



# TOOLS FOR NPS-FM IMPLEMENTATION IN URBAN CATCHMENTS


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# CONTAMINANT LIMIT SETTING

## YIELD-BASED CATCHMENT CONTAMINANT LOAD MODELS

Contaminant Load Model  
Version 2.9 March 2011

Catchment name: **CATCHMENT LOAD**



Catchment area(s)		Source catchment management area				Contaminant paths (loads) without reduction															
Source	Source type	Source ID	Area (ha)	Flow (ML/d)	Flow (ML/d)	Total suspended solids (TSS)				Total suspended particulates (TSP)				Copper suspended particulates and dissolved (Cu)				TPH suspended particulates and dissolved (TPH)			
						Year	Load (kg/d)	Load (kg/d)	Load (kg/d)	Load (kg/d)	Year	Load (kg/d)	Load (kg/d)	Load (kg/d)	Load (kg/d)	Year	Load (kg/d)	Load (kg/d)	Load (kg/d)	Load (kg/d)	
Farm	Arable/ horticulture		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Dairy		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Forest		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Water		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Waste		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
Park	Arable/ horticulture		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Dairy		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Forest		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Water		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Waste		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	
	Urban		1	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	2010	0.000	0.000	0.000	0.000	

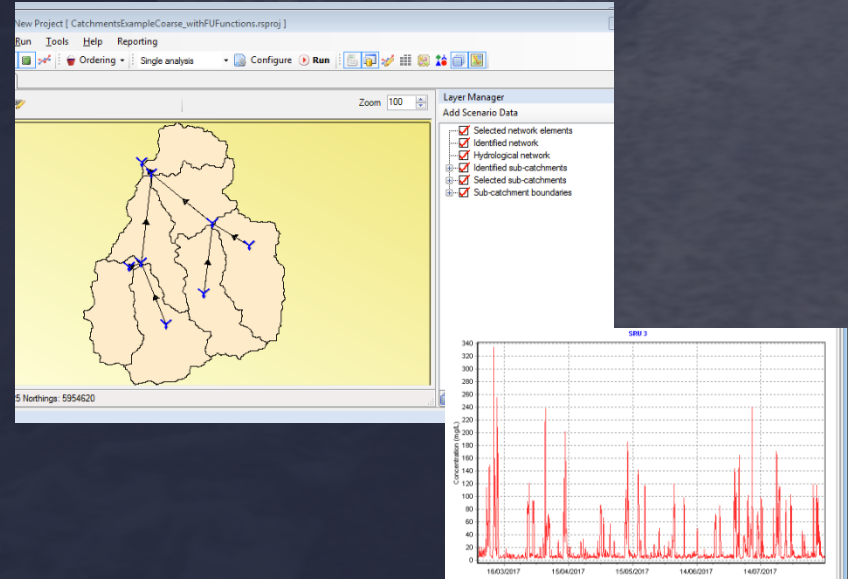
CATCHMENT GENERAL DATA FOR SOURCE AREAS

Catchment Overview of Contaminant Loads

Flow	Direct	Flow	Flow	Flow	Flow	Flow	Flow	Flow	Flow
ML/d	ML/d	ML/d	ML/d	ML/d	ML/d	ML/d	ML/d	ML/d	ML/d
100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100

Flow reduction with management: 0.000, 0.000, 0.000, 0.000

## COUPLED CATCHMENT LOAD AND STREAM HYDROLOGICAL MODELS





# OBJECTIVE

Explore methods for assessment against in-stream concentration-based attributes in urban catchments with minimal data:

1. INCORPORATION OF  
UNCERTAINTY

2. ESTIMATION OF IN-STREAM  
CONCENTRATIONS



A photograph of a person standing inside a large, circular concrete pipe. The pipe is partially filled with water, which is flowing through it. The person is standing in the center of the pipe, looking out towards a bright opening at the end of the pipe. The opening is surrounded by greenery, including tall grasses and reeds. The lighting is bright at the opening, creating a strong contrast with the dark interior of the pipe. The overall scene suggests a field inspection or a study of water flow in a pipe.

# 1. INCORPORATING UNCERTAINTY INTO LOAD MODELS



# MOTIVATION

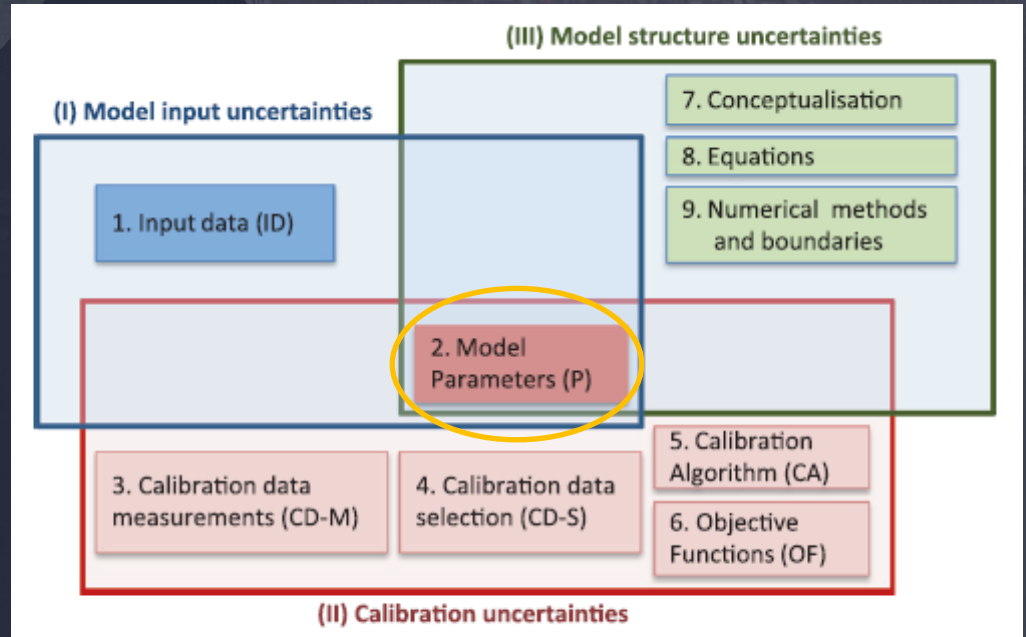
Catchment zinc load = 50 kg/year

	Mitigation A	Mitigation B
Cost	\$200 K	\$250 K
Load reduction	40% (35-50%)	60% (20-70%)
Zinc load after mitigation	28-32 kg/year	15-40 kg/year



# YIELD-BASED LOAD MODELS

- Divide catchment into source types
- Each source type has contaminant yield
- Treatment incorporated by load reduction factor
- Load from catchment =  $\sum \text{source area} \times \text{source yield} \times \text{load reduction factor}$





# ASSIGNING DISTRIBUTIONS

## SOURCE YIELDS

Assume yields are uniformly distributed between “low”, “best” and “high” CLM values

Seek to refine where possible, exploring alternative methods to define distributions

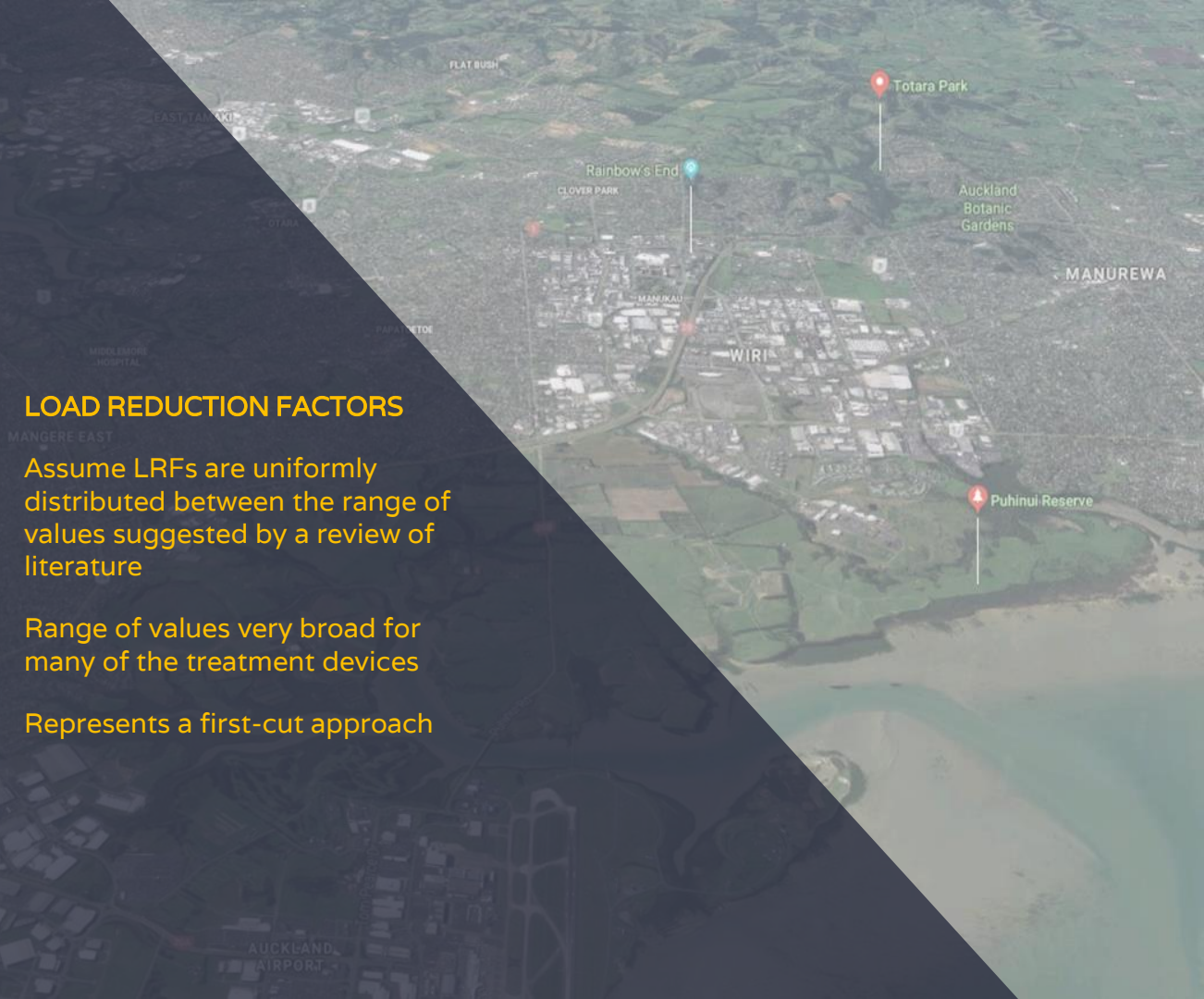
E.g. roof source yields

## LOAD REDUCTION FACTORS

Assume LRFs are uniformly distributed between the range of values suggested by a review of literature

Range of values very broad for many of the treatment devices

Represents a first-cut approach



# EXAMPLE

- 1 ha source area
- unpainted galvanised steel roof
- treatment through raingardens

## A. Baseline CLM

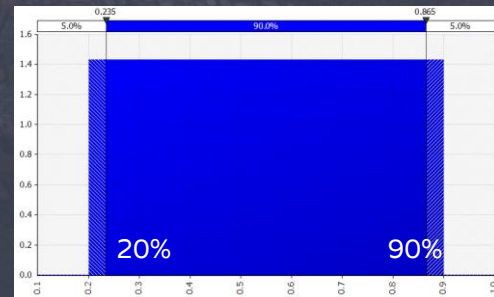
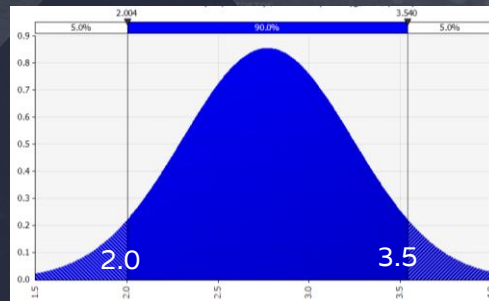
$$2.8 \text{ g/m}^2/\text{yr} \times 60\% \text{ removal}$$

*source yield*                      *load reduction factor*

$$= 9.0 \text{ kg/year}$$

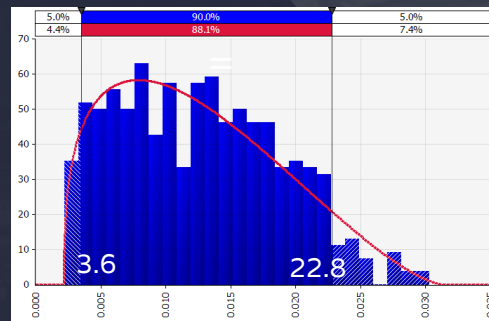
*average annual load*

## B. CLM with uncertainty




X

=



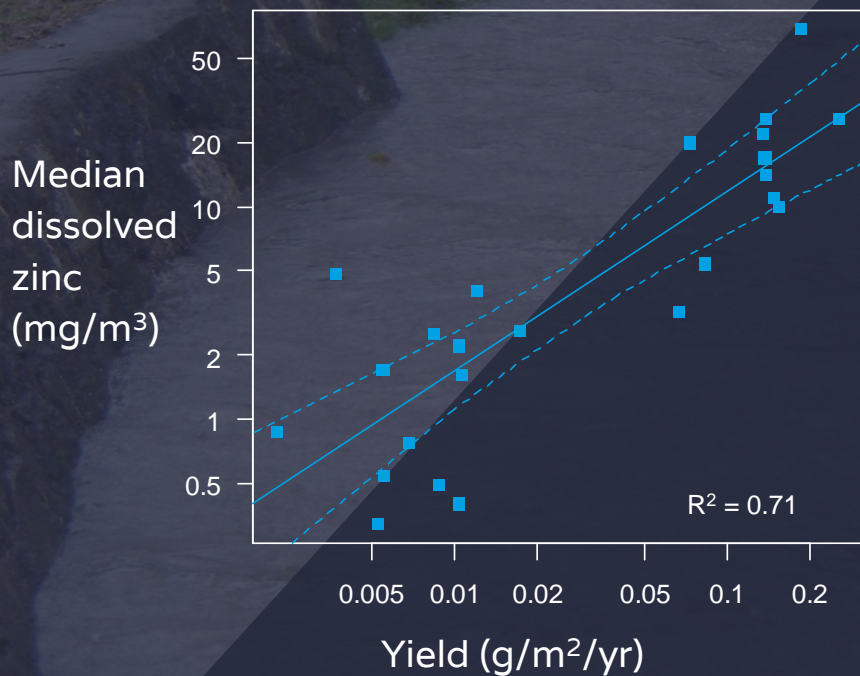
*distribution of annual loads*



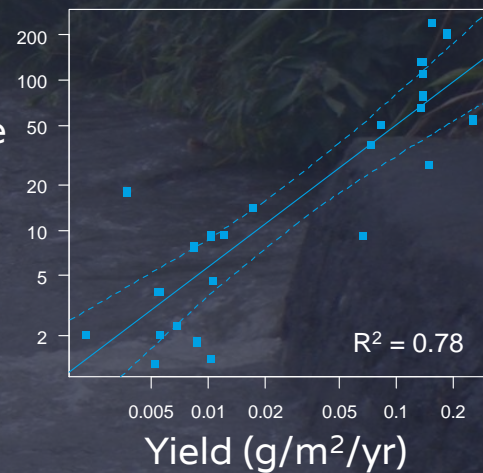
A person is standing in the center of a large, circular concrete pipe. The pipe is partially filled with water, which is flowing through it. The person is looking out towards a bright opening at the end of the pipe, where there is greenery and a bright light. The scene is captured from a low angle, looking down the length of the pipe.

## 2. ESTIMATING IN-STREAM CONCENTRATIONS FROM LOADS

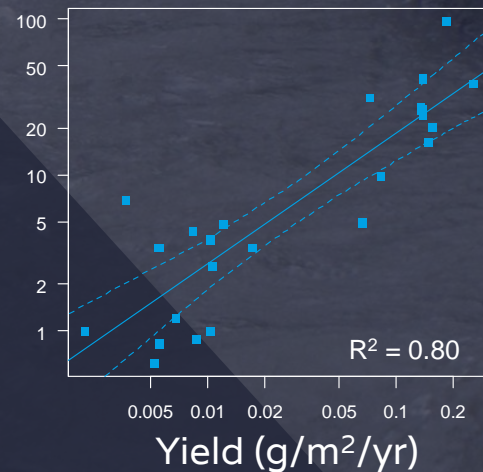
# ZINC YIELDS VS IN-STREAM ZINC CONCENTRATIONS



95<sup>th</sup>  
percentile  
dissolved  
zinc  
(mg/m<sup>3</sup>)

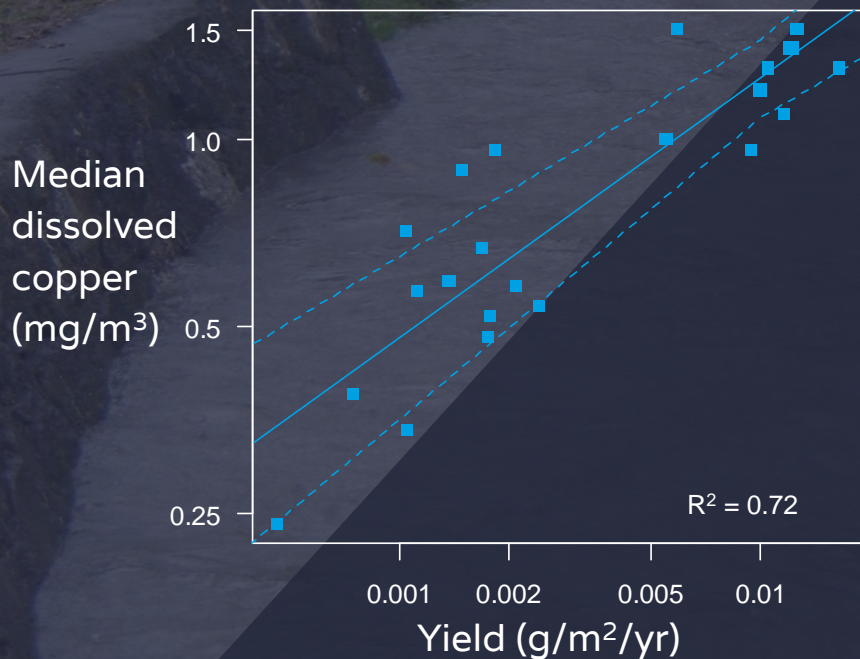


Median  
total  
zinc  
(mg/m<sup>3</sup>)

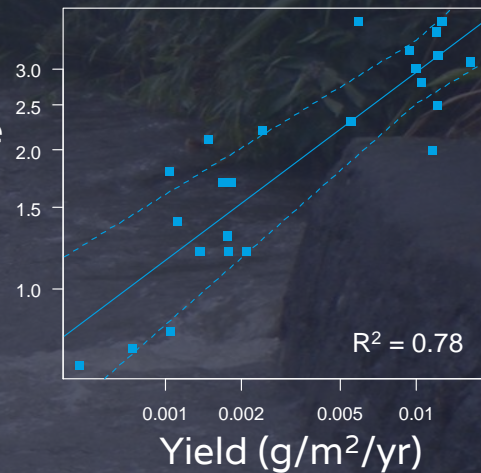




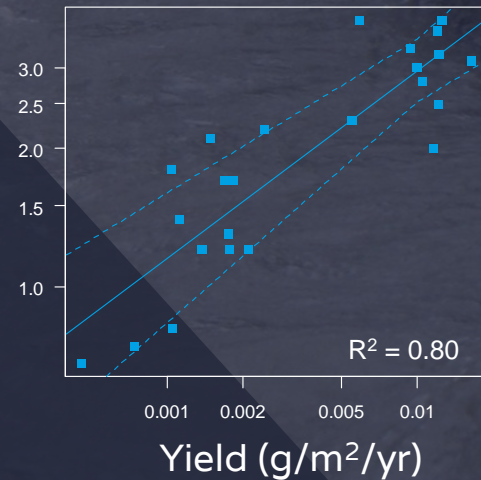
# COPPER YIELDS VS IN-STREAM COPPER CONCENTRATIONS



95th  
percentile  
dissolved  
copper  
(mg/m<sup>3</sup>)

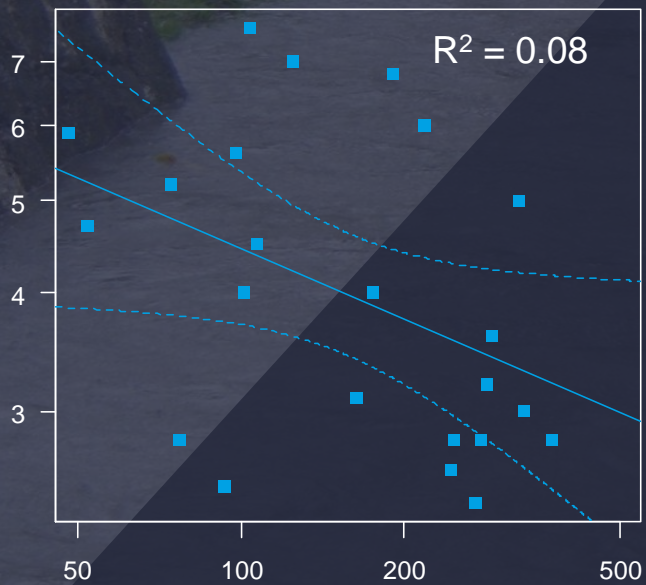


Median  
total  
copper  
(mg/m<sup>3</sup>)



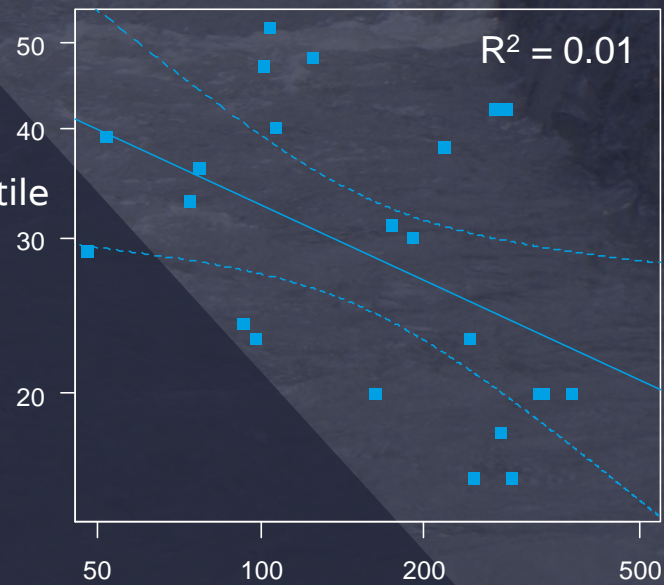
# SEDIMENT YIELDS VS IN-STREAM TSS CONCENTRATIONS

Median  
TSS  
(g/m<sup>3</sup>)



Yield (kg/m<sup>2</sup>/yr)

95<sup>th</sup>  
percentile  
TSS  
(g/m<sup>3</sup>)



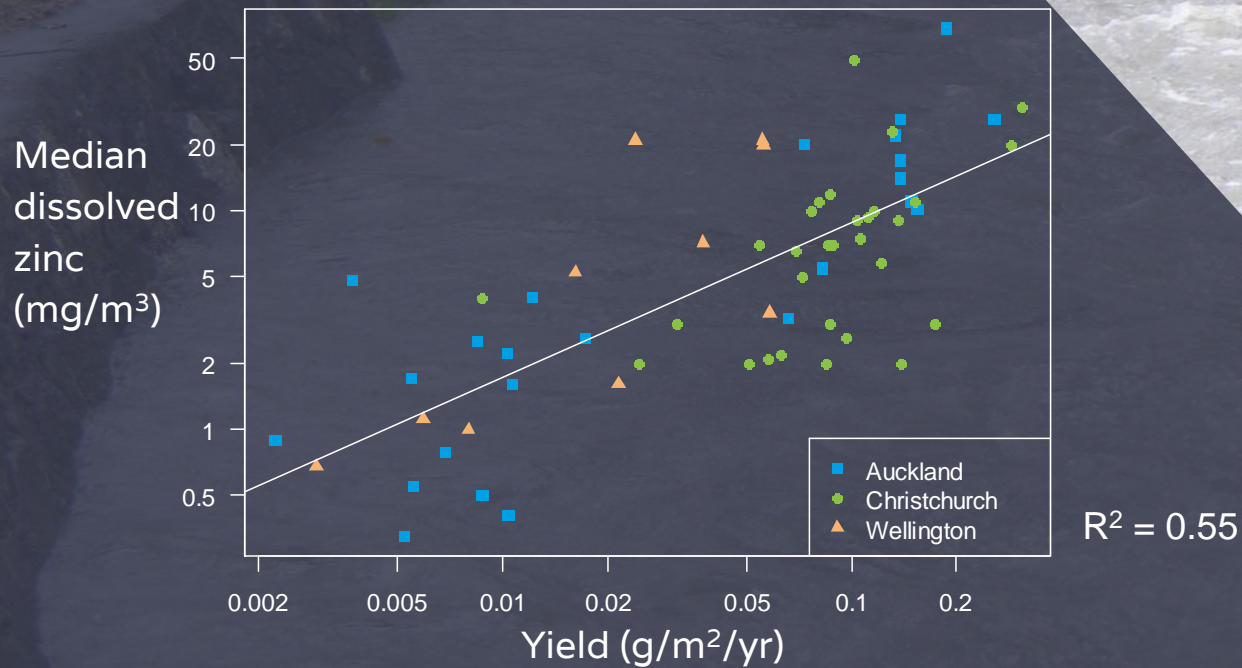
Yield (kg/m<sup>2</sup>/yr)



A person is walking away from the camera through a dark, circular tunnel. The tunnel walls are dark and textured, possibly concrete or metal. The floor is wet and reflective, showing the person's silhouette and the light from the exit. At the end of the tunnel, there is a bright opening leading to a lush, green outdoor area with trees and foliage. The overall atmosphere is mysterious and hopeful.

**Does it only work  
for Auckland?**

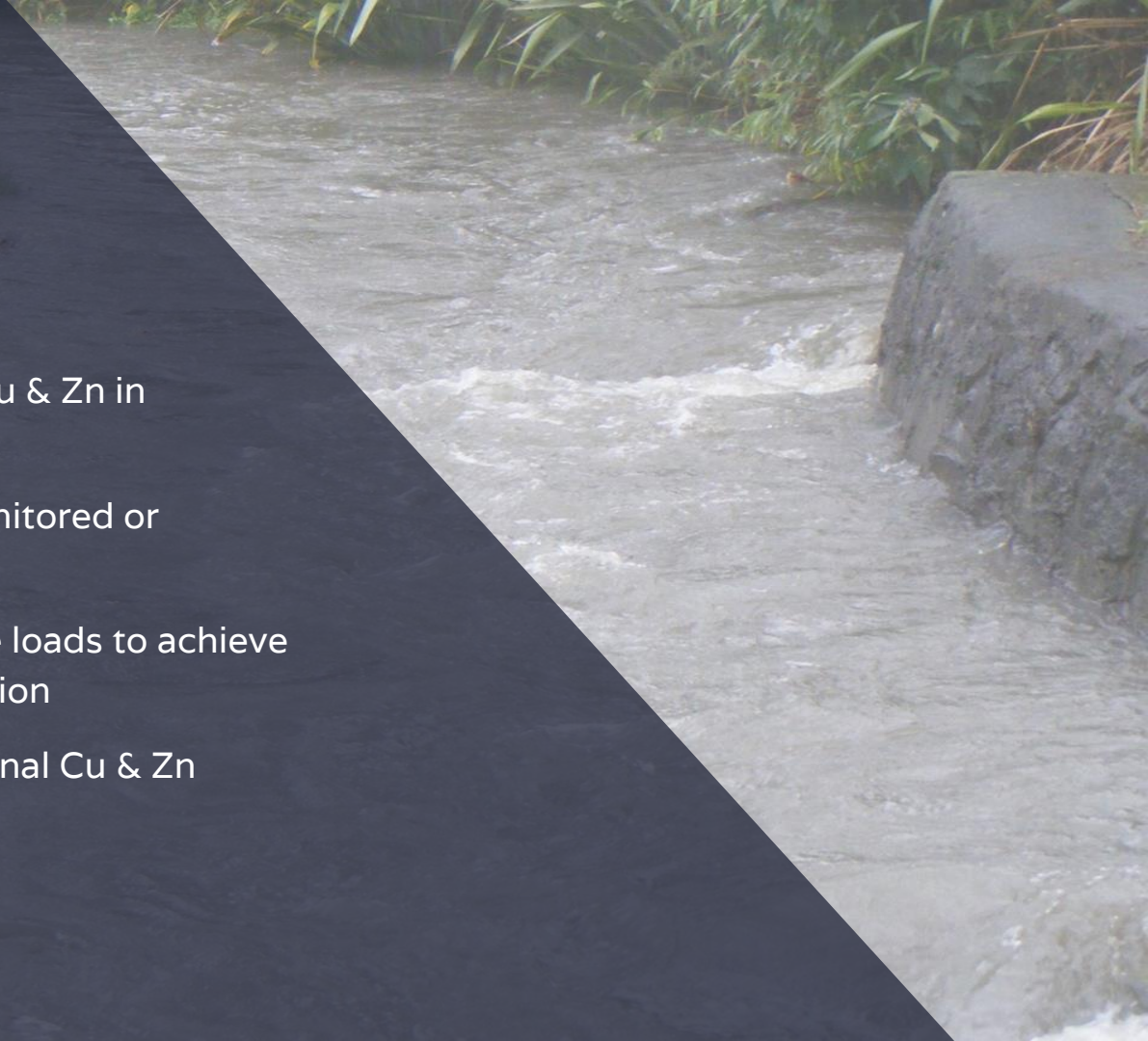
# ZINC – INCLUDING WELLINGTON AND CHRISTCHURCH





## POTENTIAL APPLICATIONS

- Estimate current in-stream Cu & Zn in unmonitored streams
- Predict future Cu & Zn in monitored or unmonitored streams
- Estimate maximum allowable loads to achieve desired in-stream concentration
- Identify streams with additional Cu & Zn sources

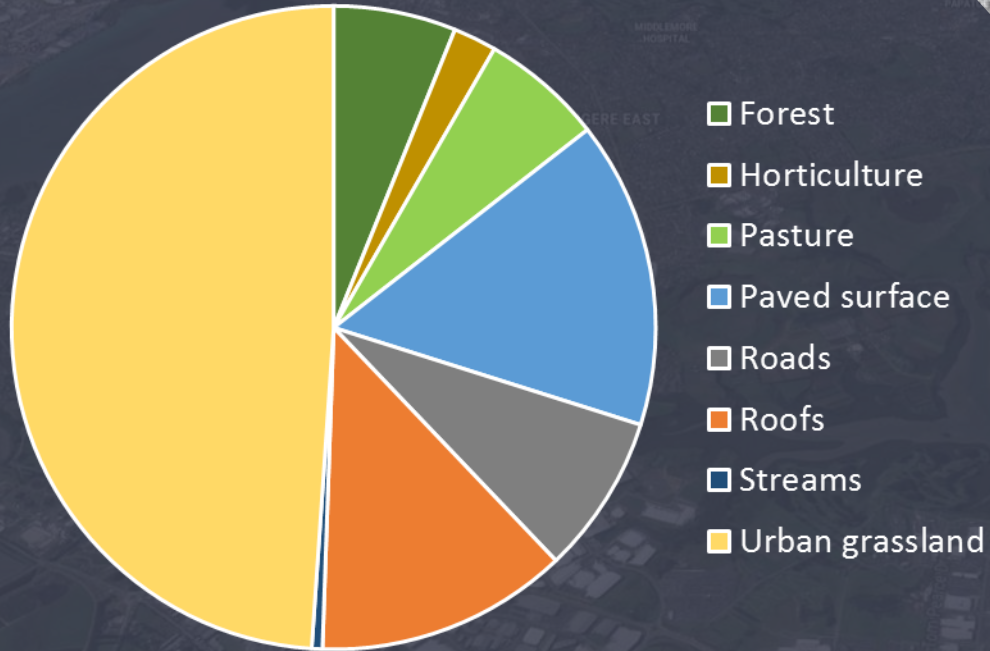


### **3. CASE-STUDY: APPLYING THE METHODS**





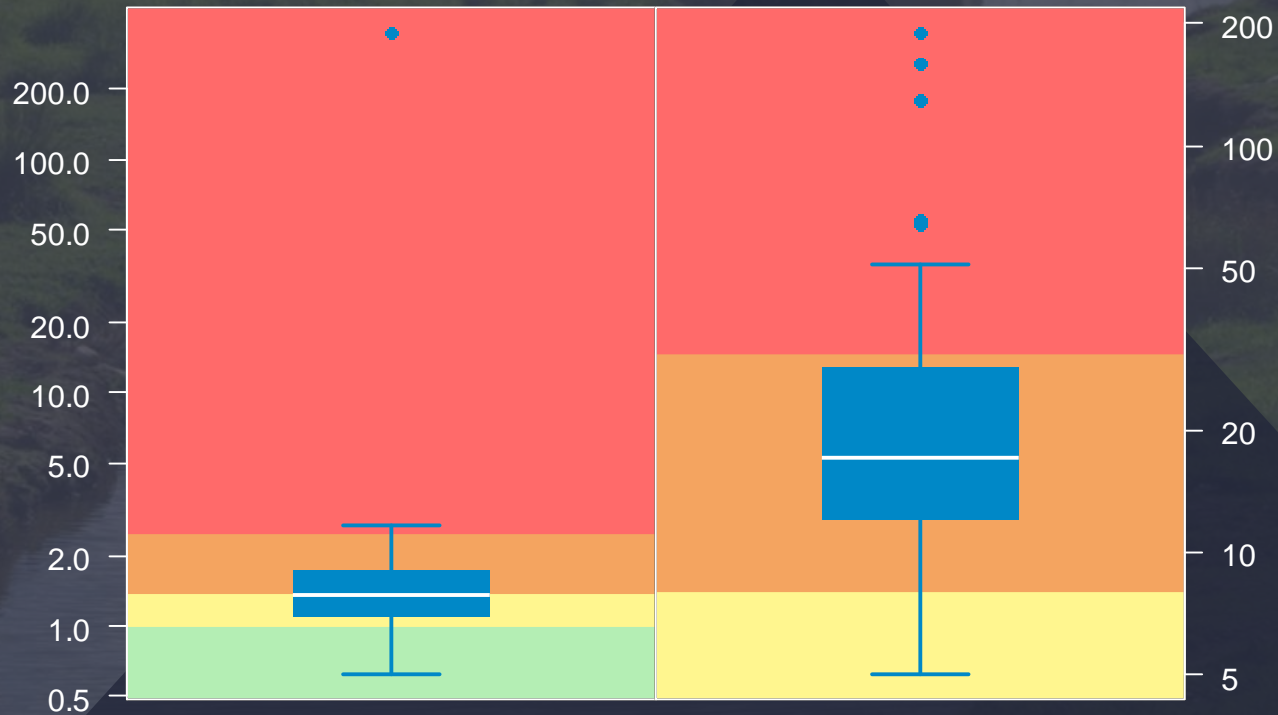
# PUHINUI STREAM CATCHMENT CURRENT LANDUSE



# CURRENT STREAM CONCENTRATIONS


Copper (mg/m<sup>3</sup>)

Zinc (mg/m<sup>3</sup>)



Coloured bands relate to protection levels from ANZECC (2000) guidelines

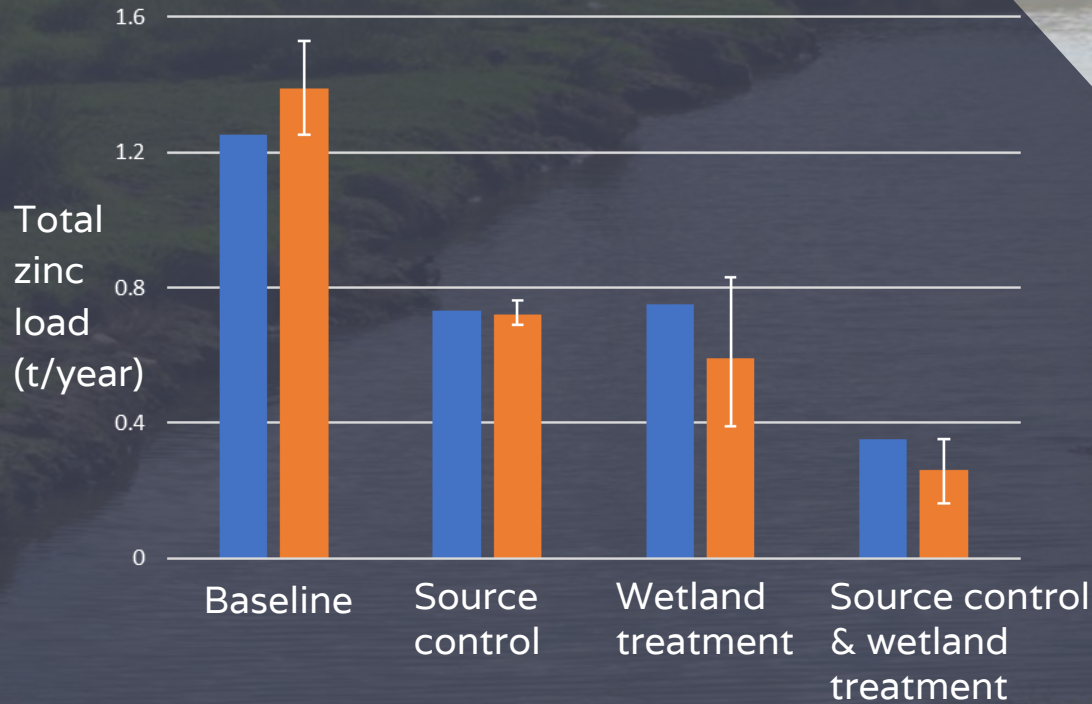




## POSSIBLE SCENARIOS TO REDUCE ZINC LOADS AND CONCENTRATIONS

- Source control – replace galvanised iron roofs with low-zinc materials
- Wetland treatment throughout the catchment
- Source control and wetland treatment

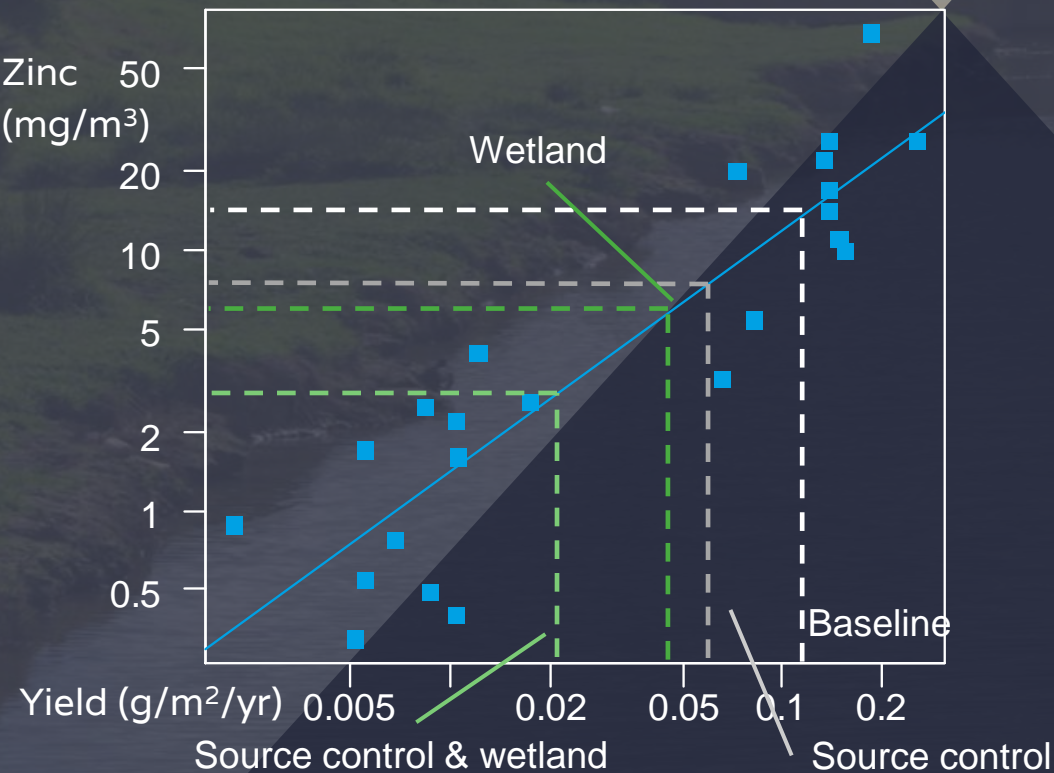
# PUHINUI STREAM CATCHMENT ESTIMATED ZINC LOADS



*Error bars represent  
10<sup>th</sup> & 90<sup>th</sup> percentiles*



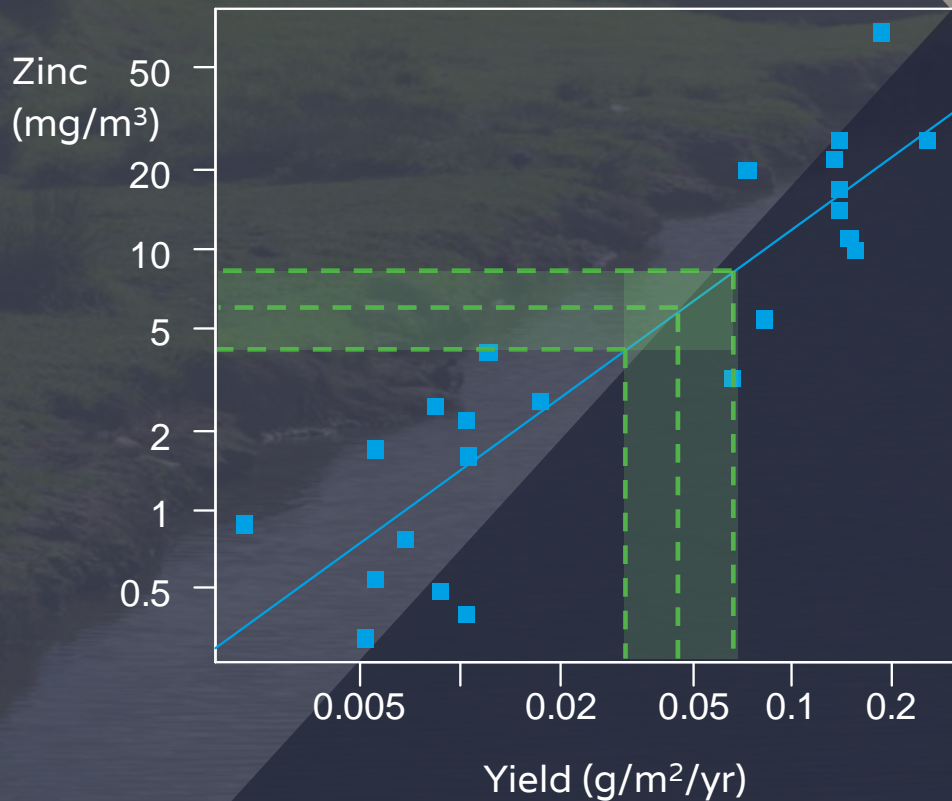
# MEDIAN DISSOLVED ZINC PREDICTED FROM YIELDS



	Median zinc conc. (mg/m <sup>3</sup> )	Attribute state *
Baseline	13	C
Source control	7.1	B
Wetland	5.9	B
Source control & wetland	2.7	B

\* Indicative only, based on ANZECC (2000) guidelines, see paper for details

# RANGE IN ZINC PREDICTIONS WITH WETLAND TREATMENT



Load estimate	Yield	Median zinc conc. (mg/m <sup>3</sup> )	Attribute state *
Mean	0.047	5.9	B
10 <sup>th</sup> percentile	0.031	4.0	B
90 <sup>th</sup> percentile	0.066	8.1	C

\* Indicative only, based on ANZECC (2000) guidelines, see paper for details



# SUMMARY

## LOADS WITH UNCERTAINTY

- It is important to quantify uncertainty in model predictions
- Uncertainty can be quantified through modelling or literature review
- Proof-of-concept will be expanded and refined

## ESTIMATING IN-STREAM CONCS

- Need to model in-stream concentrations
- Simple empirical relationships can provide screening estimates
- Refinement of data and relationships needed



Catchment load estimates with uncertainty, linked to estimates of in-stream concentrations



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