Increasing rural drinking water security within Fijian watersheds

Jacqueline Thomas [1], Shylett Anthony [2], Thompson Daurewa [2], Sikeli Gavidi [2], Pierre Horwitz [3], Aaron Jenkins [3,4], Stacy Jupiter [5], Shuang Liu [1], Kinikoto Mailautoka [2], Sangeeta Mangubhai [5], Kelera Naivalu [2], Timoci Naivalulevu [2], Vilisi Naivalulevu [2], Sikeli Naucunivanua [5], Mereia Ravoka [5], Andrew Tukana [5] Donald Wilson [6,] and Joel Negin [4]

1. School of Civil Engineering, The University of Sydney, Darlington, NSW 2008, Australia
2. Fiji Institute of Pacific Health Research, Fiji National University, Hoodless House, Suva, Fiji
3. School of Science, Edith Cowan University, Joondalup, WA, Australia
4. School of Public Health, The University of Sydney, Camperdown, NSW 2008, Australia
5. Wildlife Conservation Society, Suva, Fiji
6. College of Medicine, Nursing and Health Sciences, Fiji National University, Suva, Fiji

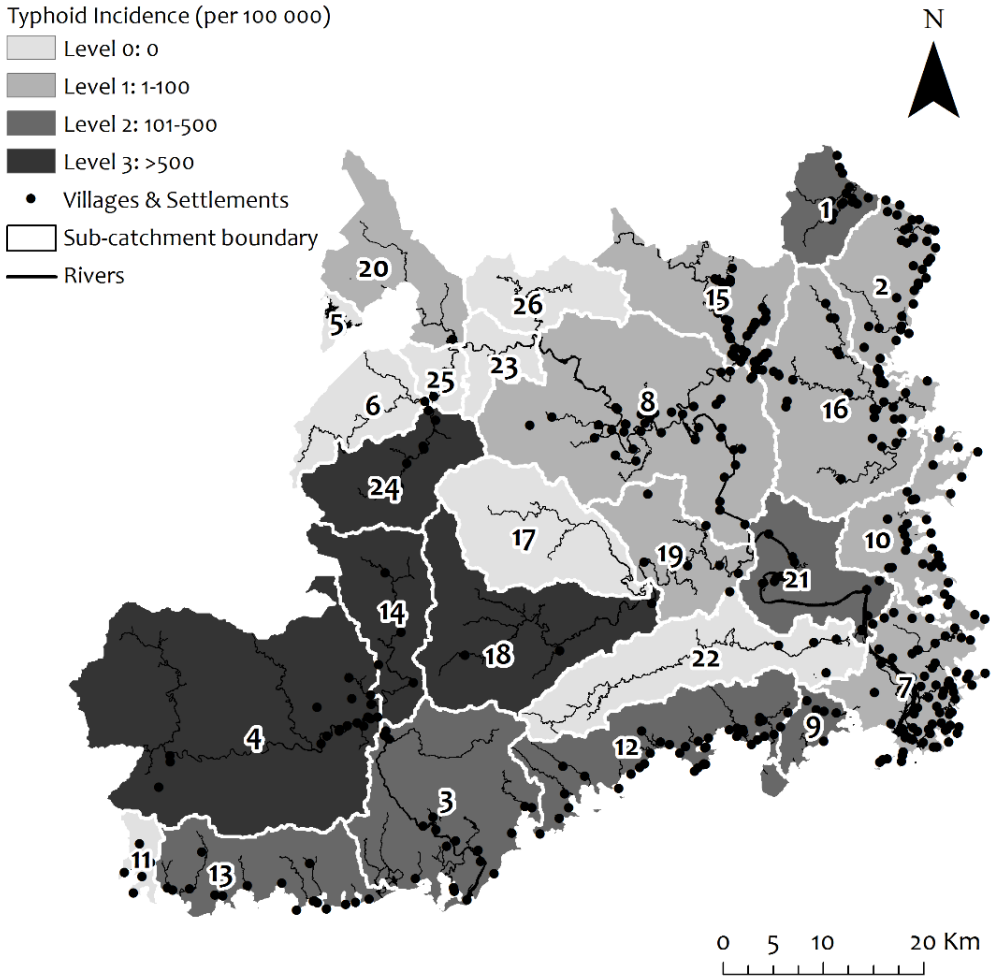
WATER & WASH FUTURES 2023
Achieving SDG6 in a Changing Climate
#WaWF23

Rural Fijian context

Drinking water
Basic service level
(safely managed?)

Sanitation
Basic service level
(safely managed?)

Typhoid Fever
Incidence ~ 30 to 50 per 100 000 annual



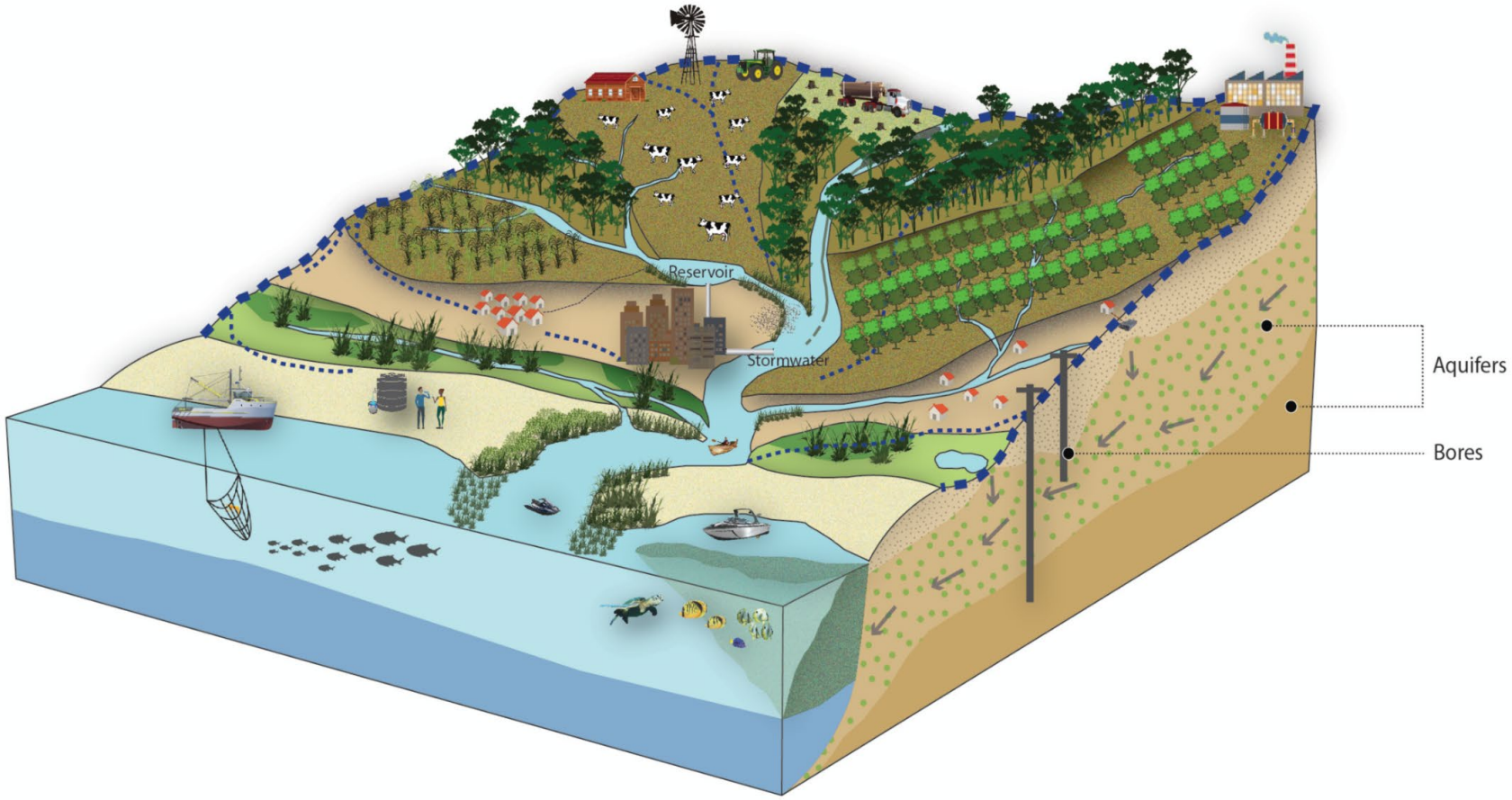
(Jenkins et al., 2016 EcoHealth)

Watershed Interventions for Systems Health (WISH Fiji)

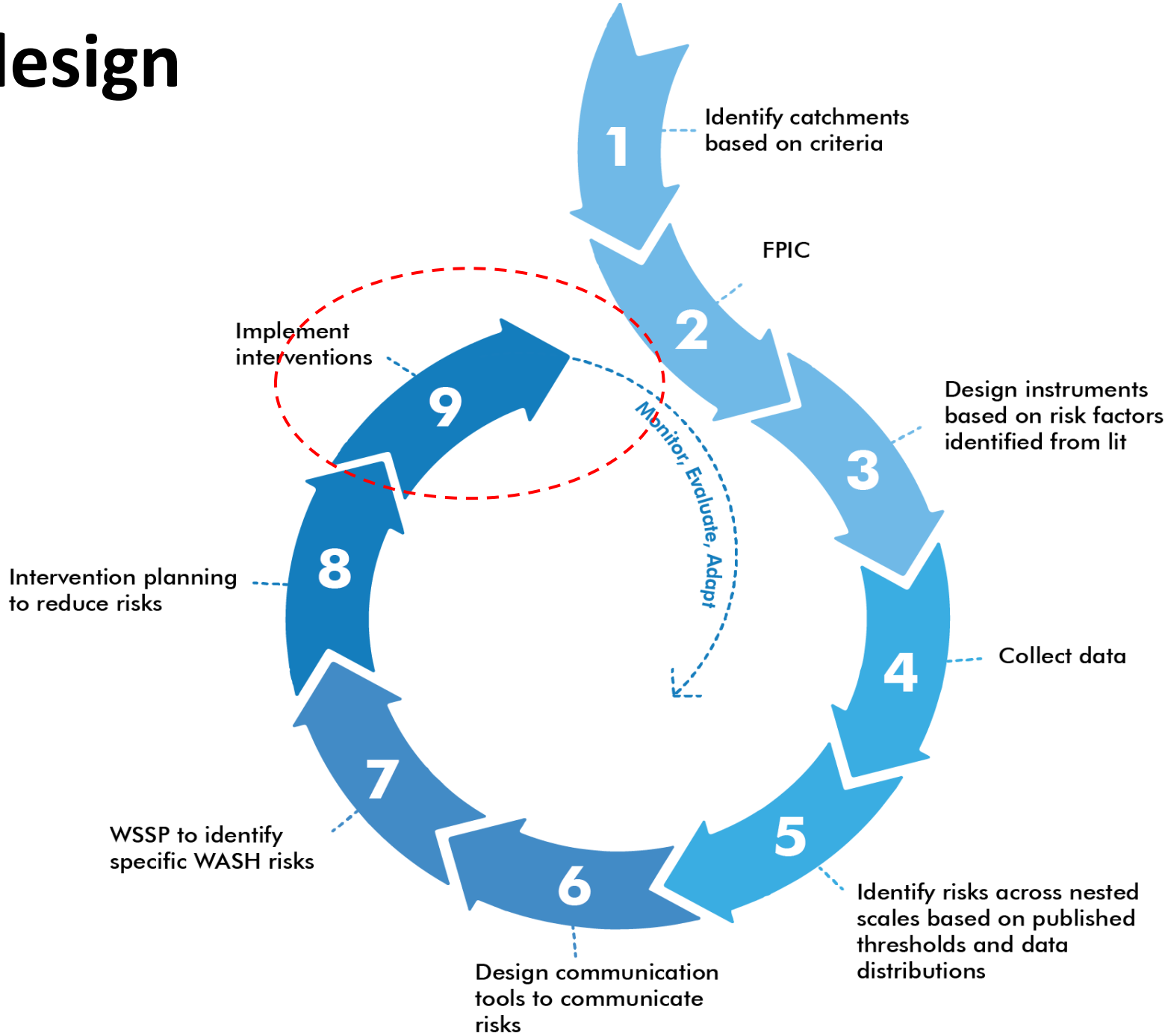
Aim: To use a Planetary Health approach to reduce the burden of disease from the three plagues: typhoid, leptospirosis and dengue, and to improve downstream ecosystem condition through active watershed interventions (including WaSH)

WISH

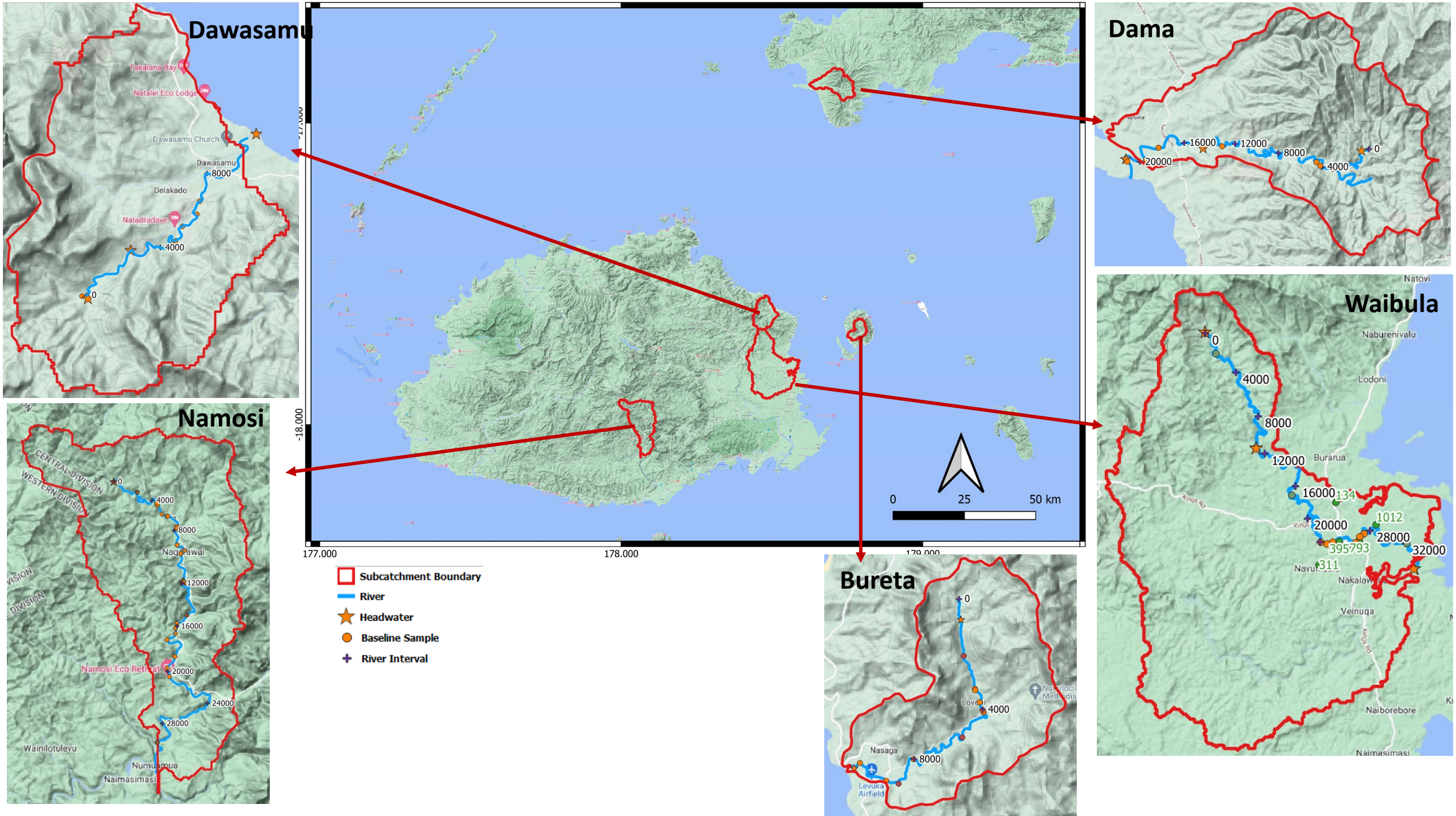
Watershed Interventions for Systems Health in Fiji



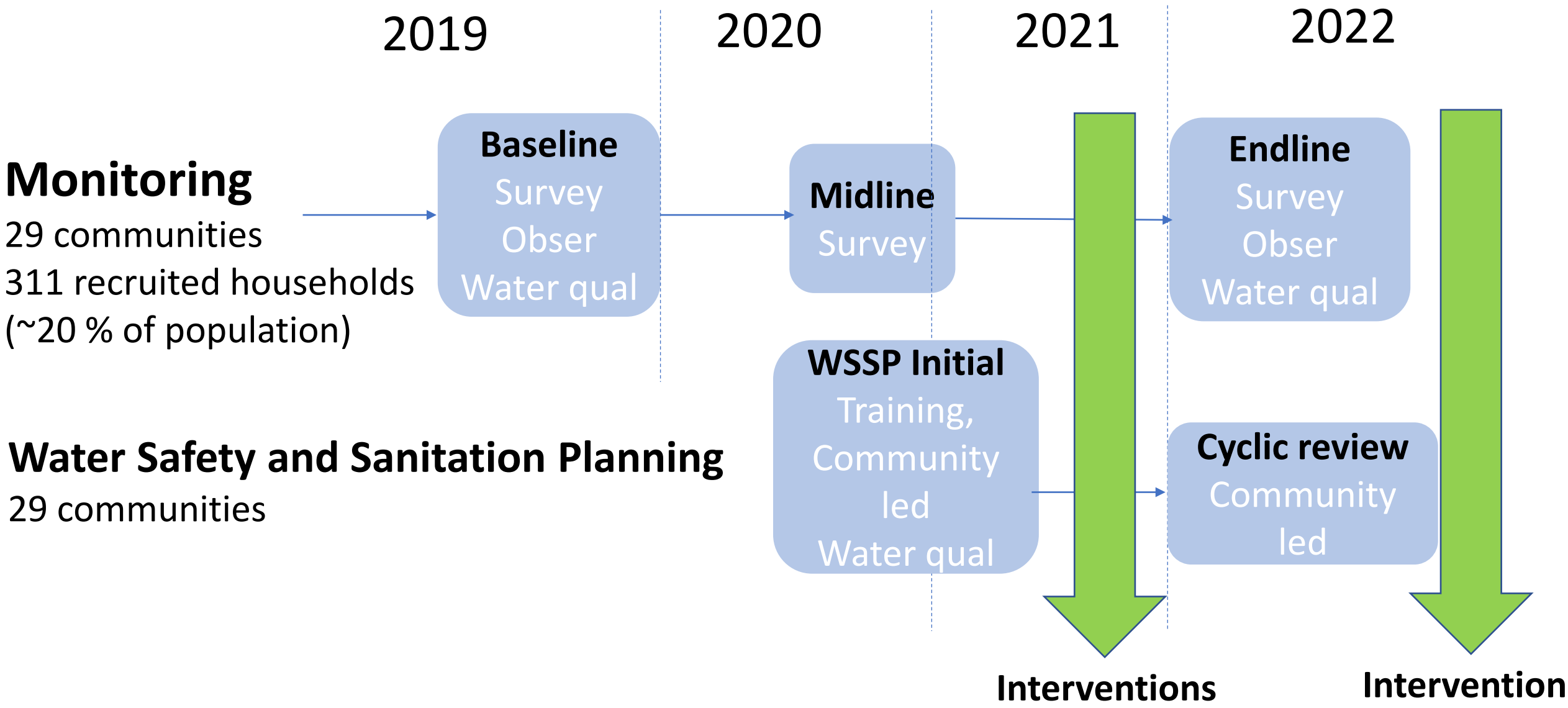
Project design



WISH
Watershed Interventions for Systems Health in Fiji


Dawasamu
Tjakalana Bay
Natalei Eco Lodge
Dawasamu Church
Dawasamu
8000
Delakado
Natadradave
4000
0
Dama
16000
12000
8000
20000
4000
0
Namosi
CENTRAL DIVISION
WESTERN DIVISION
0
4000
8000
Naqarawai
12000
16000
Namosi Eco Retreat
20000
24000
28000
Wainilotuleyu
Numumua
Naimasimasi
Bureta
0
4000
Nasaga
8000
Levuka Airfield
Waibula
Natovi
Naburenivalu
Lodoni
0
4000
8000
12000
Burarua
16000
134
1012
20000
28000
395793
32000
311
Nakalawa
Veinuqa
Naiborebore
Naimasimasi
-17.000
-18.000
177.000
178.000
179.000
0
25
50 km
Subcatchment Boundary
River
Headwater
Baseline Sample
River Interval

Monitoring program



Water and soil testing

Routine samples

Physio-Chemical tests (immediate)
- pH
- Temperature (use pH meter)
- Conductivity (uS or mS)
- Dissolved Oxygen (DO)
- [Chlorine (free and total)]

Chemical tests (< 12 hr)
- Turbidity (NTU)
- Ammonia (mg/L)
- Nitrate (mg/L)
- Nitrite (mg/L)
- Odour

Microbiology (< 6 hr cold)
- Total coliforms (TC)
- *Escherichia coli* (*E. coli*)

Targeted samples

Chemical tests (< 72 hr)
- Alkalinity
- Colour
- Sulphate
- Chemical Oxygen Demand (COD)
- Total Nitrogen
- Total Phosphorous

Microbiology (< 24 hr cold)
- Total coliforms (TC)
- *Escherichia coli* (*E. coli*)

Sample concentration
- Vacuum filtration
- Peristaltic pumps

DNA Extraction (frozen)
- Qiagen Power Water Kits
- Qiagen Power Soil Kits

DNA analysis

Quantitative PCR
- *Salmonella Typhi*
- Leptospirosis
- *Feacal source tracking (Bacteroidales)*

Metagenomics
- Pathogens
- Protozoa
- Microbiological ecology

Samples taken:

~ 2000 individual samples

~ 7 - 10 paramaters each

> 18 000 data points

Drinking water systems in the communities


Spring fed creek with dam


Reservoir tanks


Piped to households

Rural drinking water quality

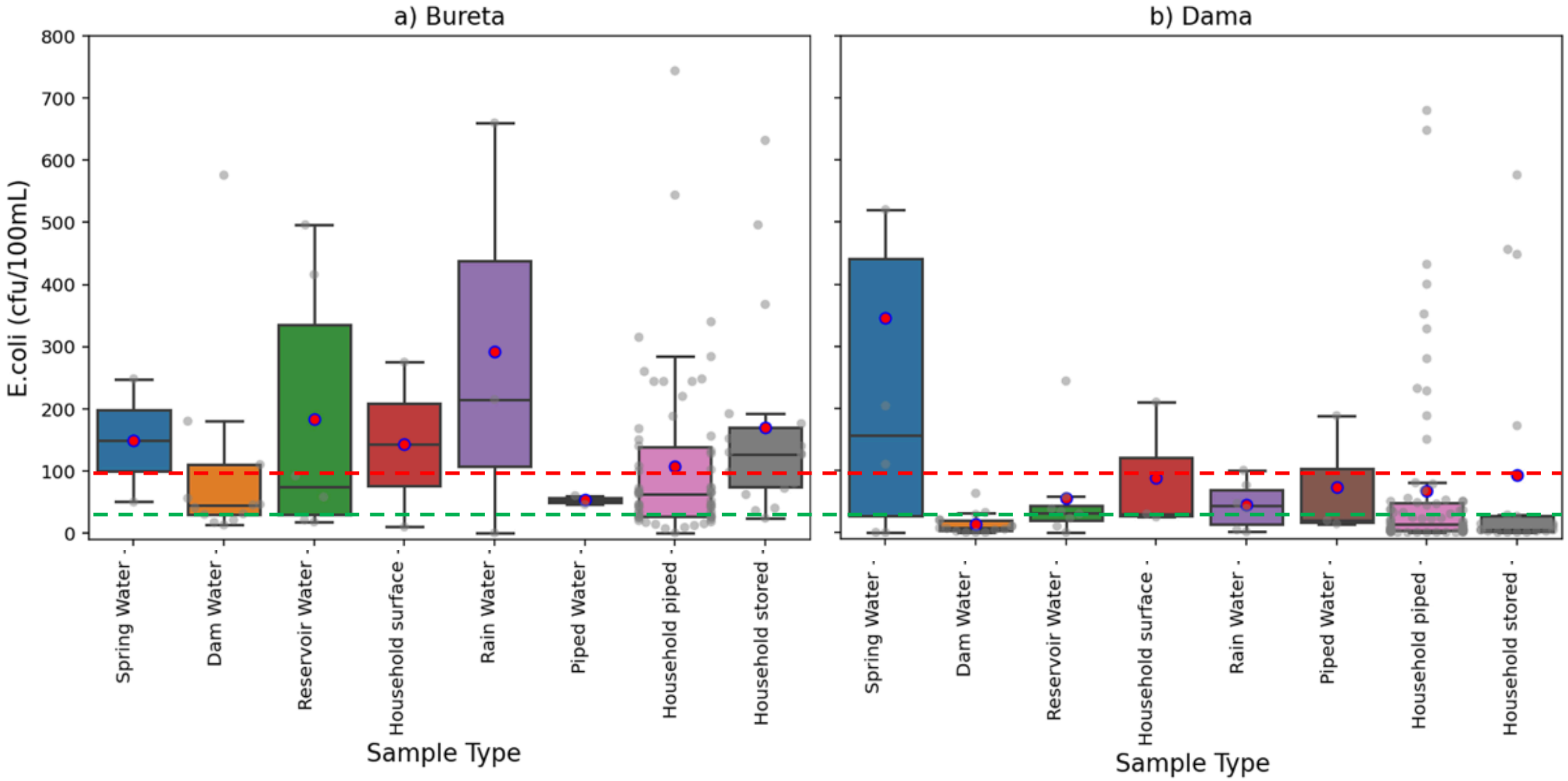
Setting risk thresholds for small supplies

WISH FIJI Risk thresholds	**High risk**	**Medium risk**	**Low risk**
***E. coli* (faecal indicator bacteria)**	> 100 cfu/100ml	20 – 100 cfu/100ml	< 20 cfu/100ml

WHO Guidelines: drinking water is considered safe when: *E. coli* < 1 cfu/100 mL

Water quality results for drinking water systems

E. coli (cfu/100mL) sampling in 2019 and 2020



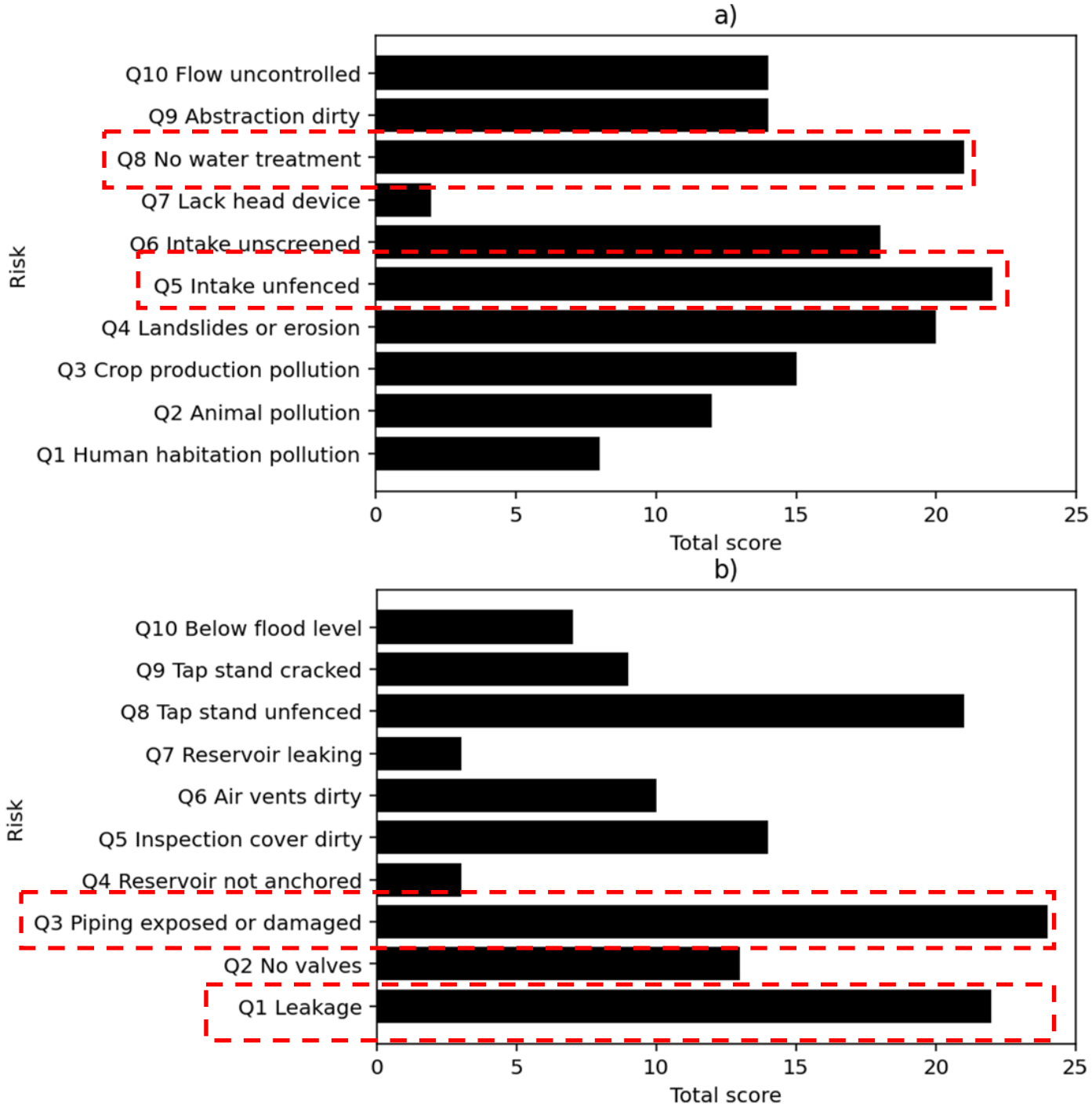
WSSP system assessment

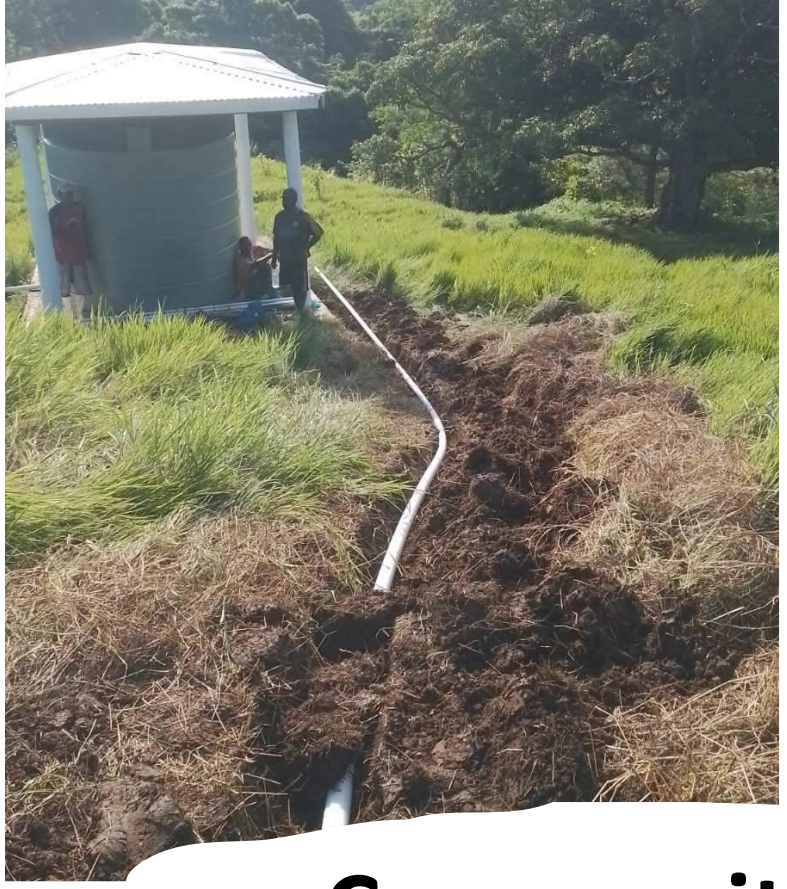
Key risk factors

- Average age of the drinking water infrastructure is 30 years old (constructed in 1990)
- 12 communities (43%) use river or creek as their main alternate drinking water system
- 5 communities had no reservoir connected

Drinking water risks

WSSP sanitary risk scores for water sources and pipes





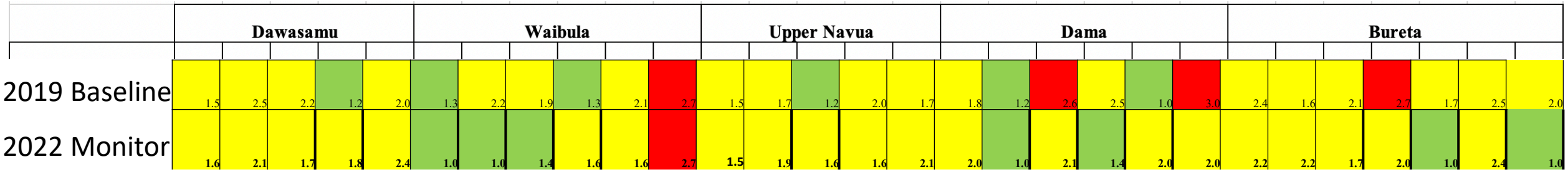
Community led interventions

- 40 new infrastructure builds
- 27 repairs of the systems
- 19 maintenance activities
- 13 advocacy and awareness

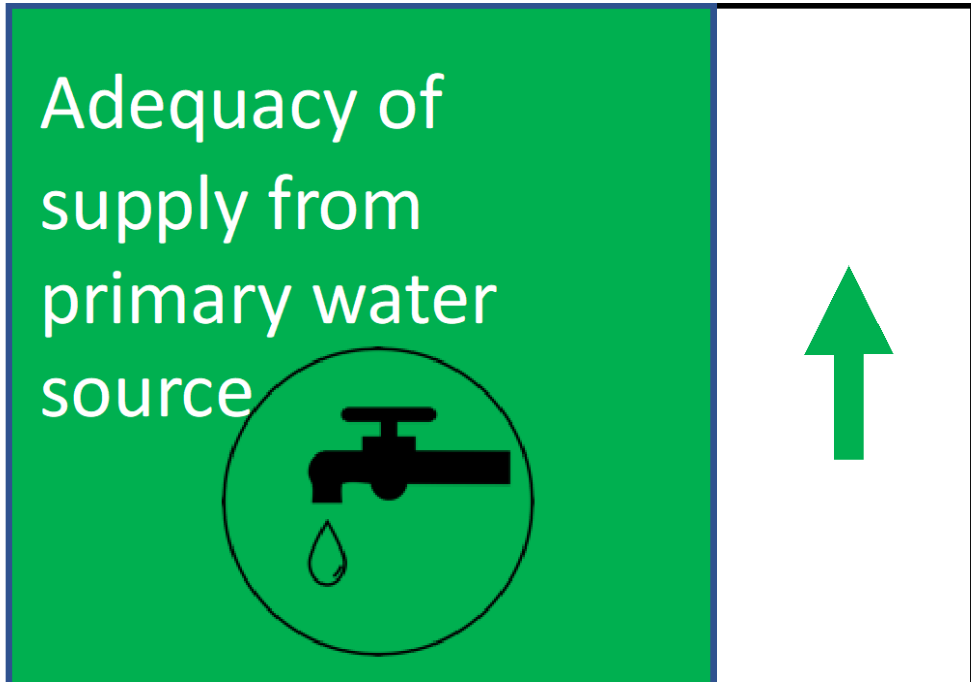
Total = 99 interventions for drinking water

Adequacy of supply from primary drinking water source

Days of inadequate supply

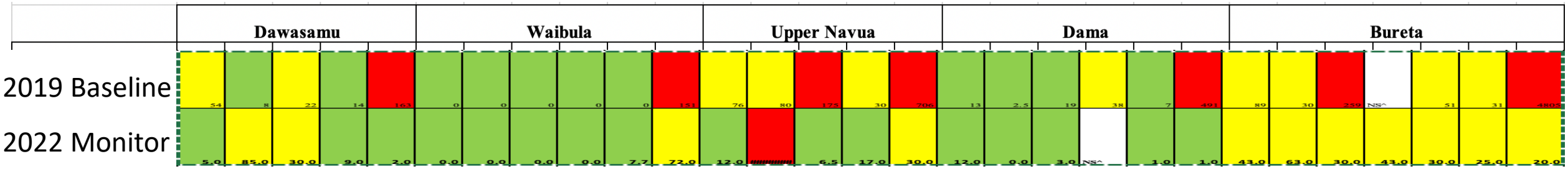


RESULTS	High risk > 2.5 score	Medium risk 1.5 – 2.5 score	Low risk < 1.5 score
2019 and 2020 Baseline and WSSP	4	19	6
2022 Monitoring post activity	1	21	7

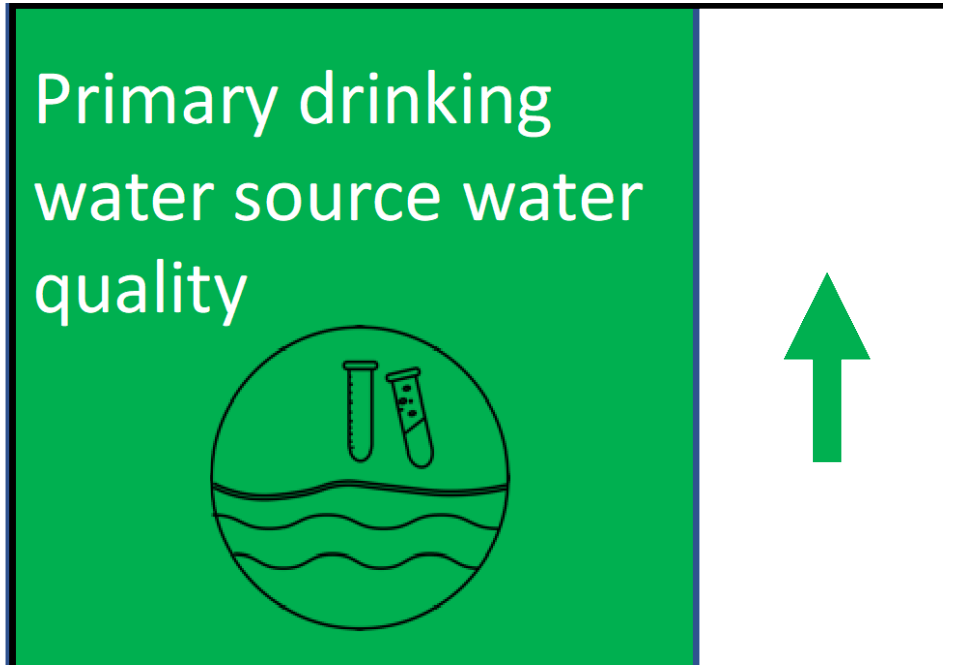


Primary drinking water source quality change

E. coli cfu/100 ml



RESULTS	High risk > 100 cfu/100ml	Medium risk 20 – 100 cfu/100ml	Low risk < 20 cfu/100ml
2019 and 2020 Baseline and WSSP	7	10	11
2022 Monitoring post activity	1	11	16

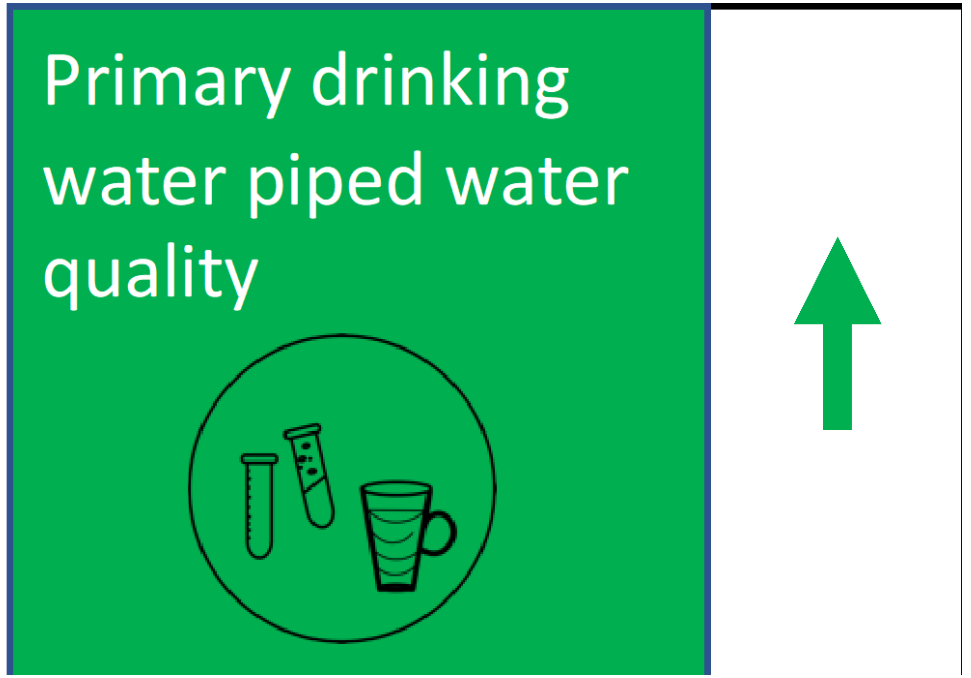


Primary drinking water piped water quality

E. coli cfu/100 ml

	Dawasamu					Waibula						Upper Navua					Dama						Bureta						
2019 Baseline	4	19	4	32	104	0	0	0	0	0	32	26	28	312	67	131	17	1	3	141	12	355	72	144	140	260	48	31	33
2022 Monitor	12.4	27.5	11.5	3.1	5.6	0.0	0.0	0.0	0.0	0.0	13.4	8.3	29.2	44.3	26.5	51.4	29.8	0.3	19.4	3.9	3.0	0.7	522.8	58.0	60.5	33.0	158.0	28.0	1008.0

RESULTS	**High risk** > 100 cfu/100ml	**Medium risk** 20 – 100 cfu/100ml	**Low risk** < 20 cfu/100ml
2019 and 2020 Baseline and WSSP	8	9	12
2022 Monitoring post activity	3	10	16



WISH
Watershed Interventions for Systems Health in Fiji

Thanks to the whole WISH team!

Workshop…. *If you would like to learn more*

Advancing Systems Health Approaches to Achieve WaSH and Conservation Goals

Wednesday PM Room D