

CONVERTING FROM INTERMITTENT TO CONTINUOUS WATER  
SUPPLY: IMPLICATIONS FOR WATER CONSUMPTION, REVENUE,  
AND INFRASTRUCTURE PLANNING IN INDIA

Kyle S. Onda

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in  
partial fulfillment of the requirements for the degree of Doctor of Philosophy in the  
Department of City and Regional Planning in the College of Arts and Sciences.

Chapel Hill  
2019

Approved by:

Meenu Tewari

Todd BenDor

Marc Jeuland

Nikhil Kaza

Emily Kumpel

© 2019  
Kyle S. Onda  
ALL RIGHTS RESERVED

## **ABSTRACT**

Kyle S. Onda: Converting from intermittent to continuous water  
supply: Implications for water consumption, revenue, and  
infrastructure planning in India  
(Under the direction of Meenu Tewari)

A bunch of text about the abstract

I dedicate this dissertation to everyone.

## TABLE OF CONTENTS

LIST OF TABLES .....	vii
LIST OF FIGURES .....	viii
LIST OF ABBREVIATIONS .....	ix
INTRODUCTION .....	1
1.1 Introduction .....	1
CHAPTER 1: FROM INTERMITTENT TO CONTINUOUS WATER SUPPLY UNDER INCREASING WATER PRICES - HOW DOES WATER DEMAND CHANGE? .....	2
2.1 Introduction .....	2
2.2 Methods .....	2
2.2.1 Study sample .....	2
2.3 Results .....	2
2.4 Discussion .....	2
2.5 Tables .....	2
2.6 Figures .....	4
CHAPTER 2: WHAT'S IN A WATER BILL? WATER BILL PAYMENT BEHAVIOR AND SERVICE QUALITY, PRICES, AND HOUSEHOLD CHARACTERISTICS IN AMRAVATI, MAHARASHTRA, INDIA. ....	5
3.1 Introduction .....	5
3.2 Methods .....	5
3.2.1 Study sample .....	5

3.3	Results .....	5
3.4	Discussion .....	5
3.5	Tables .....	5
3.6	Figures .....	7
CHAPTER 3: INTERMITTENT TO CONTINUOUS WATER SUPPLY: IMPLICATIONS FOR WATER DEMAND, SUPPLY, REVENUE AND LONG-TERM PLANNING HORIZONS IN AMRAVATI, MAHARASH- TRA, INDIA.....		8
4.1	Introduction .....	8
4.2	Methods.....	8
4.2.1	Study sample.....	8
4.3	Results .....	8
4.4	Discussion .....	8
4.5	Tables .....	8
4.6	Figures .....	10
APPENDIX: USEFUL INFORMATION.....		11
A.1	List 1 .....	11
A.2	Very long title for next section that is meant to take up more than one line in the table of contents so you can verify that those lines are single spaced according to guidelines.....	11
REFERENCES .....		12

## LIST OF TABLES

2.1	.....	3
2.2	.....	3
2.3	.....	3
3.1	List 1.....	5
4.1	List 1.....	8
A.1	List 1.....	11

## LIST OF FIGURES

2.1	(MS1: Figure 1) Title here. ....	4
3.1	(MS2: Figure 1) Title here. ....	7
4.1	(MS3: Figure 1) Title here. ....	10



## LIST OF ABBREVIATIONS

GRS Genetic Risk Score

## CHAPTER 1: INRODUCTION

### 1.1 Introduction

There are long-standing and continuing disparities in the quality of water and sanitation services accessed by citizens in the Global South, despite considerable investments made by governments and multilateral aid organizations since the 1950s to improve the quality and spread of service networks (WHO, 2015). These gaps include lack of access to piped water and safe sanitation by the poor altogether, as well as inadequate service levels characterized by poor reliability and water quality for those already connected to piped networks (Lee and Schwab 2005). WHO & UNICEF currently estimate that 578 million urban residents (15 % of the global urban population) do not have access to a reliable source of clean water to taps inside the home. Governments, financial institutions, donors, civil society groups, and academics have advanced various perspectives explaining why these gaps persist, along with similarly varied strategies to address them.

One family of explanations can be summarized as a “vicious cycle” (Spiller & Savedoff, 1999). The cycle (Figure 1) is a situation where given poor cost recovery of services provided, water utilities have insufficient revenues to cover the costs of maintenance and service expansion, leading to poor service, generating low willingness to pay for piped water, which in turn leads back to insufficient revenues.

## **CHAPTER 2: CHAPTER 1: FROM INTERMITTENT TO CONTINUOUS WATER SUPPLY UNDER INCREASING WATER PRICES - HOW DOES WATER DEMAND CHANGE?**

### **2.1 Introduction**

This is the introduction.

### **2.2 Methods**

This is the methods section. Citation here (???).

#### **2.2.1 Study sample**

Put a description here with subheading.

### **2.3 Results**

Put some results here.

### **2.4 Discussion**

Put discussion here.

### **2.5 Tables**

**Table 2.1**

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
mpg	5	20.980	1.474	19	21	21.4	23
cyl	5	6.000	1.414	4	6	6	8
disp	5	209.200	100.256	108	160	258	360

**Table 2.2**

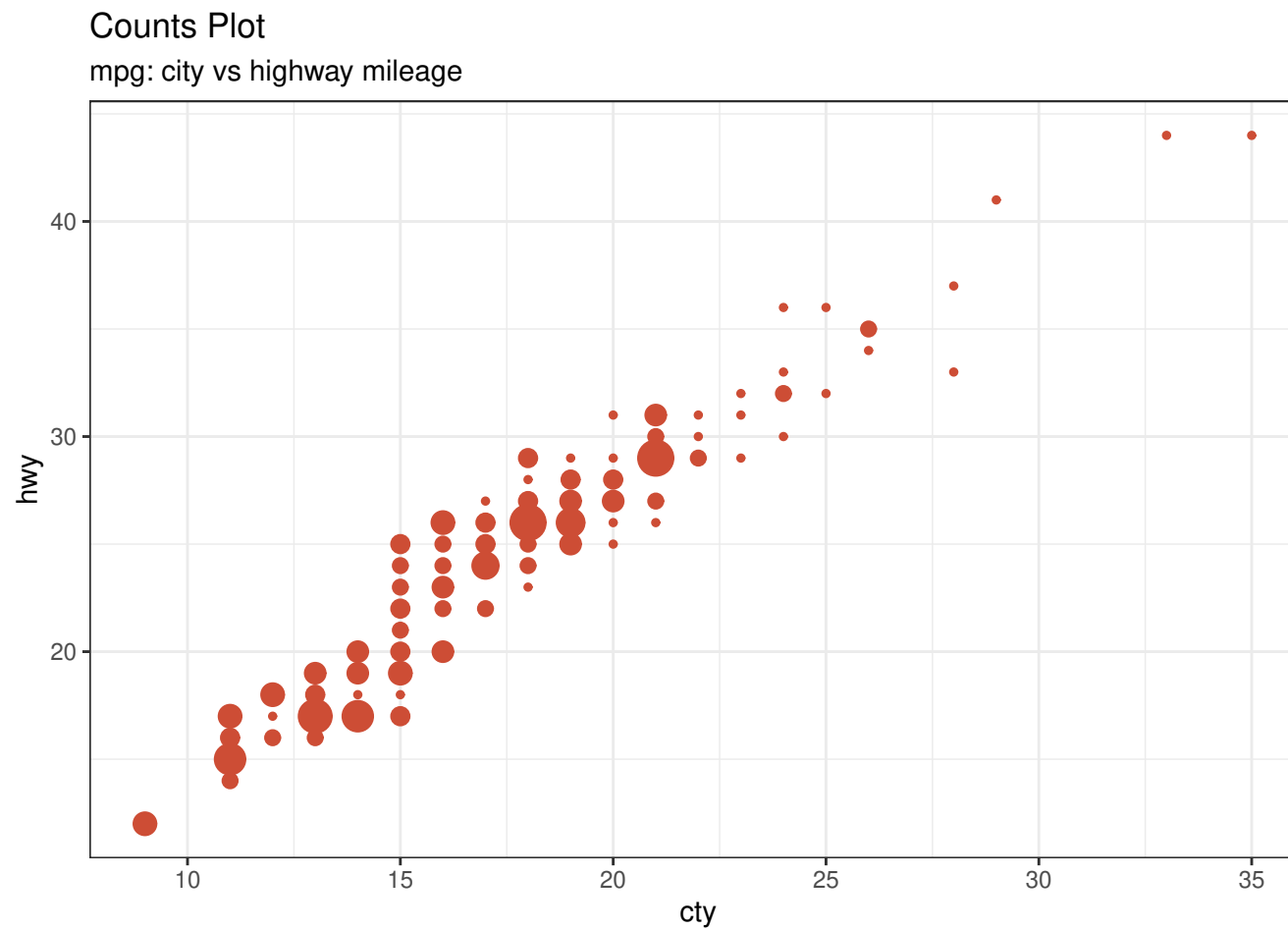
Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
mpg	5	20.980	1.474	19	21	21.4	23
cyl	5	6.000	1.414	4	6	6	8
disp	5	209.200	100.256	108	160	258	360

**Table 2.3**

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
mpg	5	20.980	1.474	19	21	21.4	23
cyl	5	6.000	1.414	4	6	6	8
disp	5	209.200	100.256	108	160	258	360

## 2.6 Figures

**Figure 2.1:** (MS1: Figure 1) Title here.



## **CHAPTER 3: CHAPTER 2: WHAT'S IN A WATER BILL? WATER BILL PAYMENT BEHAVIOR AND SERVICE QUALITY, PRICES, AND HOUSEHOLD CHARACTERISTICS IN AMRAVATI, MAHARASHTRA, INDIA.**

### **3.1 Introduction**

This is another introduction.

Mention of a name Genetic Risk Score (GRS) for the first time. Mention of the acronym for the second time, GRS.

### **3.2 Methods**

This is another methods section. Another citation here (???)

#### **3.2.1 Study sample**

Put a description here with subheading(Bivins et al. 2017).

### **3.3 Results**

Put some results here.

### **3.4 Discussion**

Put discussion here.

### **3.5 Tables**

**Table 3.1:** List 1.

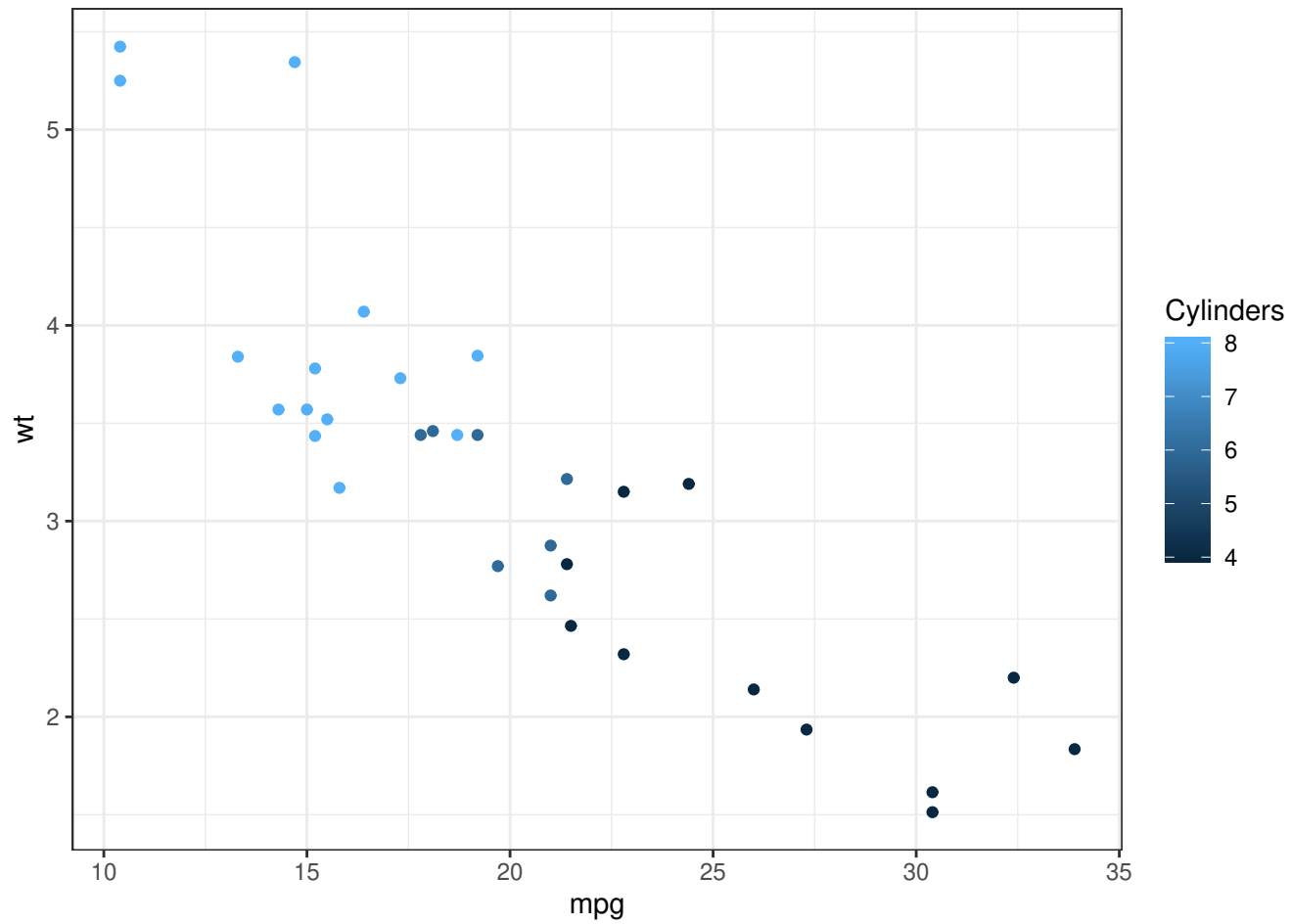
---

The rest

	column 1	column 2	column 3
Mazda RX4	6	160	110
Mazda RX4 Wag	6	160	110
Datsun 710	4	108	93
Hornet 4 Drive	6	258	110
Hornet Sportabout	8	360	175

## 3.6 Figures

**Figure 3.1:** (MS2: Figure 1) Title here.





## **CHAPTER 4: CHAPTER 3: INTERMITTENT TO CONTINUOUS WATER SUPPLY: IMPLICATIONS FOR WATER DEMAND, SUPPLY, REVENUE AND LONG-TERM PLANNING HORIZONS IN AMRAVATI, MAHARASHTRA, INDIA.**

### **4.1 Introduction**

This is another introduction.

Mention of a name GRS for the first time. Mention of the acronym for the second time, GRS.

### **4.2 Methods**

This is another methods section. Another citation here (???).

#### **4.2.1 Study sample**

Put a description here with subheading(Bivins et al. 2017).

### **4.3 Results**

Put some results here.

### **4.4 Discussion**

Put discussion here.

### **4.5 Tables**

**Table 4.1:** List 1.

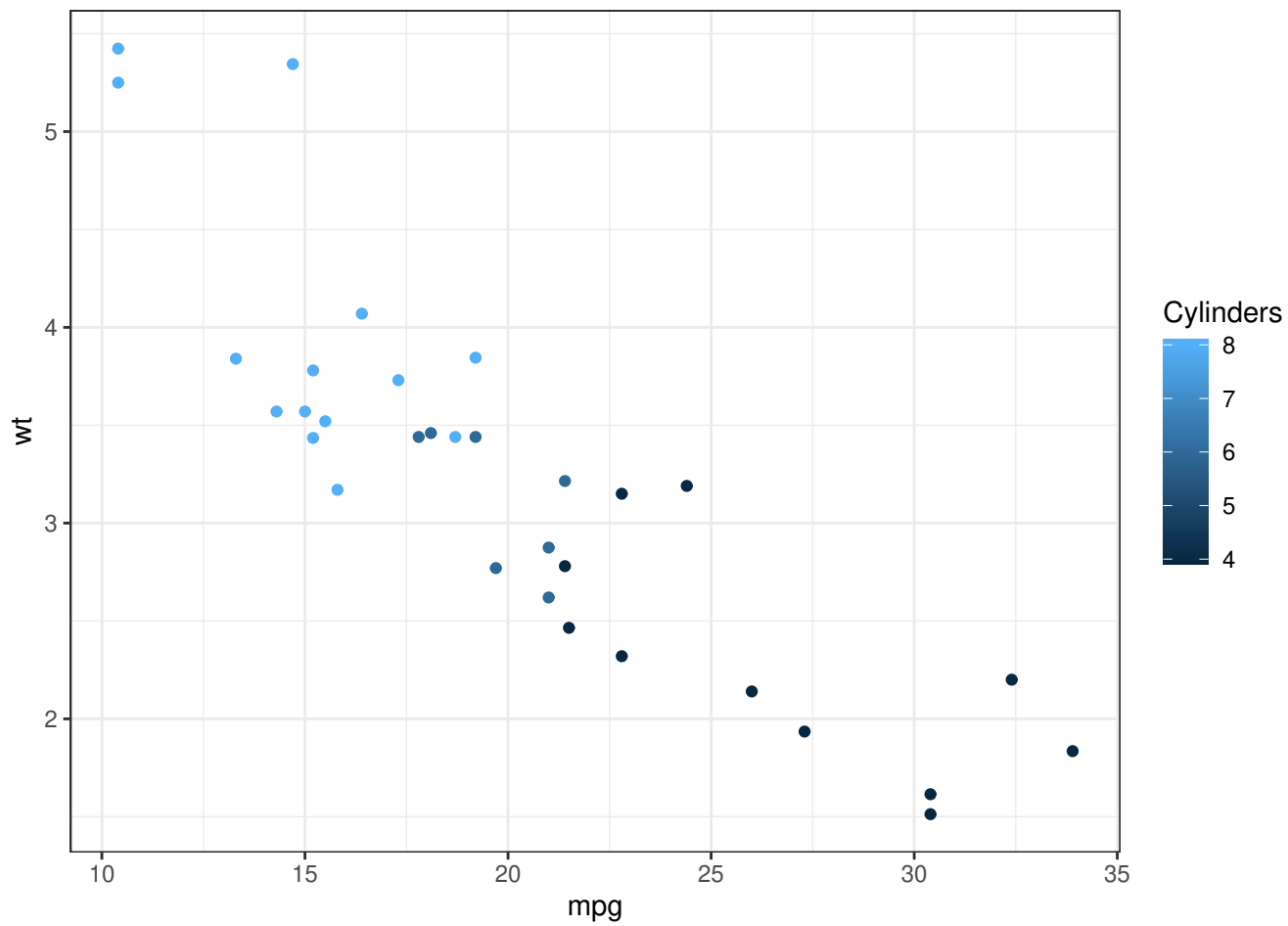
---

The rest

	column 1	column 2	column 3
Mazda RX4	6	160	110
Mazda RX4 Wag	6	160	110
Datsun 710	4	108	93
Hornet 4 Drive	6	258	110
Hornet Sportabout	8	360	175

## 4.6 Figures

**Figure 4.1:** (MS3: Figure 1) Title here.



## APPENDIX A: BACKGROUND FOR POWER CALCULATIONS

### A.1 List 1

This is one section with a formula.

$$y = a + bx$$

### A.2 Very long title for next section that is meant to take up more than one line in the table of contents so you can verify that those lines are single spaced according to guidelines.

Table A.1: List 1.

	The rest		
	column 1	column 2	column 3
Mazda RX4	21.0	6	160
Mazda RX4 Wag	21.0	6	160
Datsun 710	22.8	4	108
Hornet 4 Drive	21.4	6	258
Hornet Sportabout	18.7	8	360

## REFERENCES

- Bivins, Aaron W, Trent Sumner, Emily Kumpel, Guy Howard, Oliver Cumming, Ian Ross, Kara Nelson, and Joe Brown. 2017. “Estimating Infection Risks and the Global Burden of Diarrheal Disease Attributable to Intermittent Water Supply Using QMRA.” *Environmental Science & Technology* 51 (13): 7542–51.