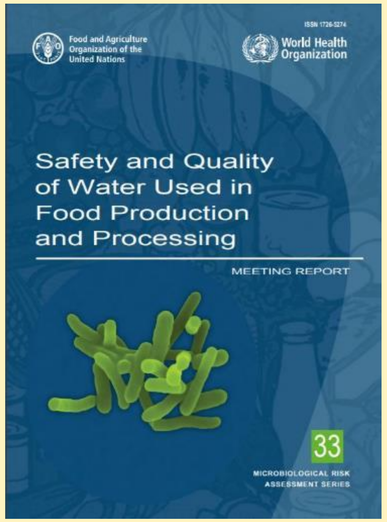
  1) fresh produce,

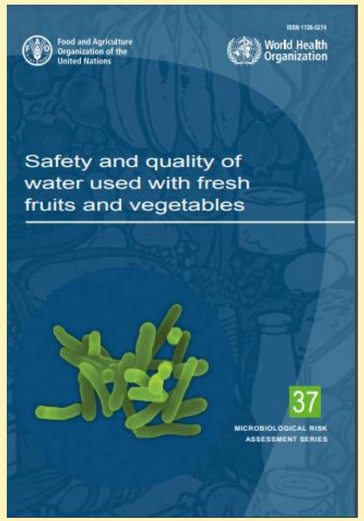
  2) fish and fishery products from primary production to retail, and

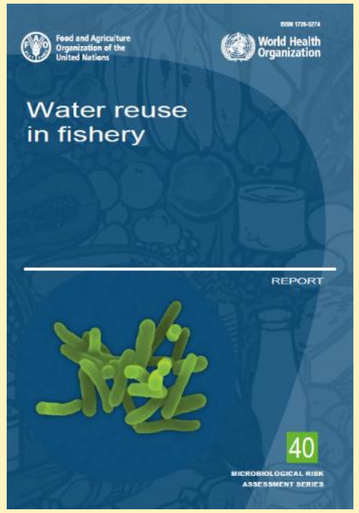
  3) in dairy sector from milk harvest to manufacturing.

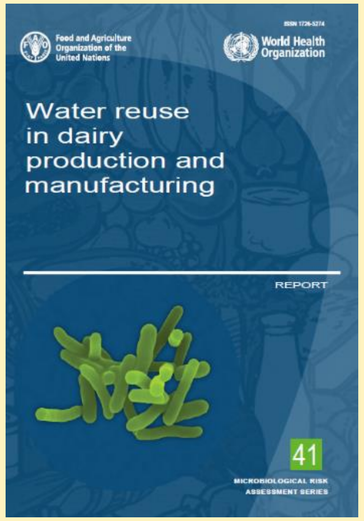
Time line of JEMRA Work on Water

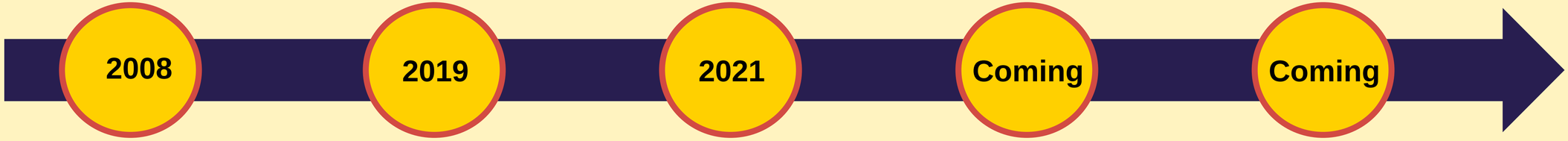








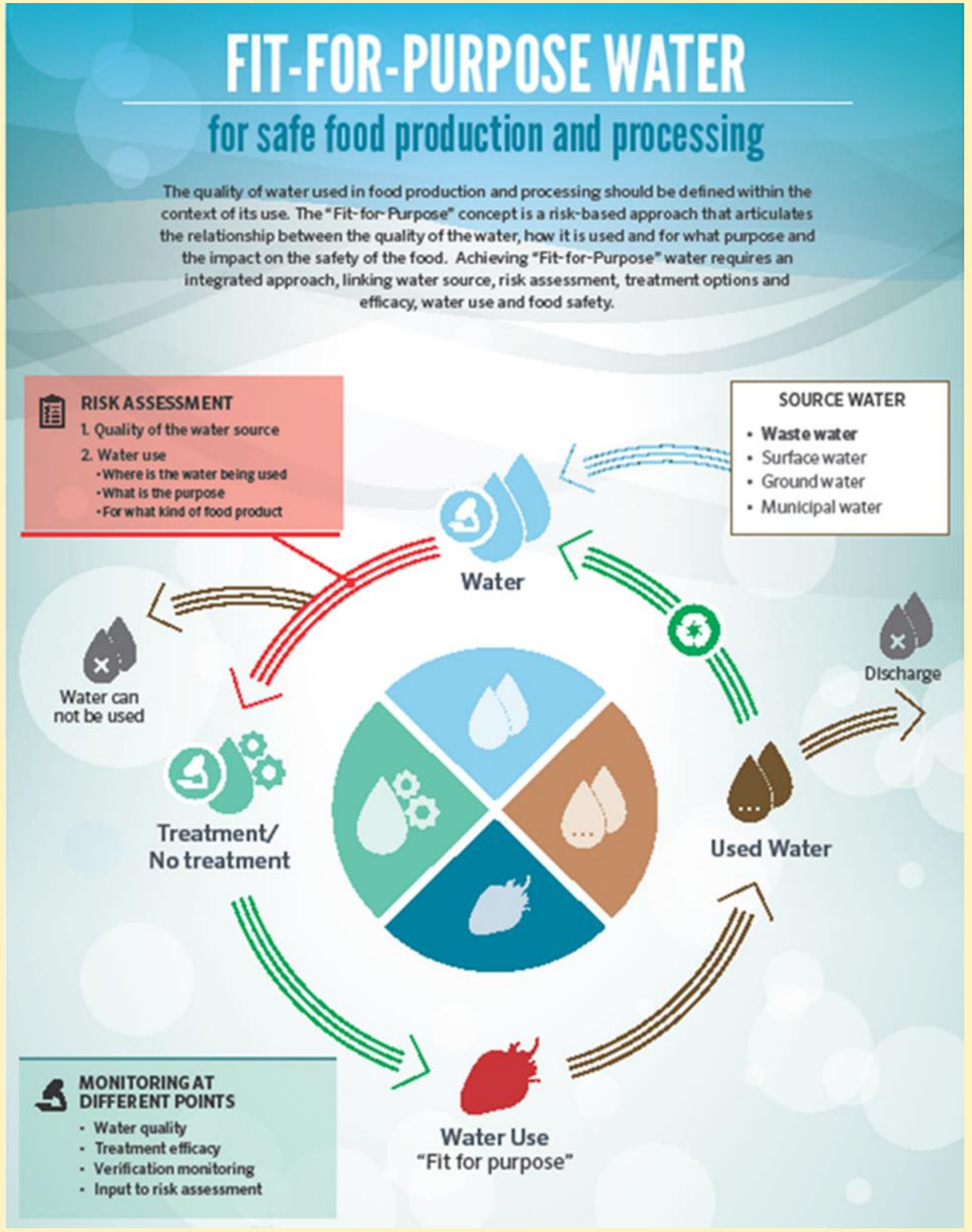




„not compromise the safety of the food”

One size does **NOT** fit all

Need for risk-based approaches

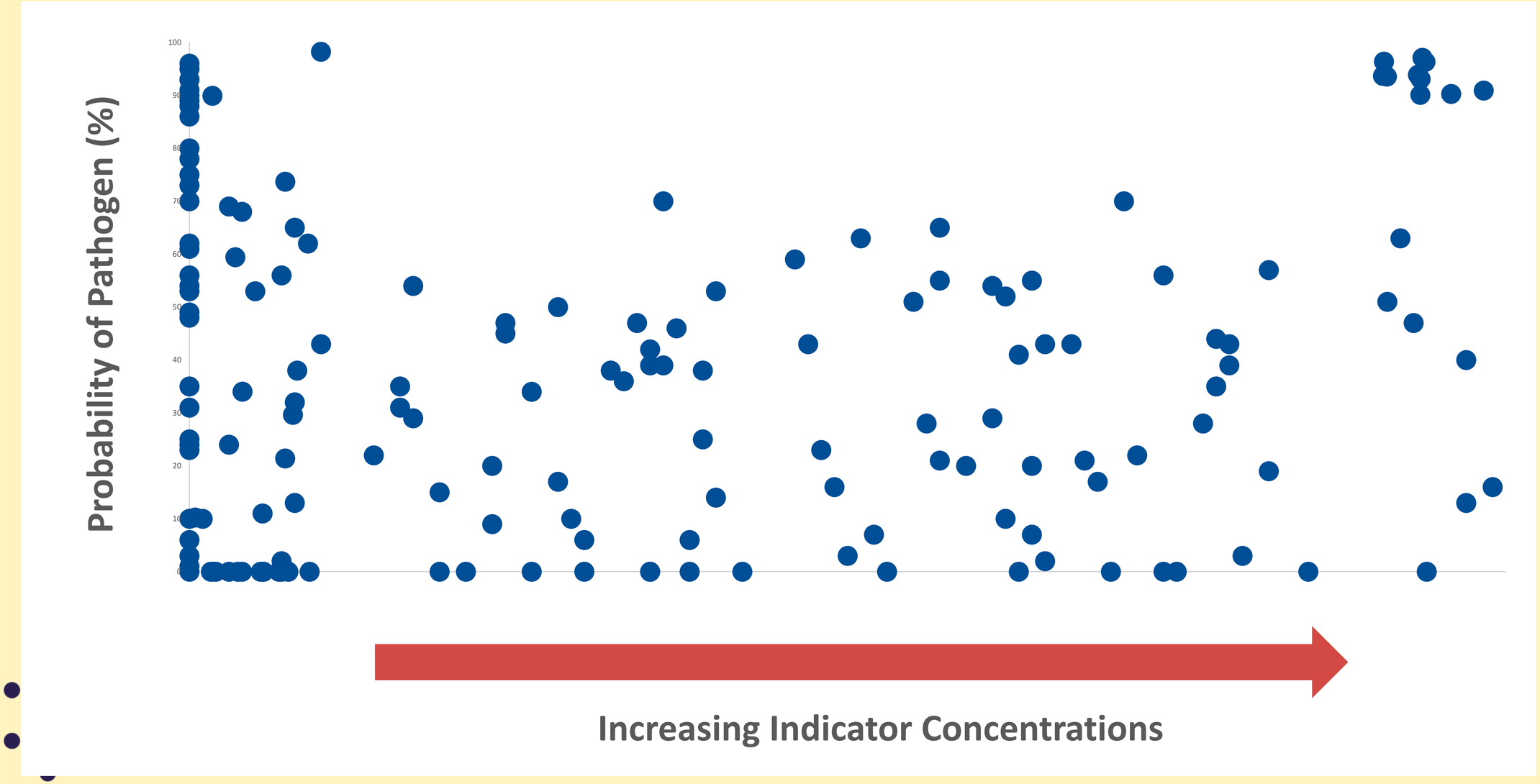


Challenges of Microbiological Criteria

1. Transfer of pathogens from water to vegetables is dependent upon multiple factors
    - Irrigation methods
    - Concentration and type of pathogen in water
2. Pathogens on vegetables can increase or decrease after contamination
    - Characteristics of the food
    - Die-off/kill (e.g. UV, water disinfection, cooking, time until consumption)
    - Recontamination & Proliferation (e.g. temperature abuse)
3. Pathogens at low concentration and may be sporadically present
4. Predicting pathogens in water based on indicators problematic

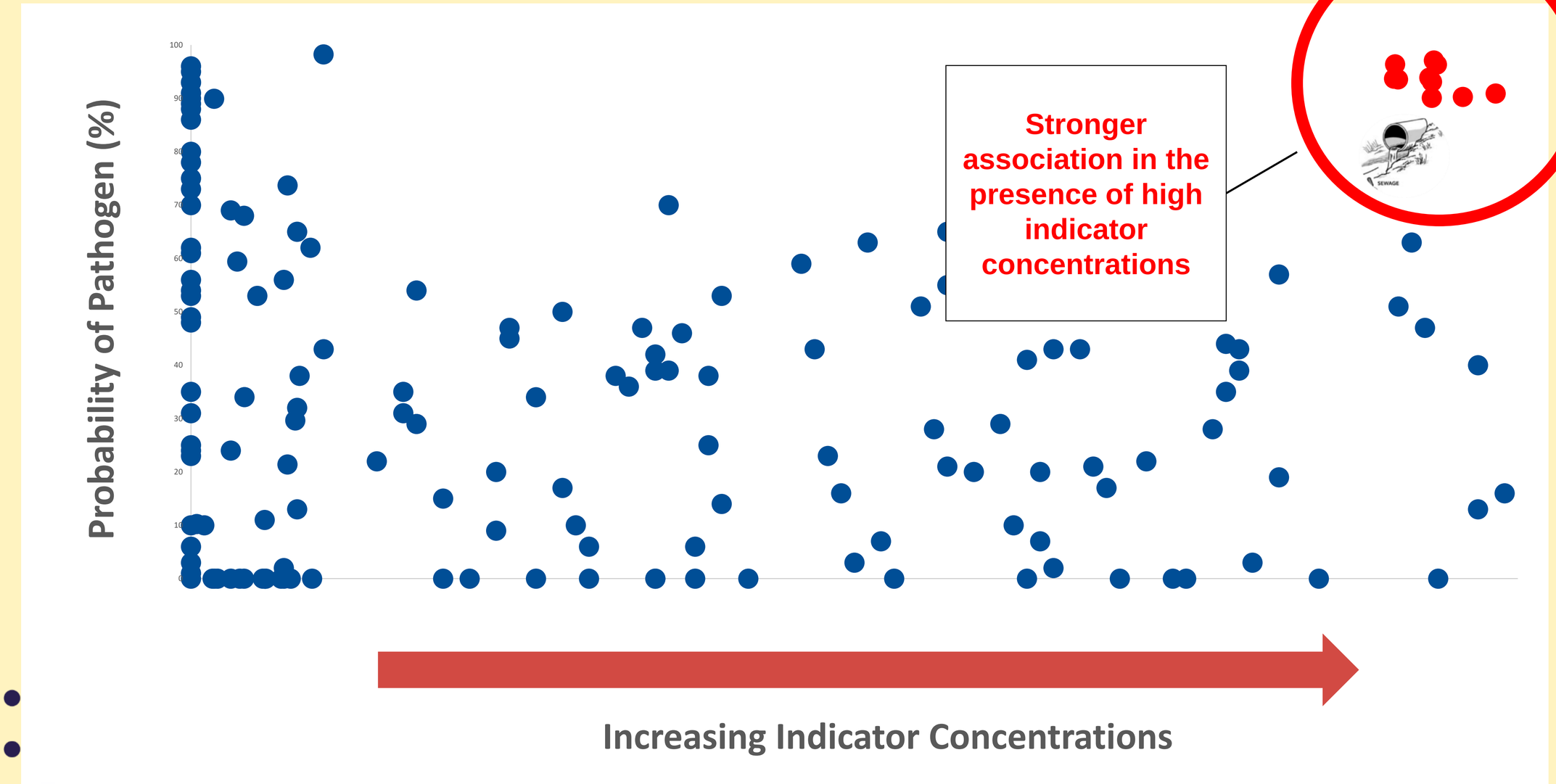
Not WYSIWYG

Indicators and pathogen presence



Example data for display purposes only

Indicators and pathogen presence



Example representative data for display purposes only

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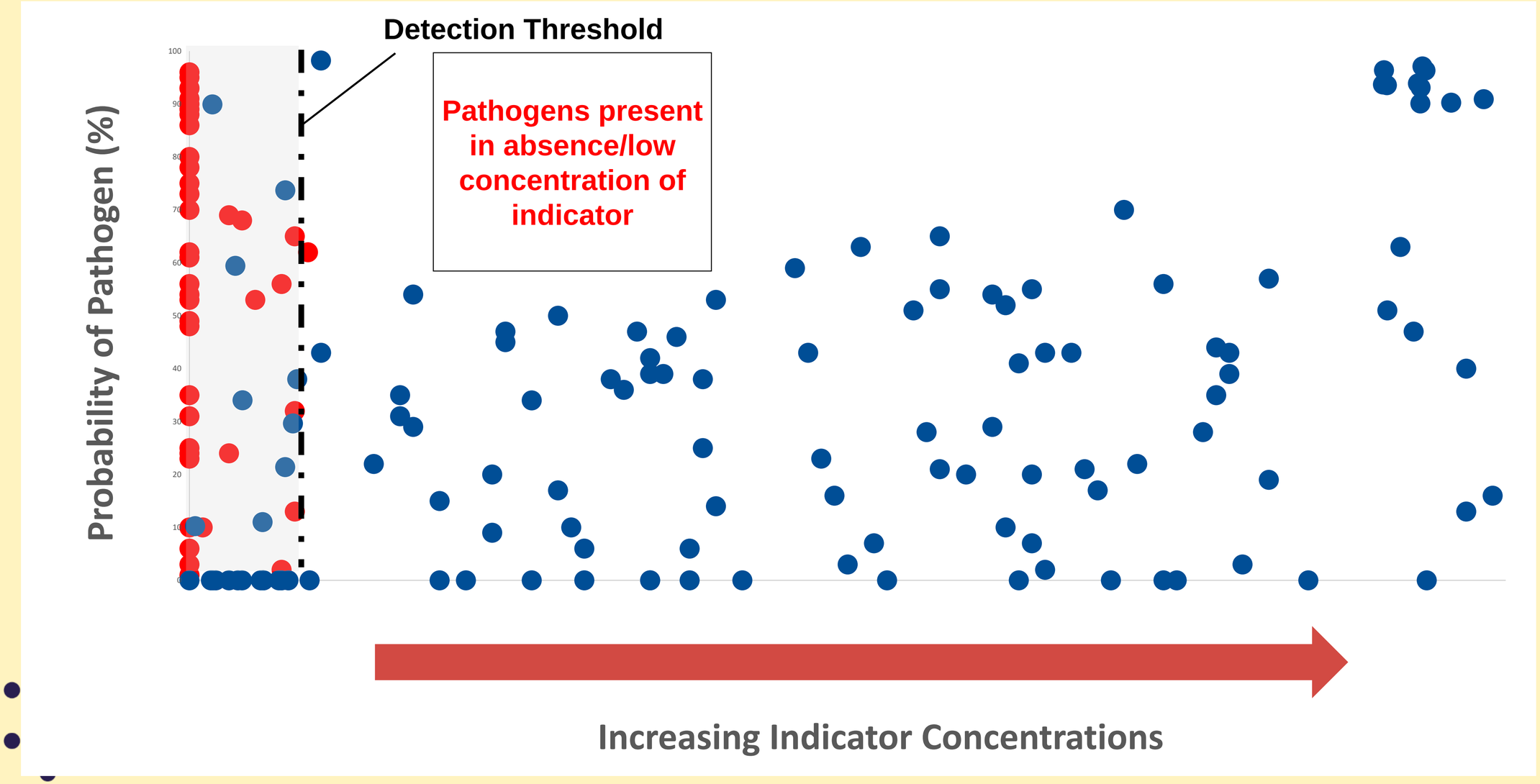

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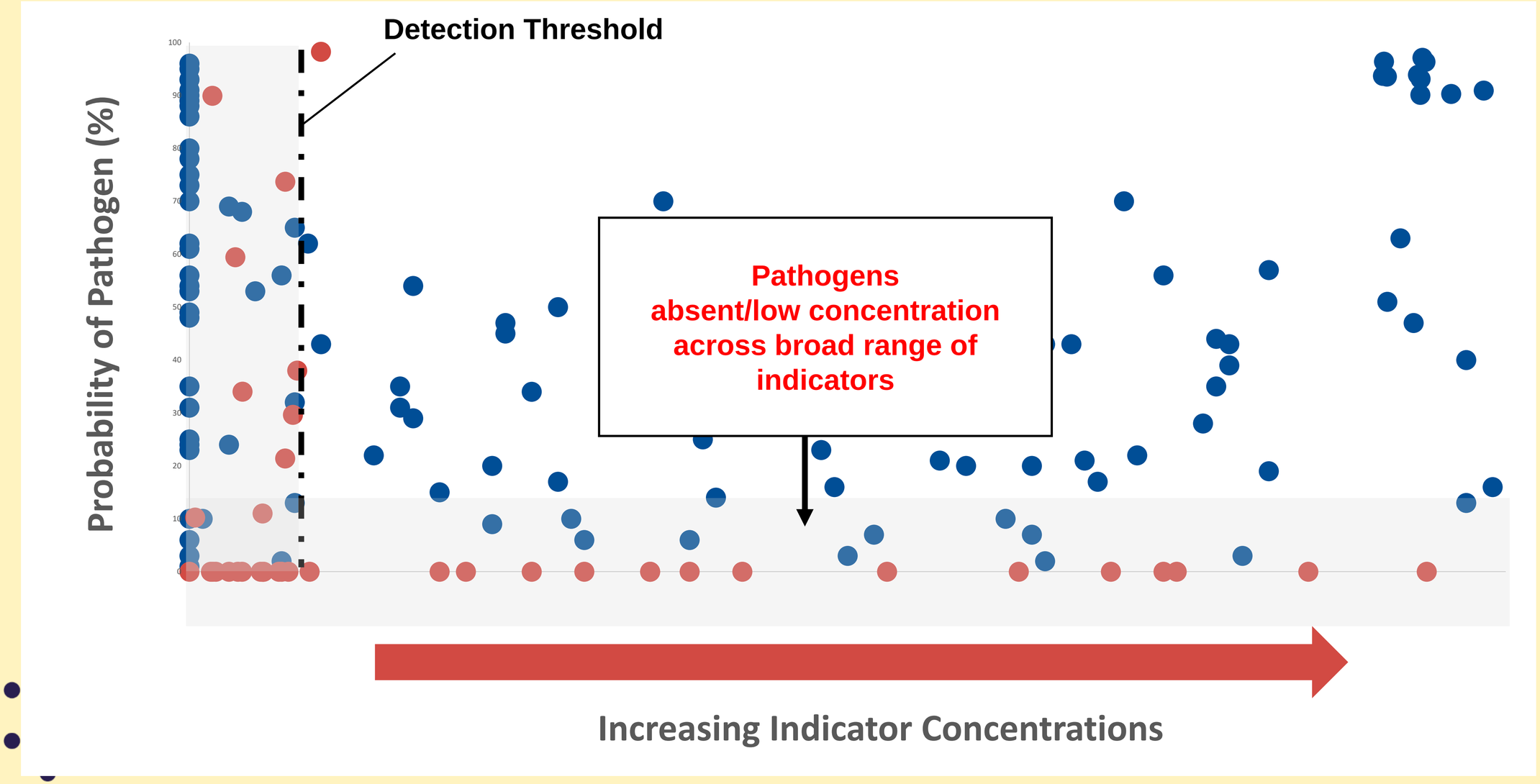

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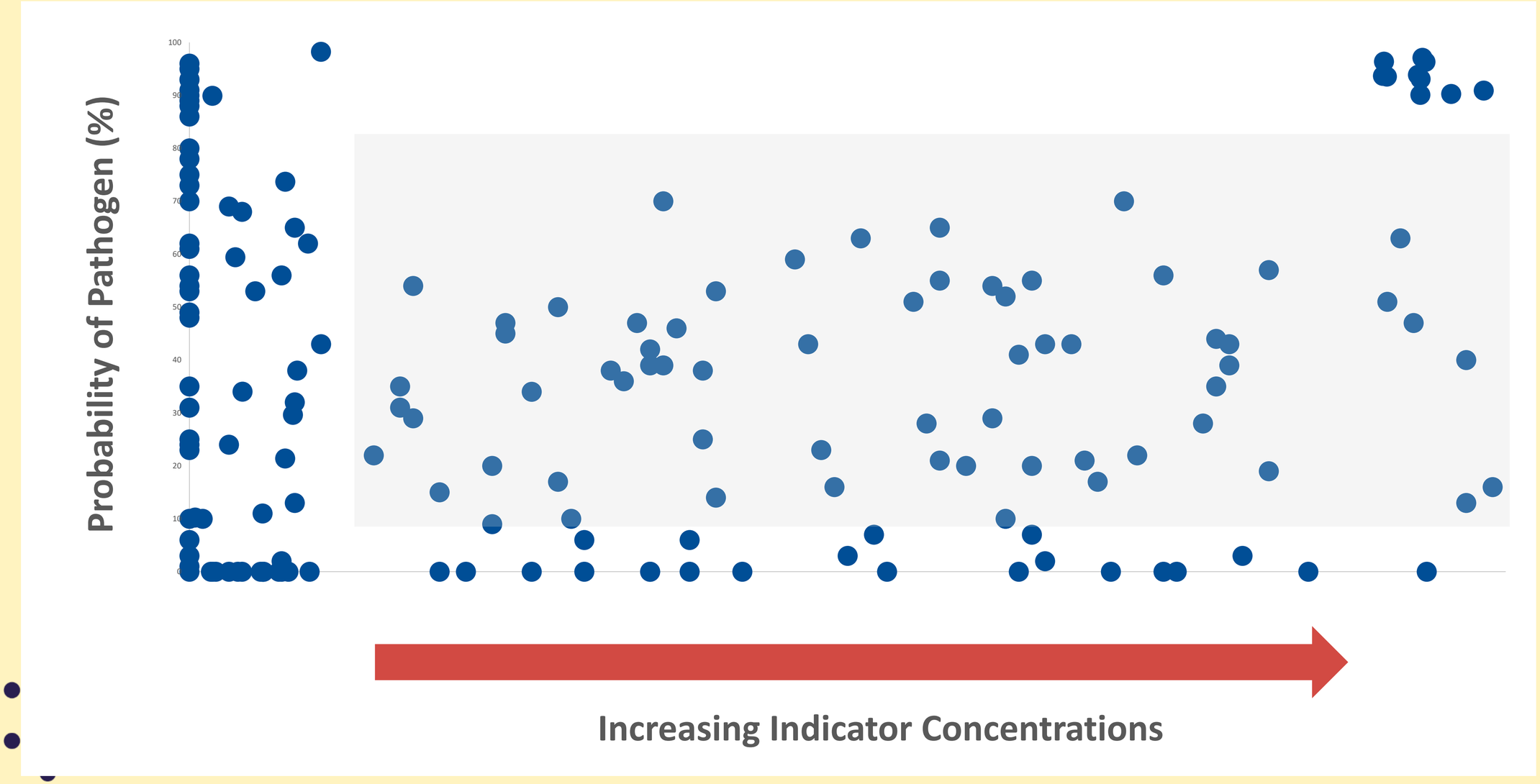

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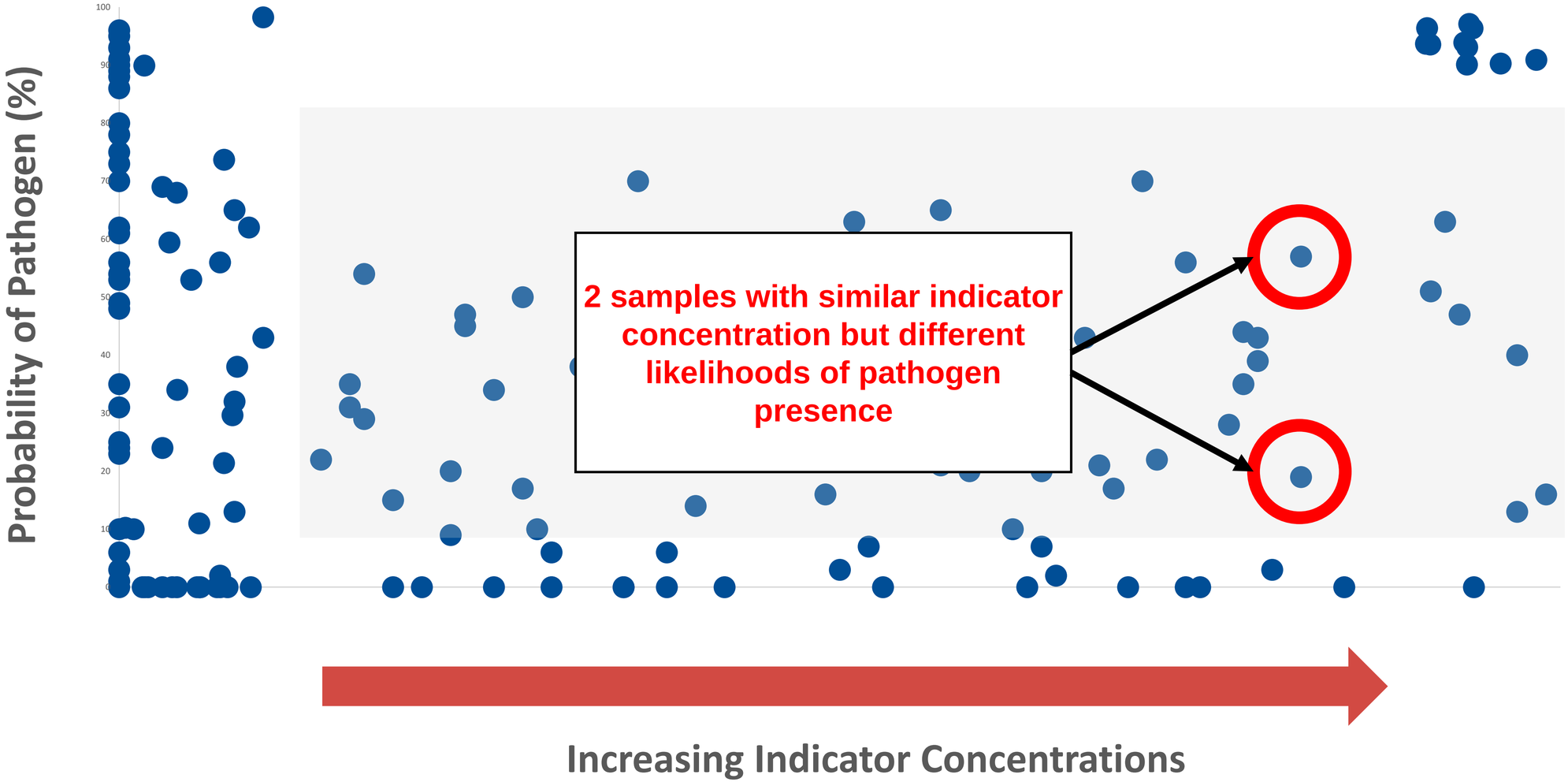

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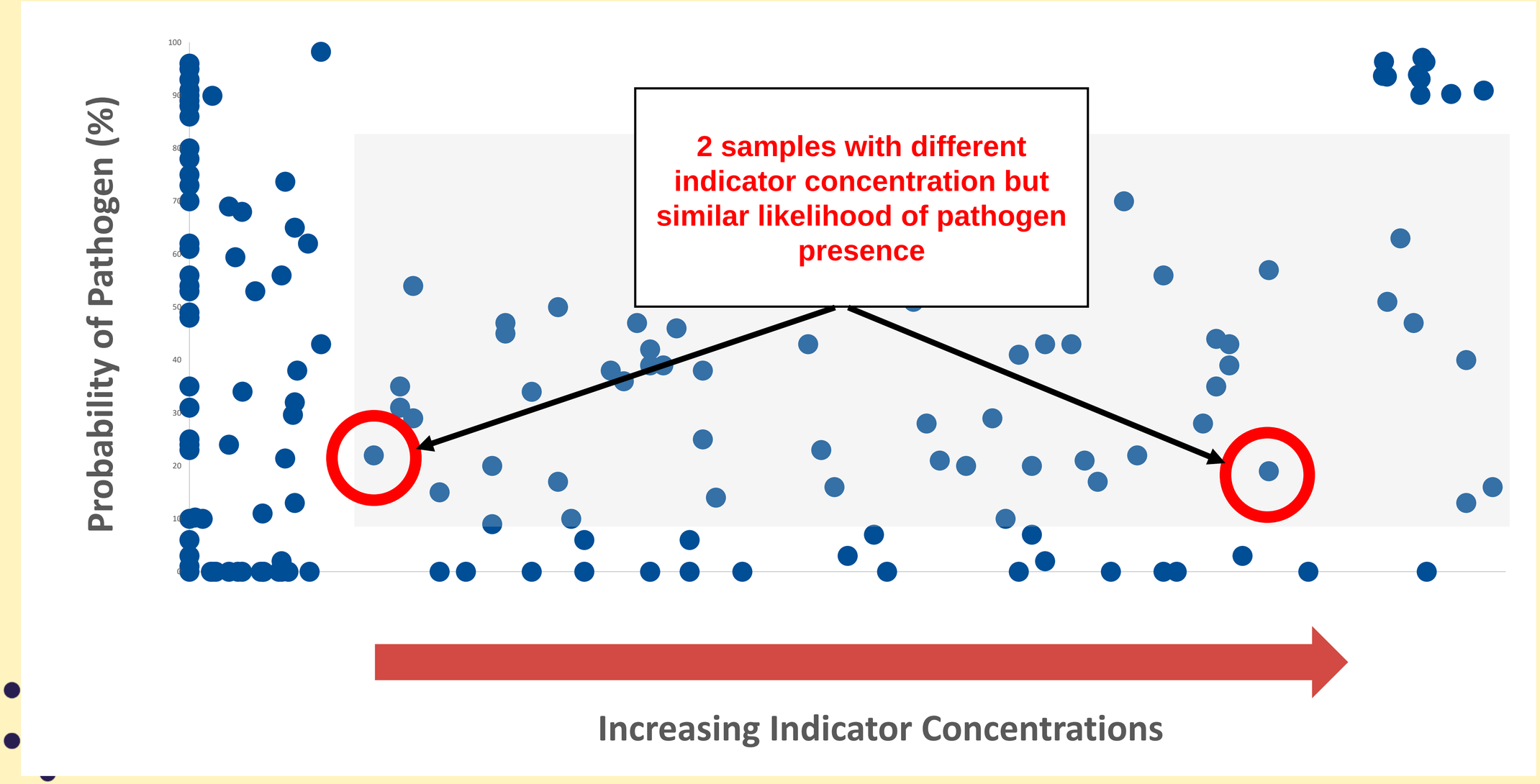
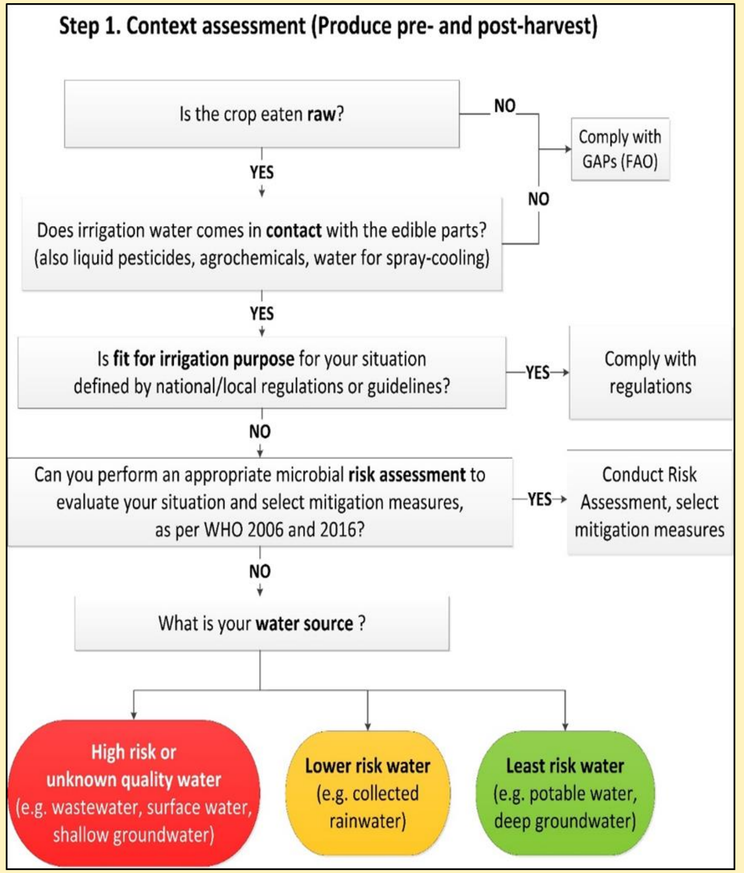


Example representative data for display purposes only

Risk-based approaches to water management: A solution to criteria-based thresholds

- Take into consideration the factors that impact contamination and persistence
- Use a systematic approach to assess risks, that can be guided by tools such as risk matrices and decision trees
- Can be tailored the specific needs and capabilities of the growers/processors



PRE-HARVEST								
Intended use of the water	Untreated wastewater	Surface water of unknown quality	Groundwater collected from shallow groundwater	Groundwater collected from deep wells	Collected rainwater	Advanced treated wastewater	Treated surface and groundwater	Municipal water
Irrigation of RTE fresh produce where irrigation water comes into direct contact with the edible portion of the product								
Irrigation of RTE fresh produce where irrigation water does **not** come into direct contact with the edible portion of the product.								
Irrigation of cooked vegetables where irrigation water comes into direct contact with the edible portion of the product.								
Irrigation of cooked vegetables where irrigation water does **not** come into direct contact with the edible portion of the product.								
Foliar application of water (pesticides, fertilizers, frost control, growth regulators) use in direct contact with the edible part of the RTE fresh produce.								
Foliar application of water (pesticides, fertilizers, frost control, growth regulators) **not** use in direct contact with the edible part of the cooked produce.								
POST-HARVEST								
Postharvest water used for direct contact with the RTE fresh produce								
Postharvest water used for direct contact with the cooked fresh produce								
Postharvest water used for **indirect** uses								

Tools for Risk Assessment: Risk matrix

Intended use of produce	Contact with edible plant portions	Water source				
		Wastewater	Surface and groundwater of unknow quality	Groundwater collected from protected wells	Collected rainwater	Portable water and deep ground water
Ready-to-eat	Contact with the edible portion	High risk / ?	High risk / ?	Medium risk	Medium risk	Low risk
	Not contact with the edible portion	High risk / ?	High risk / ?	Low risk	Low risk	Low risk
Cooked	Contact with the edible portion	Low risk	Low risk	Low risk	Low risk	Low risk
	Not contact with the edible portion	Low risk	Low risk	Low risk	Low risk	Low risk

Risk mitigation (Vegetable)

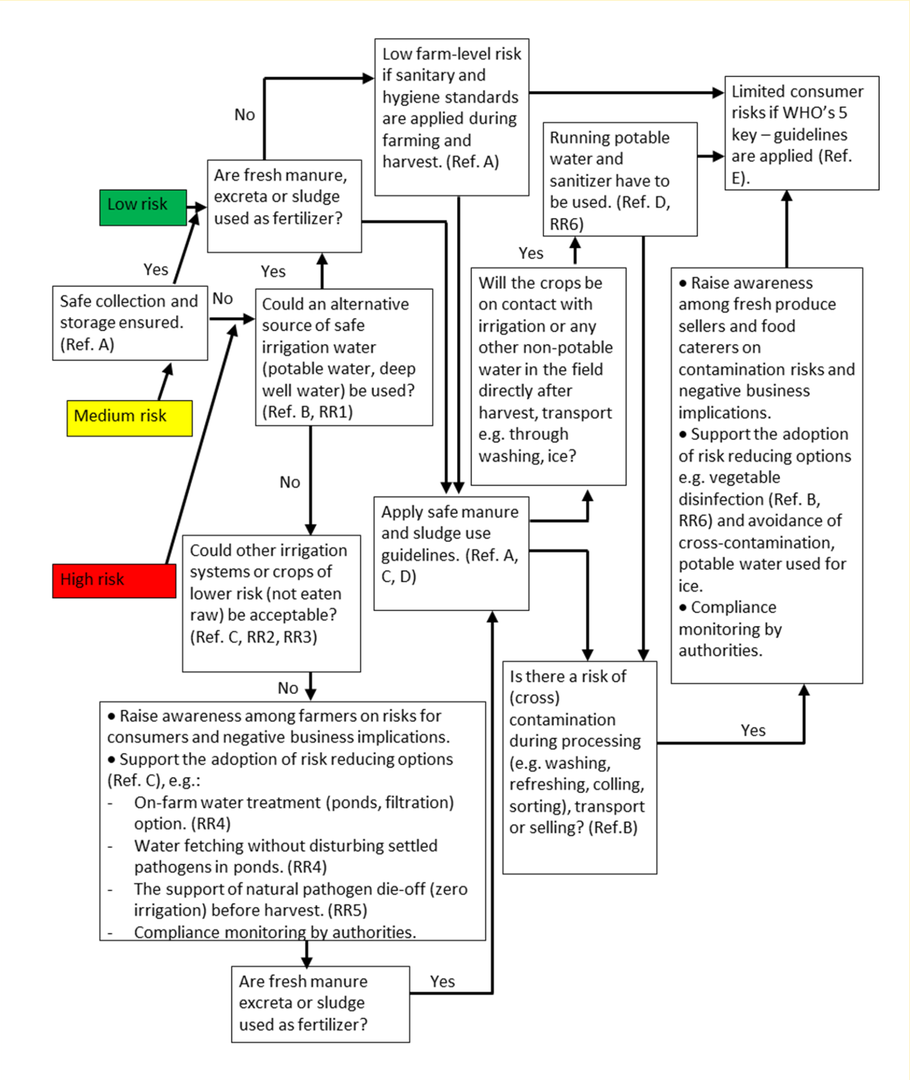
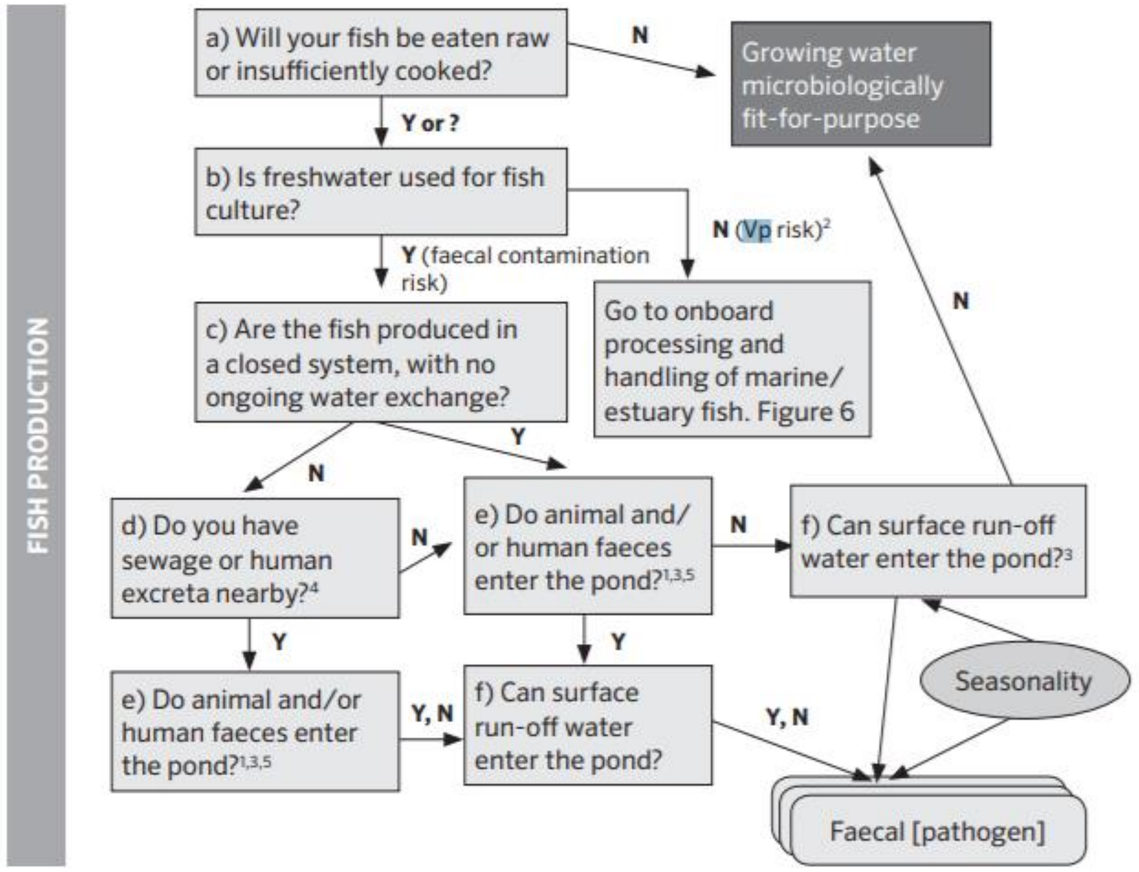


TABLE 1. Qualitative effectiveness of selected control measures for produce, with focus on a small-scale production context

Risk mitigation options	Effectiveness rating	Step 2 cross-reference
Alternative water source such as deep well or potable water	·····	RR1
Change from raw eaten vegetables to boiled vegetables	·····	RR2
Change from overhead irrigation (sprinklers, watering cans) to: Furrow irrigation Drip irrigation	· ···	RR3
On-farm water treatment ponds with 18+ hrs sedimentation period Water fetching without disturbing pond sediment	·	RR4
Filtering water before irrigation (e.g. fine sand, biochar)	·	RR4
Irrigation cessation for three days (no watering before harvest) Note: in hot climates, prolonged irrigation cessation is not feasible.	··	RR5
Peeling fresh produce (e.g. root crops, fruits, removal of cabbage outer leaves)	··	RR5
Washing salad with running potable water	·	RR6
Washing salad with running potable water and added sanitizer	··	RR6
TARGET FOR RISK REDUCTION (RR)	·····	
Example: assuming a target of 6 stars, assuming reduction is additive Filtering water + Drip irrigation + Produce washing with sanitizer = · + ··· + ·· = ·····		

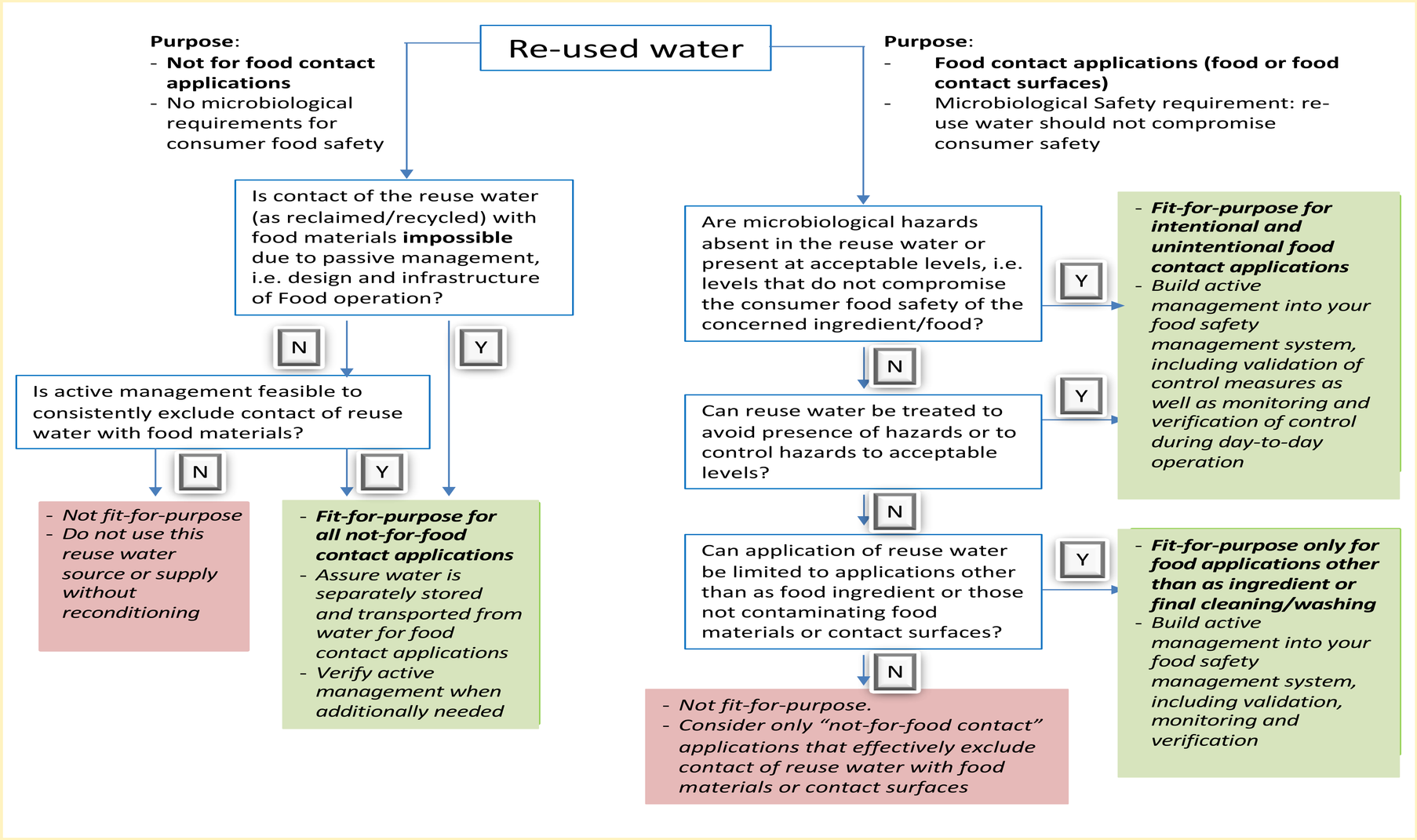
Tools for Risk Assessment: Decision Tree (Fish Production)



1 Section 6 of the Codex Code of Practice for Fish and Fishery Products on aquaculture products, pp.54-64
2 Risk assessment of *Vibrio parahaemolyticus* in seafood, WHO/FAO MRA Series 16, pp. 154-176
3 WHO Water Safety Plan. WHO/Europe 2014
4 WHO Sanitation Safety Plan Manual
5 WHO Safe Use of Wastewater, Excreta and Grey Water. Vol. 3. Aquaculture

FIGURE 4. Decision tree for production level of fish and fish products

Tools for Risk Assessment: Decision Tree (Water reuse)

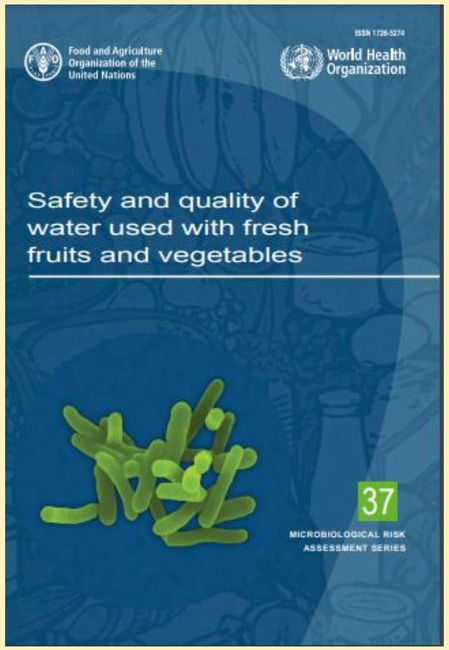


Microbial monitoring of water quality

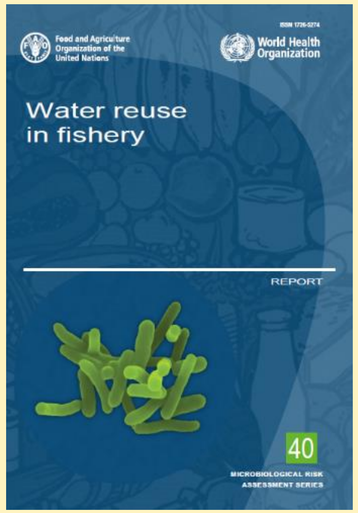
- Observations or measurements assess whether a risk reduction measure is working
- Type and frequency of monitoring should be proportionate to the risk posed and meet risk management goals
    - Validation: Determination if an intervention works
    - Operational monitoring: Routine activities, at a frequency to identify failures of the measures in a timely manner, to determine that control measures continue to work effectively
    - Verification: determination that the control measures are operating as intended, using monitoring and other methods

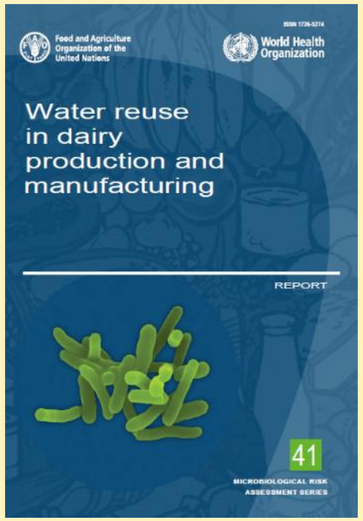
Microbial Indicators	Advantages	Disadvantages
Escherichia coli	• member of FCs found in the intestines of mammals, including humans. • is usually considered the most suitable indicator of faecal contamination. • indicates recent faecal contamination and that pathogens might be present.	• does not distinguish between human and animal faecal contamination. • may not be a suitable indicator for viruses, protozoans and helminth eggs as less persistent i.e. when absence or low numbers of *E. coli*. • *E. coli* can replicate in environmental waters.
Total coliforms	• measure of degree of pollution and sanitary quality of water. • positive TCs test can be followed by FC and E. coli tests.	• do not necessarily indicate faecal contamination.
Enterococci	• intestinal subgroup relatively specific for faecal pollution. • tend **to survive longer in water environments than E.** coli.	• number present log lower than number of *E. coli* in faeces. • have been shown to replicate in the environment.
Bacteriophages (coliphages, *Bacteroides* spp.)	• used as an alternative to faecal indicator bacteria; chosen depending on purpose. • surrogates for human viral pathogens in the environment. • microbial source tracking tools, some specific to human faeces. • models or surrogates to assess the behaviour of human enteric viruses in water environments.	• different excretion patterns phages (continual) versus enteric viral pathogen (during infection only). • detection and counting methods of some phages are more complex and expensive than other phages and for faecal indicator bacteria. • relatively low numbers of some *Bacteroides* spp. in sewage and polluted water environments. • some *Bacterioides* spp. phages exhibit low survival rates in water.

Case Studies



- **Different**
  - **geographic regions**
  - **climates**
  - **access to infrastructure**
  - **water sources**
  - **Foods**
    - **Fresh leafy, eaten raw**
    - **Lettuce**
    - **Coriander, parsley**
    - **Radish**
    - **Tomato**
    - **Berries**
    - **Carrots**
    - **Melons**





- Scientific evidence and criteria recommendations for the safety and quality of various types of water used for different production, processing, transportation, retail sale and consumption applications.
- The measures used for assessing “fitness” of water for its intended purpose and the benefits and pitfalls of these different measures.
- practical interventions being used to treat water for direct use and re-use in low- and middle-income countries to achieve an acceptable level of risk based on the intended purpose.

Ten take home messages

1. **Risk assessment is essential**

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1. Risk assessment is essential
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4. Risk assessment is essential
5. Risk assessment is essential
6. Risk assessment is essential
7. Risk assessment is essential
8. Risk assessment is essential
9. Risk assessment is essential
10. Risk assessment is essential

Ten take home messages

1. **Risk assessment is essential**
2. Water should be fit-for-purpose, not compromising the safety of the food (i.e.not making it more hazardous after contact with water)
3. Potable water is not always available, nor essential
4. Different water sources could be used for different purposes safely, included water re-use, depending upon method of application and stage of production and how the product will be consumed.
5. Typically, the closer in the value chain to the consumer, the higher quality water needed.
6. Decision tree support management tools are available
7. Interventions are available to reduce risks, multiple hurdle preferred
8. No one water quality microbial indicator is appropriate/useful for all water types, and for some water types there may not even be a single useful indicator.
9. At present, there is no reliable microbiological indicator that can reliably predict pathogen occurrence or numbers because bacterial indicators are typically surrogate measures of faecal pollution, rather than measures of pathogens themselves.
10. Monitoring should be proportionate to the risk posed and meet risk management goals

Thank you!

And special thanks and recognition to all the experts!