STATISTICAL MODELS OF POST-EARTHQUAKE IGNITIONS BASED ON DATA FROM THE TOHOKU, JAPAN EARTHQUAKE AND TSUNAMI

by

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ABSTRACT

This thesis introduces new statistical models to predict the number and geographic distribution of fires caused by earthquake ground motion and tsunami inundation in Japan. Using new, uniquely large and consistent datasets from the 2011 Tōhoku earthquake and tsunami, we fitted three types of models—Generalized linear models (GLMs), generalized additive models (GAMs), and boosted regression trees (BRTs). This is the first time the latter two have been used in this application. A simple conceptual framework guided identification of candidate covariates. Models were then compared based on their out-of-sample predictive power, goodness-of-fit to the data, ease of implementation, and relative importance of the framework concepts.

For the ground motion dataset, we recommend a Poisson GAM; for the tsunami dataset, a negative binomial (NB) GLM or NB GAM. The best models generate out-of-sample predictions of the total number of ignitions in the region within one or two. Prefecture-level prediction errors average approximately three. All models demonstrate predictive power far superior to four from the literature that were also tested. A nonlinear relationship is apparent between ignitions and ground motion, so for GLMs, which assume a linear response-covariate relationship, instrumental intensity was the preferred ground motion covariate because it captures part of that nonlinearity. Measures of commercial exposure were preferred over measures of residential exposure for both ground motion and tsunami ignition models. This may vary in other regions, but nevertheless highlights the value of testing alternative measures for each concept. Models with the best predictive power included two or three covariates.

Chapter 1

INTRODUCTION

The Tōhoku earthquake and tsunami caused at least 348 reported fires—more than any other earthquake in history. The Tōhoku fires occurred in a variety of land area types from urban to rural, and were caused by two distinct hazards—ground motion and tsunami inundation. As they were all part of a single event, the dataset describing the fires could be collected at one time ensuring a consistency not possible when compiling data from multiple events over many years. Because of the size and features of the fire dataset it generated, this event offers a unique opportunity to improve the statistical models of post-earthquake ignitions that rely on such data and that are critical for planning for the emergency response needs and total losses that can result from such fires.

Previous efforts to model post-earthquake ignitions fall into two main categories [(1)]. In the first [(2-5)], the probabilities of different mechanisms of ignition (e.g., utility damage, overturning of objects) are estimated separately and combined using fault or event trees. In the second and larger category, which dates back to Kawasumi,[(6)] statistical models are developed using data from past earthquakes. Although they differ in the data and the specific response variables and covariates they use, almost all previous statistical models have regressed some measure of ignition rate on a single measure of earthquake intensity (e.g., ignitions per sq ft of building area versus peak ground acceleration, PGA), apparently using least squares regression[(e..g 7-9)]. Ren and Xie [(10)]

estimate the number of ignitions in each area unit as the product of ignition rate from the regression and total building area of the unit. Others [(11-13)], then simulate ignitions for each area unit assuming they follow a Poisson process with that product as the Poisson parameter. Cousins and Smith [(14)] assume ignitions are normally distributed with mean ignition rate from the regression and a standard deviation of one. Lee et al. (2008) review the literature on post-earthquake ignition modeling. Davidson [(15)] introduced the use of generalized linear models (GLMs) and generalized linear mixed models (GLMMs) for this application for the first time. Unlike previous models, the approach uses discrete, nonnegative ignition counts as the response variable, examines many possible covariates, and uses a small unit of study to ensure homogeneity in variable values for each area unit. Nevertheless, the data in that analysis were only available for selected jurisdictions for each of six earthquakes, which made it impossible to fully capture the zero counts, i.e., the places where ground shaking was strong enough to cause ignitions but did not. The analysis also did not fully characterize the model's predictive ability with out-of-sample validation.

Using a new dataset compiled for the Tōhoku earthquake and tsunami, this thesis offers both methodological and application-oriented contributions. First, we introduce two additional model types—generalized additive models (GAMs) and boosted regression trees (BRTs) and compare their performance with the GLMs found to be best in Davidson [(15)]. In the process, we also improve estimation of each model's predictive power, i.e., how well it will predict the number and locations of ignitions in a future earthquake and how much and what type of errors to expect. Second, we introduce and compare new models for ground motion-generated and tsunami-generated post-earthquake ignitions in Japan. To our knowledge, no such model for tsunami-generated ignitions exists for any region. In Chapters 2 and 3, we describe the data and the three types of statistical models, respectively. The model section process is discussed in Chapter 4, followed by the analysis results in Chapter 5.

Chapter 2

DATA DESCRIPTION

2.1 Data Compilation

The study area was defined to be the region in which ignitions were physically possible, which we assumed to be comprised of the 17 prefectures that experienced at least one damaged building or fatality (not including Hokkaido) (Fig. 2.1). This area, which includes 126,768 sq km of area and 54.7 million people (34% of the total area and 43% of the total population of Japan, respectively), corresponds approximately to the region that experienced peak ground acceleration (PGA) of at least 0.035g. Municipalities were taken to be the area units for the analysis, but for the nine largest cities in the area (Chiba, Hamamatsu, Kawasaki Sagamihara, Saitama, Sendai, Shizuoka, Tokyo, and Yokohama) which are administratively divided into ku's, we used the ku's instead. These area units were chosen because many variables are available for municipality/ku and they are of similar size for analysis and small enough so that covariates are approximately homogeneous within them. Together 786 municipalities and 57 ku's cover the entire study region. Since 157 municipalities and 7 ku's were missing ignition data (Section 2.2), the final data set included 629 municipalities and 50 ku's (Fig. 2.1).

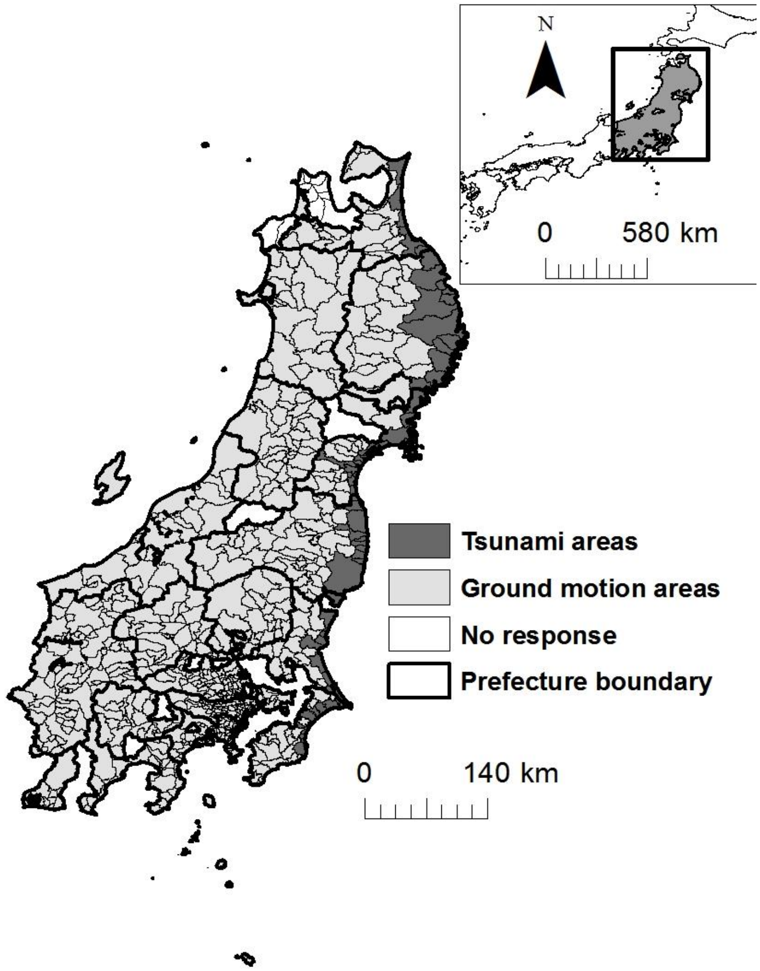


Figure 2.1: Map of study area and its location in Japan

Overlaying data from several sources in a geographic information system (GIS), we compiled a dataset that includes a value for each variable in Table 2.1 for each area unit. For covariates whose values varied over the area unit, we used the average. For analysis, because of the differences in ignition mechanisms, the dataset was divided into the *ground motion database*, which included the 615 area units with no tsunami inundation ($x_{area} = 0$) and only ignitions identified as ground motion-generated; and the *tsunami database* comprised of the 64 area units with some inundation ($x_{area} > 0$) and only ignitions identified as tsunami-generated. The complete ground motion and tsunami datasets can be found in Appendices A and B. Tables 1 summarize the variables collected for the ground motion and tsunami dataset.

Table 2.1: Definition, mean, and coefficient of variation (C.O.V.) of variables used in datasets

Concept		Variable definition	Ground motion dataset Mean	Ground motion dataset C.O.V.	Tsunami dataset Mean	Tsunami dataset C.O.V.
Ignitions	y_g	Ground motion ignitions in 10 days	0.2	3.3	---	---
	y_t	Tsunami ignitions in 10 days	---	---	1.9	2.0
Ground motion	x_{psa03}	Average PSA[a], 0.3 s (g)	0.4	0.9	0.8	0.5
	x_{psa10}	Average PSA, 1 s (g)	0.2	0.6	0.3	0.5
	x_{psa30}	Average PSA, 3 s (g)	0.1	0.5	0.1	0.4
	x_{pgv}	Peak ground velocity, PGV (cm/s)	18.8	0.5	31.5	0.3
	x_{pga}	Peak ground acceleration, PGA (g)	0.2	0.8	0.4	0.6
	x_{ii}	Instrumental intensity	6.1	0.2	7.4	0.1
Inun-dation	x_{area}	Area that experienced inundation[b] (m^2)	---	---	7,935,734	1.4
	x_{depth}	Average inundation depth[c] (m)	---	---	2.8	0.7
Exposure	x_{pop}	Population[b]	83,033	1.5	57,284	1.2
	x_{res}	Area of residential zoning[b] (1000s m^2)	7,054	1.5	7,884	1.4
	x_{estab}	Number of business establishments[b]	3,846	1.5	2,698	1.3
	x_{com}	Area of commercial zoning[b] (1000s m^2)	805	1.6	819	1.5
	x_{indus}	Area of industrial zoning[b] (1000s m^2)	1,948	1.7	3,638	1.8
Vulner-Ability	x_{pwood}	% houses that are wooden	20.4%	1.0	28.6%	0.9
	x_{pdam3}	% houses collapsed	0.1%	6.9	4.2%	2.3
	x_{pdam2}	% houses with moderate damage	0.4%	6.4	2.0%	1.9
	x_{pdam1}	% houses with minor damage	2.0%	3.5	4.6%	1.8
	$x_{pdam123}$	% houses with at least minor damage	2.4%	3.5	10.8%	1.5
Damaged buildings	x_{dam3}	Num. collapsed houses[b]	10.2	11.1	572	2.5
	x_{dam2}	Num. houses with moderate damage[b]	82.1	11.2	883	4.6
	x_{dam1}	Num. houses with minor damage[b]	349	5.0	2,149	3.4
	x_{dam123}	Num. houses with at least minor damage[b]	441	6.1	3,605	3.3
	x_h	Num. houses[d]	35,534	1.5	24,847	1.3

[a] PSA=pseudo spectral acceleration

[b] We took the natural log of all exposure variables, damage variables, and x_{area} before using them in models.

[c] Averaged only over the portion of the area unit with nonzero inundation depth.

[d] Number of houses was used to compute x_{pwood} and to apply the models from the literature (Section 4.2)

2.2 Ignition Data

Ignition data was collected by the Committee for Post-earthquake Fire Research of the Japan Association for Fire Science and Engineering (JAFSE), which included Himoto, co-author of this thesis. They sent hardcopy mail surveys to all 297 fire services in the 17 affected prefectures [(9)]. Surveys were mailed in April-May 2012, and reminders were sent in the end of 2012 to the beginning of 2013. In all, 258 surveys (87%) were returned complete. The survey included 12 open-ended questions asking the number of ignitions, and for each ignition, its location (street address), whether it was within the tsunami-inundated area or not, estimated occurrence time, reported time, apparent cause, fire type, consequent losses, and how firefighting activity was conducted [(16)]. Many of the questions were extracted from the official "Kasai Hokoku" fire report that fire services are required to submit to the larger regional agencies.

The 164 (19%) area units for which ignition data are missing appear to be randomly distributed geographically and have similar distributions for the covariates as the area units for which data are available. With no reason to believe otherwise, we thus assume that the missing data are what is known as Missing Completely At Random (MCAR), i.e., unrelated to the number of ignitions or to the covariate values [(17)]. The observed data can then be thought of as a random subsample of the hypothetically complete data, and omitting those area units from the analysis should not introduce bias in the results.

For consistency, we included only ignitions that (1) were identified as ground motion- or tsunami-generated (as determined by the JAFSE team based on the specified cause)), and (2) occurred within 10 days of the earthquake (i.e., by 11:59pm March 21). The ten-day cutoff includes most reported earthquake- or tsunami-generated ignitions (84%), and has typically been considered the ignitions that are of most interest to emergency responders and risk managers. There may have been additional fires that did not become large enough to require fire department help or otherwise were not reported, but we reasonably assume those are not of as great interest to fire departments and others planning for earthquakes and tsunamis.

2.3 Covariate Data

The choice of candidate covariates for the modeling was guided by a simple conceptual framework describing the causes of ignitions (Fig. 2.2), together with data availability. The main reported mechanisms of post-earthquake fires in the absence of a tsunami include damage to electric power and gas lines, and overturning or falling of appliances, heating equipment, candles, or other contents [(5,11)]. Ignitions can be caused directly by building damage (e.g., damage to a wall may cause a water heater to overturn and ignite), but they can also occur in the absence of building damage if, for example, an appliance overturns due to acceleration in an otherwise undamaged building. In the case of tsunami inundation, additional ignition mechanisms include damage to oil tanks and cars [(18)]. All these types of ignitions ultimately are expected to be directly related to hazard, exposure (buildings, their contents, and the utilities and cars associated with them), and building vulnerability. We identified multiple possible covariates to represent each of these concepts (Fig. 2.2). In some cases, the candidate covariates listed are alternative measures of the same concept and as such, are highly correlated (i.e., $\rho \geq 0.75$) as can be seen in the correlation matrices created in Tables 2.2 and 2.3.

Table 2.2: Correlation matrix, ground motion dataset

	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xpop	xestab	xpwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123
ground_10	1.00	0.24	0.32	0.22	0.27	0.27	0.26	0.38	0.41	0.29	0.35	0.41	0.02	0.19	0.35	0.41	0.39	-0.01	0.16	0.16	0.16
xpsa03		1.00	0.75	0.49	0.85	0.91	0.78	0.09	0.05	0.12	0.04	0.02	0.19	0.15	0.15	0.29	0.25	0.13	0.27	0.45	0.44
xpsa10			1.00	0.75	0.92	0.81	0.84	0.17	0.24	0.20	0.20	0.23	0.05	0.12	0.16	0.24	0.21	0.07	0.26	0.35	0.35
xpsa30				1.00	0.74	0.50	0.67	0.17	0.20	0.15	0.25	0.23	0.06	0.07	0.12	0.16	0.14	0.04	0.16	0.20	0.20
xpgv					1.00	0.88	0.91	0.13	0.15	0.16	0.15	0.14	0.12	0.15	0.15	0.24	0.21	0.14	0.25	0.38	0.38
xpga						1.00	0.78	0.09	0.07	0.13	0.03	0.02	0.15	0.16	0.14	0.27	0.23	0.15	0.26	0.43	0.43
xii							1.00	0.13	0.14	0.12	0.16	0.14	0.07	0.14	0.12	0.21	0.19	0.14	0.23	0.35	0.36
xres								1.00	0.75	0.65	0.81	0.68	0.09	0.15	0.27	0.31	0.30	-0.03	0.05	0.00	0.01
xcom									1.00	0.62	0.78	0.89	0.02	0.11	0.20	0.22	0.22	-0.02	0.02	-0.03	-0.02
xindus										1.00	0.55	0.52	0.11	0.17	0.30	0.30	0.30	-0.01	0.10	0.06	0.07
xdepth											-0.07	-0.06	0.04	0.38	0.12	0.11	0.15	0.52	0.18	0.08	0.28
xarea											0.00	0.01	0.07	0.36	0.16	0.14	0.18	0.26	0.13	0.08	0.18
xpop											1.00	0.85	0.00	0.04	0.12	0.15	0.14	-0.05	-0.02	-0.06	-0.07
xestab												1.00	0.00	0.05	0.12	0.14	0.13	-0.05	-0.02	-0.06	-0.06
xpwood													1.00	-0.02	-0.03	0.01	-0.01	0.01	-0.01	0.03	0.02
xdam3														1.00	0.69	0.59	0.70	0.66	0.46	0.27	0.53
xdam2															1.00	0.88	0.95	0.11	0.49	0.31	0.39
xdam1																1.00	0.98	0.09	0.44	0.50	0.51
xdam123																	1.00	0.16	0.48	0.44	0.50
xpdam3																		1.00	0.32	0.13	0.51
xpdam2																			1.00	0.49	0.73
xpdam1																				1.00	0.89
xpdam123																					1.00

Table 2.3: Correlation matrix, tsunami dataset

	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xdepth	xarea	xpop	xestab	xpwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123
ground_10	1.00	0.24	0.32	0.22	0.27	0.27	0.26	0.38	0.41	0.29	0.03	0.09	0.35	0.41	0.02	0.19	0.35	0.41	0.39	-0.01	0.16	0.16	0.16
xpsa03		1.00	0.75	0.49	0.85	0.91	0.78	0.09	0.05	0.12	0.26	0.24	0.04	0.02	0.19	0.15	0.15	0.29	0.25	0.13	0.27	0.45	0.44
xpsa10			1.00	0.75	0.92	0.81	0.84	0.17	0.24	0.20	0.25	0.32	0.20	0.23	0.05	0.12	0.16	0.24	0.21	0.07	0.26	0.35	0.35
xpsa30				1.00	0.74	0.50	0.67	0.17	0.20	0.15	0.19	0.27	0.25	0.23	0.06	0.07	0.12	0.16	0.14	0.04	0.16	0.20	0.20
xpgv					1.00	0.88	0.91	0.13	0.15	0.16	0.31	0.33	0.15	0.14	0.12	0.15	0.15	0.24	0.21	0.14	0.25	0.38	0.38
xpga						1.00	0.78	0.09	0.07	0.13	0.32	0.30	0.03	0.02	0.15	0.16	0.14	0.27	0.23	0.15	0.26	0.43	0.43
xii							1.00	0.13	0.14	0.12	0.28	0.24	0.16	0.14	0.07	0.14	0.12	0.21	0.19	0.14	0.23	0.35	0.36
xres								1.00	0.75	0.65	-0.01	0.06	0.81	0.68	0.09	0.15	0.27	0.31	0.30	-0.03	0.05	0.00	0.01
xcom									1.00	0.62	-0.01	0.05	0.78	0.89	0.02	0.11	0.20	0.22	0.22	-0.02	0.02	-0.03	-0.02
xindus										1.00	0.07	0.15	0.55	0.52	0.11	0.17	0.30	0.30	0.30	-0.01	0.10	0.06	0.07
xdepth											1.00	0.51	-0.07	-0.06	0.04	0.38	0.12	0.11	0.15	0.52	0.18	0.08	0.28
xarea												1.00	0.00	0.01	0.07	0.36	0.16	0.14	0.18	0.26	0.13	0.08	0.18
xpop													1.00	0.85	0.00	0.04	0.12	0.15	0.14	-0.05	-0.02	-0.06	-0.07
xestab														1.00	0.00	0.05	0.12	0.14	0.13	-0.05	-0.02	-0.06	-0.06
xpwood															1.00	-0.02	-0.03	0.01	-0.01	0.01	-0.01	0.03	0.02
xdam3																1.00	0.69	0.59	0.70	0.66	0.46	0.27	0.53
xdam2																	1.00	0.88	0.95	0.11	0.49	0.31	0.39
xdam1																		1.00	0.98	0.09	0.44	0.50	0.51
xdam123																			1.00	0.16	0.48	0.44	0.50
xpdam3																				1.00	0.32	0.13	0.51
xpdam2																					1.00	0.49	0.73
xpdam1																						1.00	0.89
xpdam123																							1.00

The intention is not to include all of them in a single model, but for each concept, to choose the most promising covariate of the alternatives. Thus, we defined the following rules for inclusion of the covariates in a model: Include at most one of the six ground motion covariates; at most one of the residential or commercial exposure covariates; at most one of the building damage covariates; and at most one of the percentage of building damage covariates. The framework also suggested investigation of interactions between hazard, exposure, and building vulnerability.

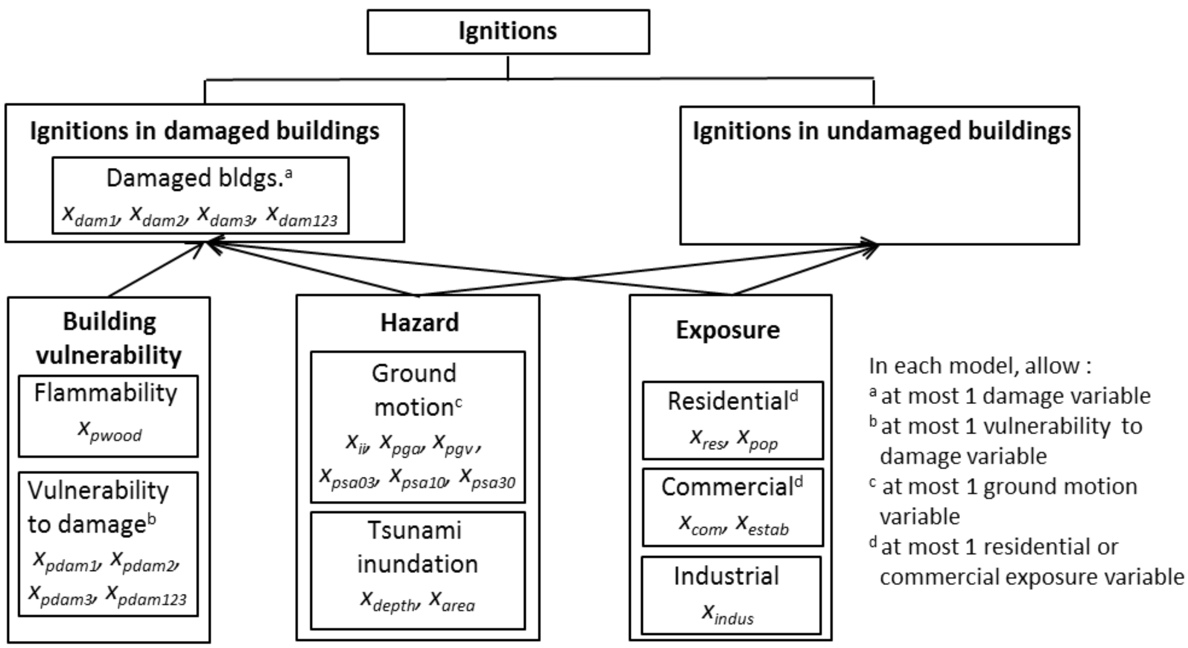


Figure 2.2: Conceptual framework of ignitions and candidate covariates (Variable definitions in Table 2.1)

Data for the ground motion and tsunami inundation hazard covariates were found from the U.S. Geological Survey Shakemap archives [(19)] and Geospatial Information Authority of Japan, respectively [(20)]. Population and establishment data were collected from the Japanese Statistics Bureau [(21)]. Data on number of wooden buildings, number of houses (to normalize wooden buildings), and zoning were all collected from the Ministry of Land and Infrastructure

[22-24]. The vulnerability to damage and damage buildings information was found through the Fire and Disaster Management Agency [2]. To avoid numerical problems associated with highly skewed distributions, before fitting any models, we took the log of all exposure and damage covariates, as well as area of tsunami inundation x_{area} (e.g., using $lx_{res}=\ln(x_{res})$ instead of x_{res}).

Chapter 3

STATISTICAL MODEL TYPES

The goal of this analysis was to develop a model to predict the expected number of ignitions in each area unit *i* as function of attributes of the area unit captured in the covariate vector $\vec{x}_i$. Three model types were considered—GLMs, GAMs, and BRTs. All were fitted using *R* software version 3.0.2 using default settings except where noted [26]. Poisson GLMs, NB GLMs, GAMs, and BRTs were fitted using the *glm* {stats}, *glm.nb* {MASS v7.3-29}, *gam* {mgcv v1.7-27}, and *gbm* {gbm v2.1-0.3} functions (in the noted {package}), respectively [27-30].

3.1 Generalized Linear Models (GLMs)

GLMs are a generalization of ordinary linear regression that allow for response variables that are not normally distributed [31]. Poisson and Negative Binomial (NB) GLMs are types of GLMs that are useful when the response variable represents nonnegative, integer count data, as in this analysis. In a Poisson GLM, the observations of the response variable y_i are assumed to be generated from a Poisson distribution, and the mean of the distribution, $\mu_i \equiv E[y_i|\vec{x}_i]$, is related to covariates $\vec{x}_i$ through Eq. 1, where $\vec{\beta}$ is a vector of unknown parameters [32]. Thus, the parameter μ_i of the distribution (the estimated mean) varies by area unit *i* depending on the values of the covariates $\vec{x}_i$ for that area unit. Using this mean, the Poisson distribution probability density function is defined as in Eq. 2.

$$ln(\mu_i) = \vec{x}_i^T\vec{\beta} = \beta_0 + \sum_{j=1}^{m} \beta_j x_{ji} \quad (1)$$

$$f(y_i|\mu_i) = \frac{\mu_i^{y_i} e^{-\mu_i}}{y_i!} \quad (2)$$

A NB GLM is similar except that the counts y_i are assumed to be generated from a Negative Binomial distribution. A Poisson GLM includes the implicit assumption that conditional on the covariates, the mean and variance are equal. In reality, data are often overdispersed (i.e., the conditional variance is greater than the conditional mean), and thus the Poisson assumption is not appropriate. In that case, a NB GLM may be preferred because in the NB model, the conditional mean is still μ_i, but the conditional variance is as defined in Eq. 3, where $\alpha \geq 0$ is the overdispersion parameter. The NB also has a larger expected proportion of zero counts and a thicker right tail than the Poisson [32].

$$Var[y_i|\vec{x}_i] = \mu_i + \alpha\mu_i^2 \tag{3}$$

The probability density function of a NB model can be seen in Eq. 4

$$f(y_i|x_i, \alpha) = \frac{\Gamma(y_i+\alpha)}{\Gamma(y_i+\alpha)\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu}\right)^{\alpha^{-1}}\left(\frac{\mu}{\alpha^{-1}+\mu}\right)^{y_i} \tag{4}$$

When $\alpha = 0$, the NB model reduces to the Poisson, so a larger estimated α value indicates NB is a more appropriate model than a Poisson. In this analysis, preliminary modeling suggested that the Poisson GLM was not appropriate, and thus we focused on NB GLM models.

3.2 Generalized Additive Models (GAMs)

GAMs are an extension of GLMs in which the only change is that the linear terms in Eq. 1, $\beta_j x_{ji}$, are replaced by non-parametric smooth functions, $s_j(x_{ji})$ [28].While different smooth functions can be selected, we used thin plate regression splines, which are the default in the {mgcv} package. The benefit of a GAM over a GLM is that it allows more flexibility in the dependence of the response on the covariates without requiring specification of detailed parametric relationships. The challenge is that GAMs require determining how to represent the smooth functions and how smooth they should be. If any smooth functions were allowed, maximum likelihood estimation would tend to estimate ones that overfit the data. To avoid this, {mgcv} uses penalized likelihood maximization, in which a penalty for each smooth function is added to the model (negative log) likelihood to penalize its "wiggliness" (or lack of smoothness). For each term, a smoothing parameter controls the tradeoff between smoothness and goodness of fit. In {mgcv}, smoothing parameters are estimated automatically so as to minimize prediction error, as measured with an Un-Biased Risk Estimator (UBRE) criterion as defined in Eq 5. when the scale parameter is known (or GCV as defined in Eq 6, if the scale parameter is not known, as in the case of quasipoisson or negative binomial model). UBRE is a linear transformation of AIC. Based on early results, we also set $\gamma = 2$ to avoid overfitting the smooths. The parameter $\gamma \geq 1$ is a factor that inflates the degrees of freedom in the UBRE or GCV score, thus encouraging a smoother model [28].Given the deviance (D), number of data points (n), scale parameter (s) and the effective degrees of freedom for the model (DoF), the GCV and UBRE can be calculated according to Eq. 5 and 6, respectively.

$$UBRE = \frac{D}{n} + \frac{2sDoF}{n} - s \qquad (5)$$

$$GCV = \frac{nD}{(n-DoF)^2} \qquad (6)$$

Based on early results, we also set $\gamma = 2$ to avoid overfitting the smooths. The parameter $\gamma \geq 1$ is a factor that inflates the degrees of freedom in the UBRE or GCV score, thus encouraging a smoother model [28].

3.3 Boosted Regression Trees (BRTs)

BRTs is a newer method that is fundamentally different than GLMs and GAMs because instead of aiming to fit a single best model to relate a response variable to a set of covariates, BRTs works by fitting and combining a large number of relatively simple models. We chose to try BRTs for this application because they are able to handle interactions and nonlinear relationships well, and at least in some cases, they have been shown to provide better predictions than GLMs and GAMs [33]. BRTs combine statistical and machine learning techniques through the use of two algorithms—classification and regression trees (CART) and boosting [34-35]. The former is used to develop individual models; the latter builds and combines collections of those individual models to optimize predictive performance.

CARTs are a non-parametric, rule-based classification technique that groups observations with similar values of the response variable using a binary recursive partitioning algorithm [35-36]. Starting with the entire dataset, the algorithm selects a covariate to be the basis of the first split and a value of that covariate to be the split point that defines the two groups. Similar binary partitions are applied recursively until a stopping criterion is reached, with splitting variables and split points determined each time so as to minimize prediction errors. The result is a tree that specifies how to group observations based on their values on each of the splitting variables. Figure 3.1 gives a simple visual of the CART process using some of the covariates included in this analysis. In this figure, one would move to the left if the value is less than the node criteria and to the right for values greater than the node criteria.

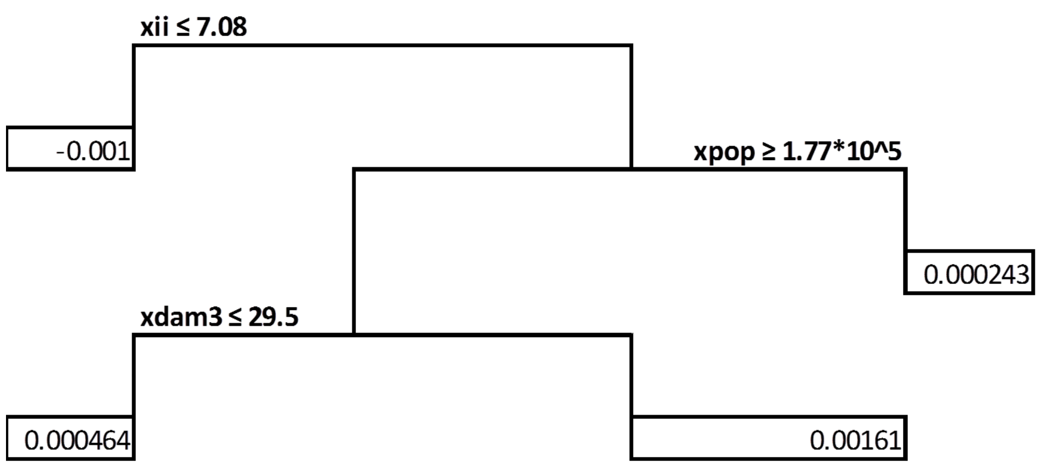


Figure 3.1: CART Tree Image

For regression trees (which are used in this analysis), the response for each observation is assumed to be the mean response of all observations in the same terminal node of the tree. Regression trees are intuitive, unaffected by changing covariate measurement scales, and insensitive to outliers or inclusion of extra covariates, but they exhibit relatively poor predictive performance. Combining CARTs with boosting aims to overcome that limitation. Boosting is an iterative, forward, stagewise procedure. In the first step, a regression tree is fitted to the data to minimize a selected loss function (deviance is used in the {gbm} package). In each subsequent step, a tree is fitted to the residuals of the previous trees and the new tree is added to all the previous trees (which are left unchanged). The final BRT model is a linear combination of many regression trees (usually thousands).

Since our response variable, number of ignitions in area unit *i*, is count data, we again assumed it follows a Poisson distribution by specifying the loss function to be the Poisson deviance [(30)]. We set the bag fraction to the default value of 0.5, meaning that at each step, a randomly selected 50% of the training set data is used. This typically improves speed and accuracy [(37)]. Fitting BRTs requires setting three main parameters: (1) learning rate or shrinkage *lr*, which determines the contribution of each tree to the model; (2) tree complexity or interaction depth *tc*, which indicates the number of splits used for each tree; and (3) number of trees or iteration *nt*, which indicates the maximum number of trees used.

Chapter 4

MODEL SELECTION PROCESS

The aim of the selection process was to identify and compare the best models based on predictive power, fit to the sample data, and ease of use. There were two main steps: (1) preliminary analyses for each model type, and (2) cross validation (CV) analysis to compare the best models of each type, plus a few others of interest.

4.1 Preliminary Analyses for Each Model Type

For the GLMs, we first selected a covariate to represent each concept in the framework (Fig. 2.2). Since we wanted to include at most one of the six candidate ground motion covariates (see rules in Section 2.3), for example, we first compared models that were the same except for the covariate used to represent ground motion. We then chose the most promising models considering only that smaller set of covariates and including the possibility of interactions suggested by the framework (hazard covariate*exposure covariate, or hazard*exposure*building vulnerability covariates). In all cases, GLMs were compared based on the following goodness-of-fit metrics: (1) the deviance pseudo-R-squared, R_{dev}^2; (2) a pseudo-R-squared based on α, R_{α}^2; and (3) the Akaike information criteria, AIC. In linear regression models, R^2 represents goodness of fit as the percentage of variability in the observation y_i that a model explains. Alternative pseudo-R^2 statistics have been developed for nonlinear and discrete count models. The deviance pseudo-R^2 is defined as $R_{dev}^2 = 1 - [D(y,\hat{\mu})/D(y,\bar{y})]$ where $D(y,\hat{\mu})$ is the deviance for the fit model and $D(y,\bar{y})$ is the deviance for the intercept-only model (a model with $\hat{\mu}_i = \bar{y}$ for all *i*). It measures reduction in deviance due to the inclusion of covariates, and generally increases with the addition of new covariates, but cannot be used to compare Poisson and NB models [38]. For NB models, $R_{\alpha}^2 = 1 - (\alpha/\alpha_0)$, where α and α_0 are the overdispersion parameters (Eq. 3) from the fit model and the intercept-only model, respectively, is an appropriate measure as well. While both R^2_{dev} and R^2_{α} are always from zero to one, the former measures the fraction of total variation in the raw counts y_i explained by the model, and the latter measures the fraction of the variation in the true Poisson means explained by the model. When the mean count μ_i is small (as in this case), most of the variability in the counts y_i can be due to the Poisson variability, and thus, R^2_{dev} are much lower than R^2_{α}. The AIC is defined as $AIC = -2logL + 2q$, where $logL$=log-likelihood, q=number of independent parameters, and a smaller AIC indicates the preferred model [(39)]. Unlike the pseudo-R^2 metrics, AIC penalizes more complicated models. With an aim to fit the data well without overfitting it, we also selected the promising GLMs based on a preference for simpler models when two fit the data equally well. In some cases models were included for purposes of comparing with other model types using the same terms. A similar process was followed with the GAMs, but using the UBRE/GCV as an additional goodness-of-fit metric (Section 3.2).

For the BRTs, the preliminary analysis began with the smaller sets of covariates (one for each concept) determined for the GLMs and GAMs and then focused on determining appropriate values of the three main modeling parameters—learning rate *lr*, tree complexity *tc*, and maximum number of trees *nt*. As suggested in Elith et al [(34)], we used cross validation with deviance reduction as the measure of success to compare all combinations of values of learning rate (0.01, 0.005, 0.001), tree complexity (1, 2, 3, 5), and number of trees (up to 15,000) and thus choose the optimal ones for our datasets. Figure 4.1 displays the results of this analysis.

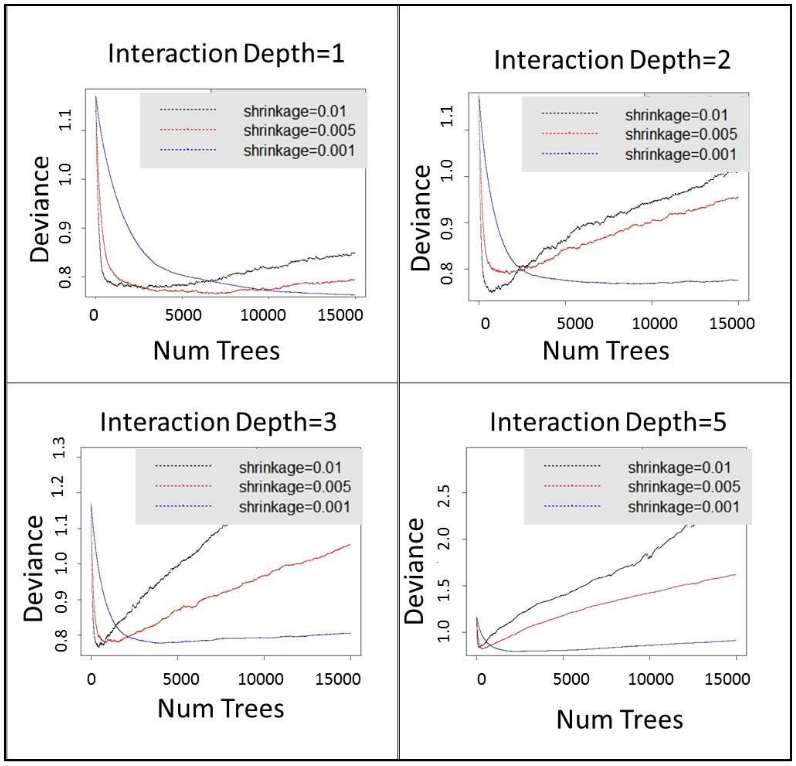


Figure 4.1: BRT deviance versus number of trees, ground motion dataset

From this analysis, one was able to see that too high an interaction depth or too low a shrinkage value leads to models quickly overfitting the data. Based on that analysis, we used *lr*=0.001, *tc*=2 or 3, and *nt*=15,000 for all ground motion runs; and *lr*=0.001 or 0.0005, *tc*=3, and *nt*=15,000 for all tsunami runs. However since the BRT can overfit the data when too many trees are included, within each run, the ten-fold cross validation option of *gbm* was used to identify the optimal number of trees. Note that this cross-validation exercise to determine *lr*, *tc*, and *nt* is separate from that described in Section 4.2.

4.2 Cross Validation Analysis

The best models of each of the three types were then compared, plus a few additional models of interest. To compare predictive power of the models, we conducted a ten-fold cross validation (CV). The observations were partitioned into ten randomly-sampled folds. For each fold, the 90% of observations not in the fold comprised the training set. They were used to fit the models, which were then applied to predict values for each of the 10% of observations in the fold—the validation set. In this way, we developed out-of-sample predictions of ignition rate $\hat{\mu}_i$ for each observation, and estimates of mean absolute error (MAE), square root of the mean squared error ($RMSE$), mean error (ME), and error in the expected total number of ignitions for the region (TE) and for each prefecture P (TE_P) (Equations 7-11), where y_i is the observed number of ignitions in area unit i, n_P is the set of observations i in prefecture P. To minimize the effect of the particular fold sample, we repeated the cross validation 140 times, each with a different set of randomly-generated folds and averaged the resulting 140 estimates of each error metric (Eq. 3-7) for each model.

$$MAE = \frac{1}{n}\sum_i^n |y_i - \hat{\mu}_i| \tag{7}$$

$$RMSE = \sqrt{\frac{1}{n}\sum_i^n (y_i - \hat{\mu}_i)^2} \tag{8}$$

$$ME = \frac{1}{n}\sum_i^n (y_i - \hat{\mu}_i) \tag{9}$$

$$TE = \sum_i^n y_i - \sum_i^n \hat{\mu}_i \tag{10}$$

$$TE_P = \sum_{i \in n_P} y_i - \sum_{i \in n_P} \hat{\mu}_i \; \forall P \tag{11}$$

For comparison, for the ground motion dataset, we compared our models to four from the literature—Kawasumi, Mizuno, HAZUS, and Zhao. Using the form of each model presented in Zhao et al. [(13)], we refit the models with our ground motion dataset and computed the predictive errors. For Kawasumi, ln(y_g/x_h) is linear function of ln(x_{pdam3}). For Mizuno, ln(-ln(1-(y_g/x_h))) is a linear function of ln(1-x_{pdam3}). For HAZUS and Zhao, y_g/x_h are second order polynomial and linear functions of x_{pga}, respectively. These analyses had to be done using the larger prefecture as the area unit rather than municipality/ku, or there would be too many zeros. As a result, there were only 17 observations and we did leave-one-out rather than ten-fold cross validation.

Chapter 5

GROUND MOTION RESULTS

Each model allows prediction of the expected number of ignitions $\hat{\mu}_i$ for each area unit i (and $\hat{\alpha}$ for NB models) as a function of the attributes of the hazard intensity and built environment in the area unit. The $\hat{\mu}_i$ (and $\hat{\alpha}$) defines the Poisson (or NB) distribution that describes occurrence of ignitions in that area unit. Thus, each model can be used as a predictive tool, and to understand the relative importance of variables contributing to ignitions. With these uses in mind, we first discuss the results of the preliminary analyses, and then compare the models according to: (1) predictive power (i.e., ability to predict both total number of ignitions for the whole region and geographic distribution of ignitions); (2) goodness-of-fit to the data; and (3) relative importance of covariates. Finally, we discuss recommended models and their application as predictive tools.

5.1 Preliminary Analysis Results

For the GLMs, in the first step, instrumental intensity (x_{ii}) and area of commercial zoning (x_{com}) were clearly the preferred measures of ground motion intensity and residential/commercial exposure, respectively. The best NB GLM with x_{pga} underestimated the total count by TE=18.2 compared to TE=4.1 for the best NB GLM with x_{ii} (Table 6.1.1). For GAMs, instrumental intensity (x_{ii}) and peak ground acceleration (x_{pga}) were both promising measures of ground motion intensity, and area of commercial zoning (x_{com}) and number of business establishments (x_{estab}) were both promising measures of residential/commercial exposure. A nonlinear relationship is apparent between ignition rate and ground motion with the marginal increase in ignition rate declining with ground motion (e.g., Fig. 5.1).

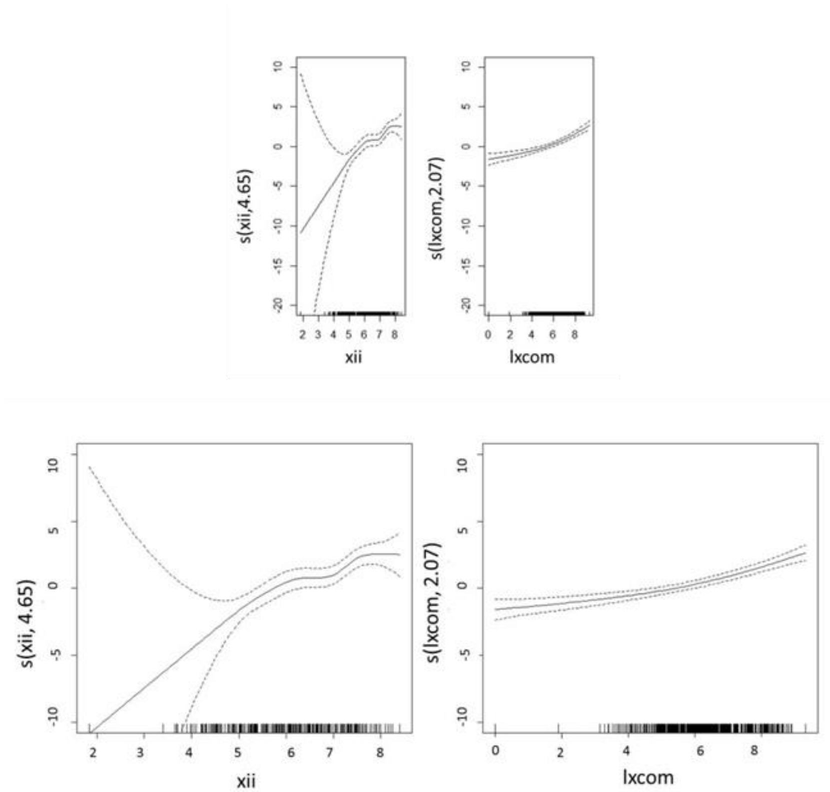


Figure 5.1: Smooths for P GAM Model 4, for ground motion dataset (y-axis labels include the estimated degrees of freedom of the smooth)

Since the GLM cannot capture that nonlinearity, instrumental intensity x_{ii}, which is defined to be more directly related to damage and has a nonlinear relation with PGA provides a better fit to the data [(40)]. Since GAMs can capture the nonlinearity, the choice between x_{ii} and x_{pga} is not as pronounced. The preference of an indicator of commercial exposure (x_{com} or x_{estab}) over residential exposure (population, x_{pop}, or area of residential zoning, x_{res}) is also notable since one might expect the latter to be preferred since most post-earthquake ignitions occur in residential buildings [(11)], and x_{pop} would be easier data to collect for application of the model. Although they are highly correlated with x_{pop} ($\rho = 0.8$), it appears that x_{com} or x_{estab} are consistently preferred at least in part because of three observations in Tokyo (Chiyoda, Minato, and Shinjuku), which have multiple ignitions (2, 7, and 1, respectively) and higher values of x_{com} and x_{estab} than expected given the population. Thus, x_{com} and x_{estab} are better able to predict those counts than x_{pop}. In other regions, x_{pop} may be equally appropriate.

In both GLMs and GAMs, while the choice of covariates to represent the concepts of damaged buildings and vulnerability of buildings to damage did not matter greatly to the model fit, based on comparison, number of houses with minor damage (x_{dam1}) and percentage of houses that collapsed (x_{pdam3}), respectively, were selected. In the second step, we determined that the area of industrial zoning (x_{indus}), building damage (x_{dam1}), and building vulnerability to damage (x_{pdam3}) covariates did not contribute substantially to the model goodness-of-fit and thus were not considered in the final models.

5.2 Predictive Power

Table 5.1 compares the most promising of each model type according to five measures of predictive power (defined in Section 4.2): $RMSE$, MAE, ME, TE, and $E[|TE_P|]$. Comparing the $RMSE$, MAE, and ME across models suggests that the average errors ($RMSE$ and MAE) are slightly smaller for BRTs than GLMs and GAMs, but the BRT predictions are biased a bit low (with a mean error of 0.03 for the models in Table 6.1).

Table 5.1: Summary comparison of selected most promising models of each model type, for ground motion dataset

	Model	Root mean squared error RMSE	Mean absolute error MAE	Mean error ME	Total error TE	Total error %	Average of total absolute prefecture errors E[|TEp|]	alpha	R2 alpha	R2 dev	UBRE /GCV	AIC	Moran's I p-value	Formula
1	NB GLM	0.689	0.301	0.01	4.1	3%	2.8	0.99	0.82	0.43	---	557	0.36	xii + lxcom:xii
2	NB GLM	0.692	0.302	0.01	4.6	3%	2.8	1.00	0.82	0.43	0	557	0.24	xii + lxcom
3	NB GLM	0.696	0.303	0.01	4.8	3%	2.9	0.99	0.82	0.43	---	559	0.28	xii + lxcom + xpwood
4	P GAM	0.688	0.298	0.00	0.3	0%	2.5	---	---	0.46	-0.39	564	0.97	s(xii) + s(lxcom)
5	P GAM	0.691	0.298	0.00	0.3	0%	2.4	---	---	0.44	-0.35	579	0.57	s(xii, lxcom, xpwood)
6	P GAM	0.693	0.299	0.00	0.6	0%	2.1	---	---	0.49	-0.38	553	0.82	s(xii) + s(lxcom) + s(xpwood)
7	NB GAM	0.670	0.289	0.00	0.3	0%	2.5	0.51	0.90	0.49	-0.50	542	0.61	s(xpga) + s(lxestab) + s(xpwood) + s(xpga,lxestab) + s(xpga,lxestab,xpwood)
8	NB GAM	0.680	0.291	-0.01	-3.3	-2%	2.1	0.51	0.90	0.48	-0.53	536	0.17	s(xpga) + s(lxestab)
9	NB GAM	0.688	0.298	0.00	1.6	1%	2.4	0.84	0.83	0.46	-0.51	557	0.26	s(xii, lxcom, xpwood)
10	BRT	0.663	0.288	0.03	18.8	13%	3.2	---	---	0.63	---	---	---	xpga + lxcom + xpwood + lxindus
11	BRT	0.652	0.278	0.03	19.1	13%	2.4	---	---	0.62	---	---	---	xpga + lxestab + lxindus + xpdam3 + xpwood + lxdam1
12	BRT	0.682	0.287	0.03	19.6	13%	2.6	---	---	0.63	---	---	---	xii + lxcom + xpwood + lxindus
13	HAZUS	8.7	5.6	-2.6	-44.4	-30%	5.6	---	---	---	---	---	---	xpga (2nd order polynomial)
14	Zhao	9.1	5.9	-3.2	-55.2	-38%	5.9	---	---	---	---	---	---	xpga (linear)
15	Kawasumi	16.8	12.4	-7.3	-124.5	-85%	12.4	---	---	---	---	---	---	ln(xpdam3) (linear)
16	Mizuno	15.8	11.1	-7.6	-129.9	-88%	11.1	---	---	---	---	---	---	ln(1-xpdam3) (linear)

Notes: For all smooths shown, k=20. For all BRTs shown, tc=2, lr=0.001, and nt=15,000. Observed total number of ignitions=147. Five leftmost columns computed in cross validation. Six rightmost columns computed based on fitting model with the full dataset. R2dev for Poisson and NB models are not directly comparable.

To gain more insight into the practical significance of the errors, it is useful to examine the models' ability to predict the total numbers of ignitions, both for the entire study region and to get an idea of the models' ability to capture the geographic distribution—the total for each prefecture. Table 5.1 shows that although the BRTs had the best $RMSE$ and MAE values, they underestimate the total number of ignitions by almost twenty. The Poisson GAMs, on the other hand, are within one ignition of the observed total of 147. Remembering that these are out-of-sample predictions, the GLMs and GAMs provide results that should be accurate enough to be of practical use. All four models from the literature provide substantially worse predictions, with errors that are two to six times larger (Table 5.1).

Figure 5.2 summarizes each model's predictive errors by prefecture, TE_P. Table 5.1 includes the average of absolute ignition count errors across prefectures (almost all are between 2 and 3). These results suggest that although the number of ignitions for the region is predicted quite well, there is some error in geographic distribution. In particular, the GLMs have somewhat higher prefecture errors than the other model types, and the BRTs underestimate prefecture counts more than overestimate. The largest errors are underestimation in Miyagi and Iwate prefectures, and overestimation in Tochigi.

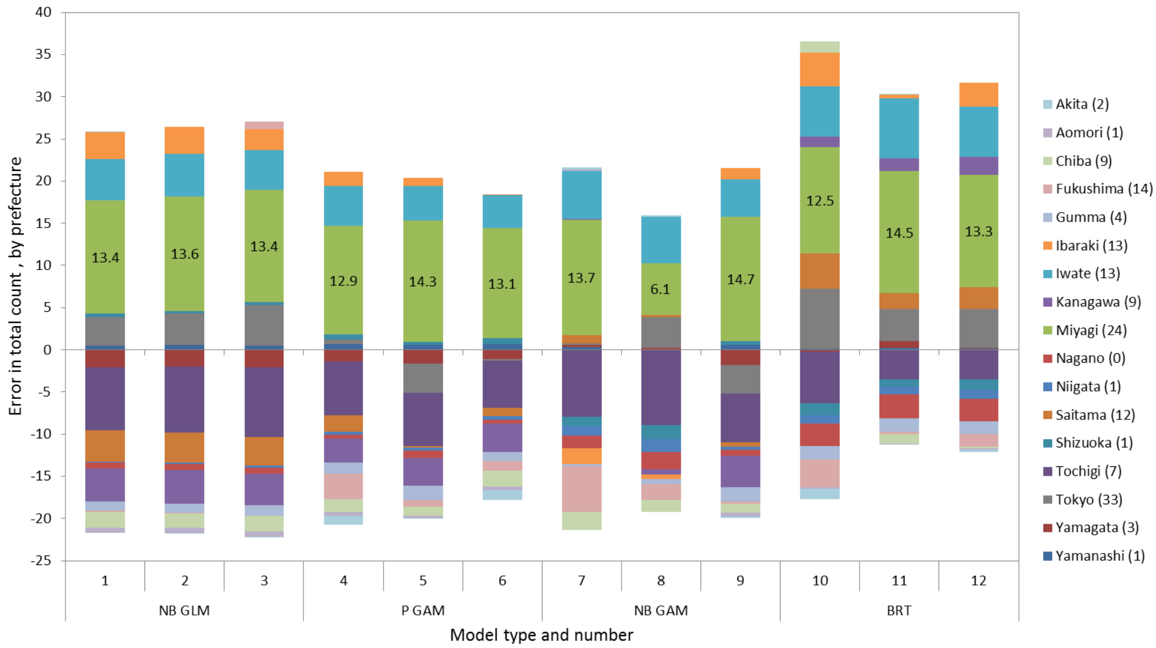


Figure 5.2: Errors in total number of ignitions TE_p (observed-predicted) by prefecture and model, for ground motion models.

(Labeled column layers are for Miyagi prefecture. Each prefecture name includes the total number of observed ground motion-ignitions.)

5.3 Goodness-of-fit

Because the models are intended for use in prediction, predictive power is arguably more important than goodness-of-fit and while we seek models that fit the sample data well, we do not want to overfit it. Nevertheless, goodness-of-fit measures were useful in the preliminary analyses to identify promising models for the CV analysis and can help identify model misspecification, thus we include them (computed using the full dataset) in Table 5.1. First, we consider the assumption of a Poisson versus negative binomial distribution for the ignition counts. A quantile-quantile (qq) plot of deviance residuals provides an indication of the appropriateness of the assumed distribution. The closer the residuals are to the 45° line, the more appropriate the model.

As an example, Figure 5.3 shows qq plots for Model 4 (Poisson GAM with formula $s(x_{ii}) + s(lx_{com})$) and the same model but with a NB assumption. It suggests that the NB is a more appropriate assumption in this case, and the same conclusion holds for most similar models we tested. The overdispersion parameter values $\alpha > 0$ suggest some preference for a NB model as well. Nevertheless, the predictive errors are larger for the NB GAM (*TE*=4.5 compared to 0.3 for the Poisson).

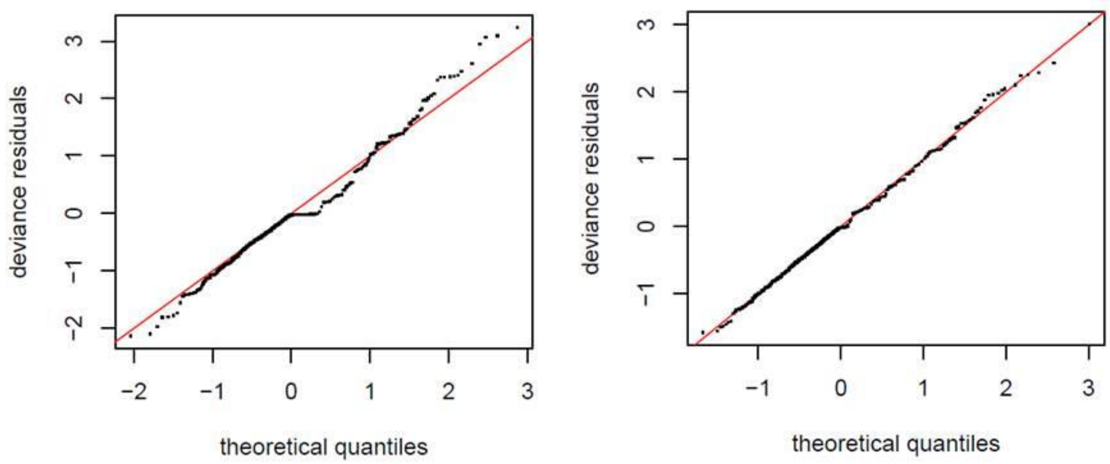


Figure 5.3: qqplot of deviance residuals for (a) Poisson GAM Model 4 and (b)same model but with NB GAM, for ground motion dataset

Second, in this analysis, we implicitly assume that conditional on the covariate values, the observations are independent. Since the observations are actually derived from spatial data, we check the reasonableness of that assumption by determining if there is spatial correlation in the residuals. If there is, that would suggest we should use a more complicated model that assumes spatially correlated residuals [(41)]. For each model, we used the package {ape} in *R* to compute the *Moran's I* for the residuals [(43)]. *Moran's I* is a commonly used measure of spatial autocorrelation. For each model, the *p*-value of the null hypothesis that there is no spatial autocorrelation is included in Table 5.1, showing in each case no evidence to suggest rejecting that hypothesis and moving to a more complicated model.

5.4 Relative Importance of Covariates

Refitting each model with the full set of data, we can examine how they compare in terms of the relative importance they assign to each concept in the framework—ground motion, exposure, vulnerability, and damage. For the BRTs, the {gbm} package provides a measure of the relative importance of each covariate. It is "based on the number of times a variable is selected for splitting, weighted by the squared improvement to the model as a result of each split, and averaged over all trees" [(34)]. It is then scaled so the contributions of all covariates sum to 100, with higher numbers indicating greater contributions. For each GLM and GAM, we estimated the relative importance of each covariate by computing the range of the response $\hat{\mu}$ over the observed range of the covariate, then normalizing those values so that the normalized values over all covariates sum to 100. For the same models in Table 5.1, Figure 5.4 shows the relative importance of each concept by model. It shows that ground motion and exposure are most important, with vulnerability covariates never exceeding a contribution of 14 out of 100, and damage not contributing to most models. For comparison, we included some models with only a ground motion covariate, but found that while it could estimate the total ignition count well, they did not capture the geographic distribution well. For example, a Poisson GAM with only the covariate x_{ii} had $TE = -0.2$ but the average absolute value of the prefecture error was $E[|TE_P|] = 4.2$ with much higher errors for Tokyo, for example, which experienced relatively low ground motion intensity but has almost twice the exposure as the next largest prefecture. Comparing Models 4 and 6 (Poisson GAMs without and with x_{pwood} included) suggests that included the vulnerability covariate x_{pwood} can reduce prefecture errors from $E[|TE_P|] = 2.5$ to 2.1. Looking at the smooth for x_{pwood} in Model 6, however, shows that it is not monotonically increasing, but rather "wiggles" up and down, which has no ready interpretation and may indicate overfitting. The results also show that the NB GLM assigns a much higher contribution to ground motion than exposure, whereas the reverse is true for the GAMs and BRTs. This is likely related to the inability of the NB GLM to capture the nonlinearity in the ground motion intensity.

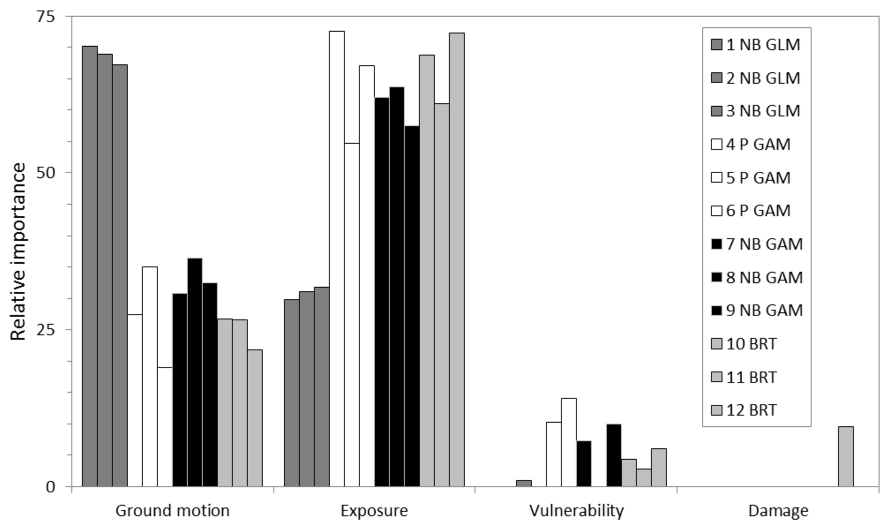


Figure 5.4: Relative contribution of variable representing each concept by model type and number, for ground motion dataset

5.5 Recommended Models

The results show that the best specific model depends to some extent on what one considers the most important criteria. No one model is best across all metrics and the models differ in ease of use as well. While all model types are intended to be used in a predictive mode, it is more straightforward for GLMs which result in a closed form expression than GAMs or BRTs which do not. Some specific models also require data for more covariates or for covariates that are more difficult to measure consistently (e.g., percentage of buildings damaged). Nevertheless, taken together, the results suggest that a GAM provides the best predictive power and Model 4 would be a reasonable choice. It achieves low predictive errors (0.3 in the total number of ignitions and an average of 2.5 for each prefecture). It is a relatively simple model with just two covariates, and the smooths for Model 4 (Fig. 5.1) make sense intuitively, with larger values of ground motion intensity and exposure leading monotonically to higher ignition rates. Model 4 would be straightforward to implement in that it requires data for only two covariates that are relatively easy to find. If one required the closed form equation provided by a NB GLM, Model 1 would be a reasonable choice, with final form as given in Equation 12.

$$ln(\mu_i) = -10.075 + 0.874x_{ii} + 0.066x_{ii}\ln(x_{com}) \tag{12}$$

While the dataset enjoys several strengths (Chapter 1), it is important to remember that it comes entirely from a single earthquake in Japan and thus may not be applicable in other countries and may not capture features associated with the time of occurrence (day of the year or time of the day), which is thought to affect the occurrence of post-earthquake ignitions[11] .

5.6 Future Application of Models

The selected model can be used to compute the expected number of ignitions $\hat{\mu}_i$ for each area unit i, and those $\hat{\mu}_i$ can then be used for prediction for a specified past or hypothetical earthquake scenario. To obtain the expected number of ignitions for the total area or a specified prefecture, one can just sum the expected number of area unit ignitions $\hat{\mu}_i$ as we did in this study (Eqs. 10-11). Maps displaying the prediction total and predictions errors using Model 4 are shown in Figure 5.5, respectively.

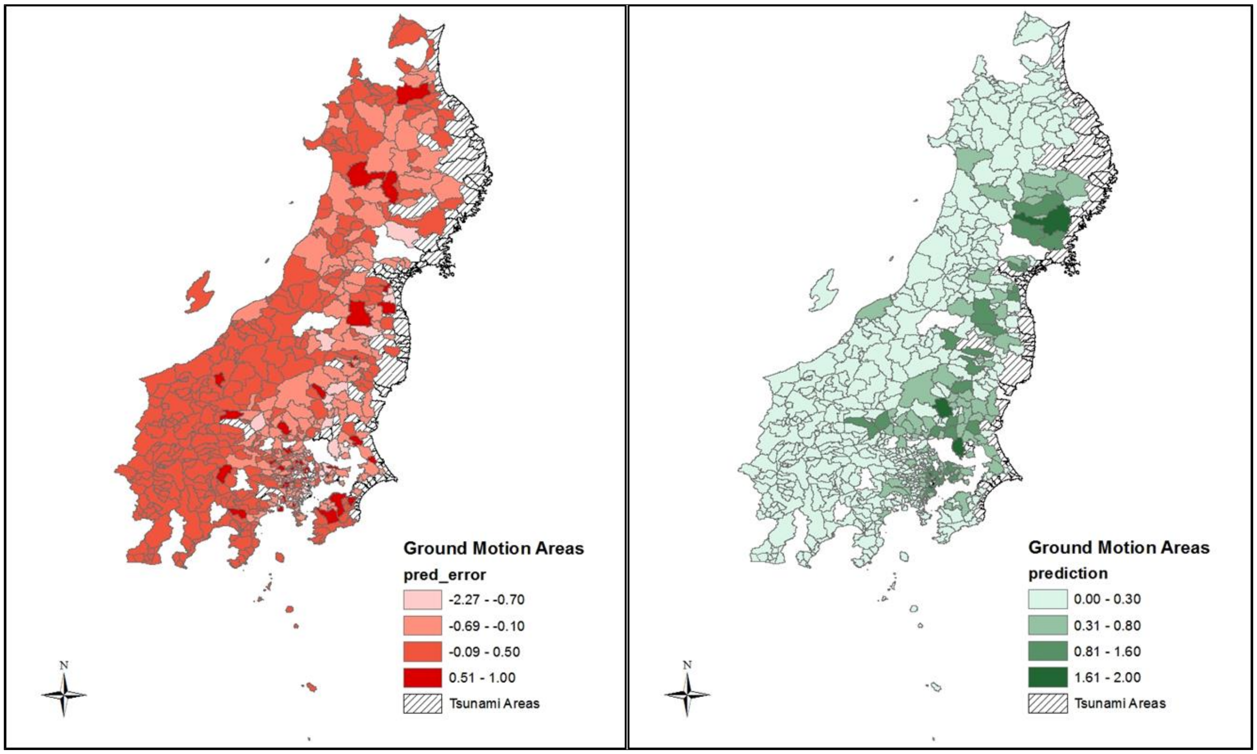


Figure 5.5: Prediction errors and predictions by municipality/Ku area unit using Model 4, for ground motion dataset

One can also use the Poisson or Negative Binomial distribution with those estimated parameters to simulate many (say, a thousand) realizations of ignition maps, each of which can be used as input for fire spread models to estimate damage and losses. Summing the ignitions in each map allows one to make a histogram of total number of ignitions, providing a description of the variability around the expected total regional and prefecture ignition counts. Figure 5.6 shows an example of two such histograms developed for Models 5 and 9 using the out-of-sample predictions for the Tōhoku earthquake (and common random numbers to reduce sampling variability when comparing models). Note that while both are centered on the mean of 147 ignitions (the observed value), there is still a great deal of variability around that expected value, so any one of the thousand realizations of ignition maps from the simulation may have many fewer or more than 147. Note also that, as expected, the assumption of a NB distribution results in a larger variability than Poisson (Equation 3). This is consistent with the R^2_{dev} and R^2_{α} values

(Table 6.1), which suggest that while a large proportion of the variation in the true Poisson means are explained by the models (high R_{α}^2 values), a much smaller proportion of the variation in the raw ignition counts y_i are (lower R_{dev}^2 values).

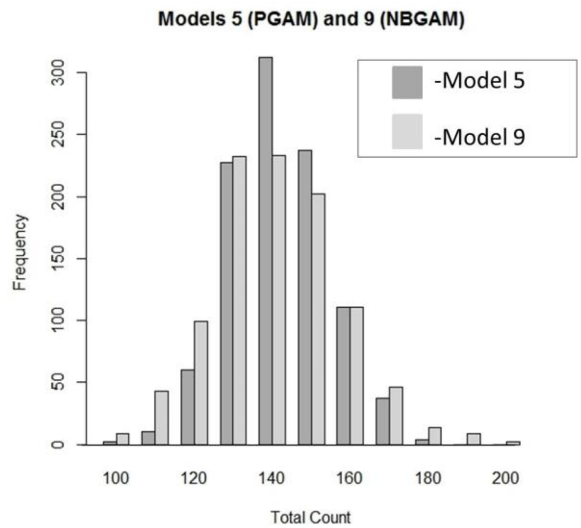


Figure 5.6: Histograms of total number of ignitions simulated using out-of-sample predictions from Models 5 (Poisson GAM) and 9 (NB GAM), for ground motion dataset

Chapter 6

TSUNAMI RESULTS

For the tsunami dataset, the preliminary GLM and GAM analyses suggested that x_{pga}, x_{pgv}, and x_{ii} were candidates for best ground motion covariate. Both $ln(x_{area})$ and x_{depth} were potentially useful covariates. For exposure, $ln(x_{estab})$ again appeared to give the best fits, although the for GAMs, the superiority was less pronounced than for the ground motion dataset, so $ln(x_{pop})$ was tried as well. The preference for commercial covariates was likely due to the fact that a few area units had no residential zoning and very small population. Of the damage and vulnerability covariates, only x_{pdam3} appeared likely to improve the fit substantially and was considered in the CV analysis.

Table 6.1 compares some of the most promising models of each model type for the tsunami-generated ignition data.

Table 6.1: Summary comparison of selected most promising models of each model type, for tsunami dataset

	Model	Root mean squared error RMSE	Mean absolute error MAE	Mean error ME	Total error TE	Total error %	Average of total absolute prefecture errors E[|Tep|]	alpha	R2 alpha	R2 dev	UBRE /GCV	AIC	Moran's I p-value	Formula
1	NB GLM	3.11	1.81	-0.02	-1.4	-1%	3.5	1.08	0.62	0.44	---	199	0.54	xpga + lxarea
2	NB GLM	3.11	1.82	0.00	-0.2	0%	3.5	1.04	0.63	0.45	---	200	0.63	xpga + lxarea + xdepth
3	NB GLM	2.99	1.72	0.02	1.3	1%	3.7	0.92	0.67	0.47	---	200	0.55	xpga + lxarea + xdepth + lxestab
4	NB GLM	3.04	1.77	0.01	0.5	0%	3.8	1.02	0.64	0.44	---	200	0.53	xpga + lxarea + lxestab
5	P GAM	3.72	2.03	-0.11	-7.1	-6%	9.6	---	---	0.47	1.691	248	0.53	s(lxarea) + s(lxestab)
6	P GAM	3.76	2.02	-0.16	-10.5	-9%	10.1	---	---	0.53	1.500	235	0.62	s(lxarea) + s(lxpop)
7	NB GAM	3.38	1.91	0.01	0.7	1%	7.8	1.11	0.61	0.43	0.115	199	0.86	s(lxarea) + s(lxestab)
8	NB GAM	3.92	1.96	-0.03	-2.0	-2%	3.3	0.98	0.65	0.46	0.110	196	0.56	s(xpga) + s(lxarea)
9	NB GAM	3.85	1.92	0.01	0.9	1%	3.8	0.90	0.68	0.47	0.192	197	0.54	s(xpga) + s(lxarea) + s(lxestab)
10	NB GAM	3.23	1.87	0.09	5.5	5%	4.9	0.83	0.71	0.48	0.234	197	0.56	s(xpga) + s(lxarea) + s(lxpop)
11	BRT	3.46	1.82	0.24	15.1	12.6%	6.4	---	---	0.78	---	---	---	xpgv + lxarea + xdepth+ lxestab + xpdam3 + lxdam1
12	BRT	3.32	1.76	0.27	17.1	14.4%	6.1	---	---	0.79	---	---	---	xpga + lxarea + xdepth + lxestab + xpdam3 + lxdam1

Notes: For all smooths shown, k=5. For all BRTs shown, tc=3, lr=0.001, and nt=15,000. Observed total number of ignitions=119. Five leftmost columns computed in cross validation. Six right most columns computed based on fitting model with the full dataset. R2dev for Poisson and NB models are not directly comparable.

Again, while the BRT average prediction errors ($RMSE$ and MAE) are comparably small, they are biased low compared to the other model types with $ME > 0.2$. In terms of error in the predicted total number of ignitions for the region, again, the BRTs are the worst, underestimating the total number of 119 by at least 15 ignitions (12%). Interestingly, while Poisson GAMs had excellent predictive power for the ground motion models, they perform relatively poorly for tsunami models. The two P GAMs shown in Table 6.1 are the best of the thirteen included in the CV analysis, and they still overestimate the total number of ignitions by 7.1 and 10.5 ignitions, and have the highest prefecture-level errors (see $E[|TE_p|]$). Quantile-quantile plots of deviance residuals as seen in Figure 6.1 provide information on the appropriateness of the models to the assumed distribution. Comparing NB GLMs and NB GAMs suggest comparable performance in terms of predictive power, so the simpler NB GLMs are preferred. For all model types, the Moran's I values do not provide evidence for spatial correlation in the residuals for any models.

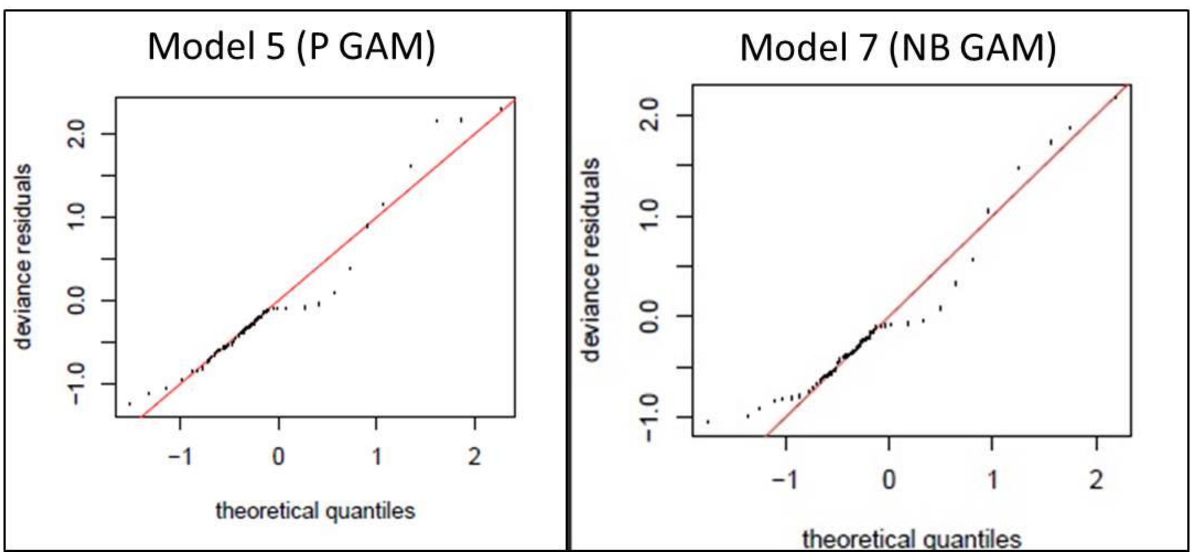


Figure 6.1: qqplot of deviance residuals for (a) Poisson GAM Model 5 and (b)same model but with NB GAM, tsunami motion dataset

Figure 6.2, which shows the errors in prefecture-level ignition counts, TE_p, indicates that as with the ground motion models, the tsunami models underestimate the number of ignitions in Miyagi and Iwate prefectures, and overestimate the number in Fukushima. This suggests the errors are not due misidentifying some ignitions as tsunami- vs. ground motion-generated, but rather that there may be additional covariates that are important for determining the number of ignitions that are not captured in these models. Some ignitions in Fukushima also may not have been reported because many in that area evacuated due to the nuclear power plant threat. BRTs again tend to underestimate more than overestimate prefecture-level ignition totals.

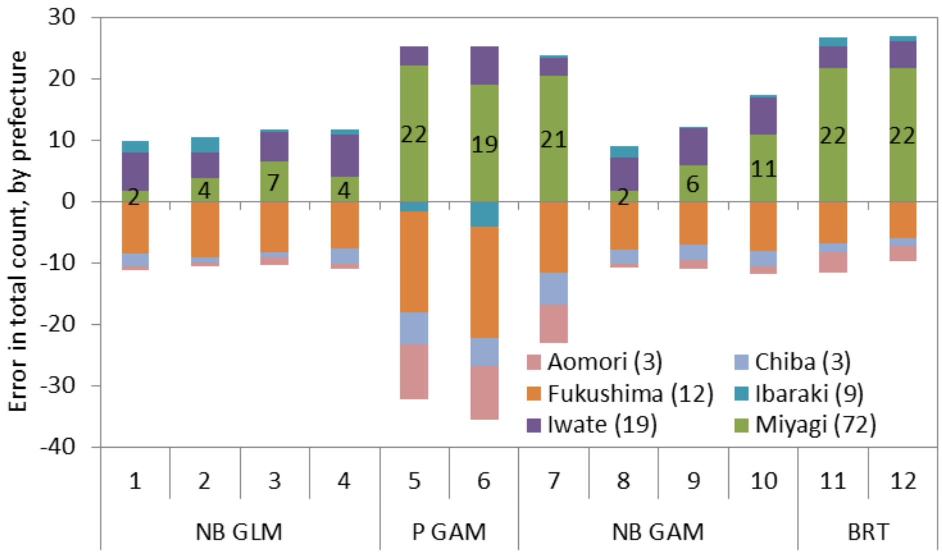


Figure 6.2: Errors in total number of ignitions TE_p (observed-predicted) by prefecture and model, for tsunami dataset. Labeled column layers are for Miyagi prefecture. Each prefecture name includes the total number of observed tsunami-ignitions

Finally, Figure 6.3 shows the relative importance of the concepts in each model. In the best model types (NB GLMs and NB GAMs), inundation covariates are most important; followed by ground motion covariates, which are about half as important; then exposure. This is in contrast to the ground motion models, in which exposure was the most importance concept (Fig. 5.5).

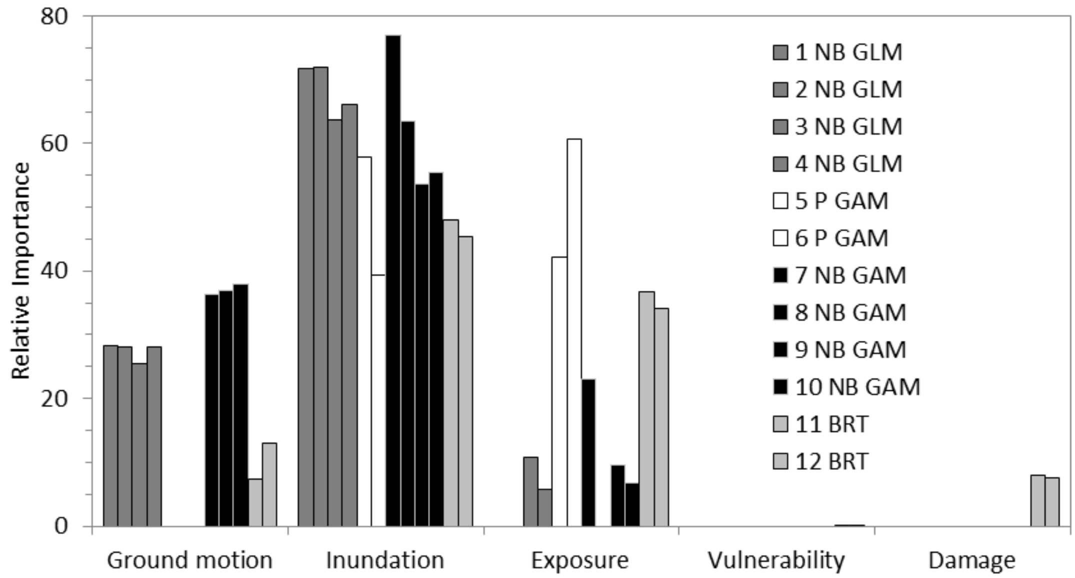


Figure 6.3: Relative contribution of variable representing each concept by model type and number, for tsunami dataset

Again, more than one model is promising depending on the relative importance afforded the different criteria. Nevertheless, Model 1 could be one reasonable choice, offering a relatively simple model- a NB GLM with just two covariates (x_{pga} and $\ln(x_{area})$), and relatively small predictive errors (Eq. 9).

$$ln(\mu_i) = -11.556 + 1.680x_{pga} + 0.726\ln(x_{area}) \qquad (13)$$

Chapter 7

CONCLUSIONS

In this thesis, we developed new ignition models using data from the Tōhoku earthquake and tsunami. We compared three different model types (GLMs, GAMs, and BRTs) for two datasets (ground motion- and tsunami-generated ignitions). Results of a cross validation analysis show all models demonstrate predictive power far superior to those that were tested from the literature. In general, the BRTs result in small mean errors, but are not as good as the other model types in predicting the total number of ignitions for the region. For the ground motion dataset, a GAM is recommended; for the tsunami dataset, a NB GLM or NB GAM is preferred. Out-of-sample predictions by the best models predicted the total number of ignitions in the region within one or two. At the prefecture level, however, errors were greater (approximately three on average), underpredicting the number in Miyagi and Iwate prefectures in both cases, overpredicting in Tochigi for the ground motion dataset and Fukushima for the tsunami dataset. The analysis suggests exposure then ground motion had the greatest contributions in the ground motion ignition models; and inundation, then ground motion in the tsunami ignition models. A nonlinear relationship was apparent between ignitions and ground motion, so for GLMs, which assume a linear response-covariate relationship, instrumental intensity was preferred over other possible ground motion covariates because it captures part of that nonlinearity. Measures of commercial exposure were preferred over measures of residential exposure for both ground motion and tsunami ignition models. This may vary in other study regions, but does highlight the value of testing alternative measures for each concept. The models with the best predictive power included two or three covariates. Those with just one were not able to capture as much variability; those with more did not improve the predictive ability and in some cases overfit the data.

Though the proposed models are able to capture a great deal of the variability in the mean number of ignitions per municipality/ku, it is important to remember that substantial Poisson (or NB) variability remains in predicting the specific ignition map that will occur for a given earthquake or tsunami. Further, while the datasets enjoy several strengths (Section 1), it is important to remember that they come entirely from a single earthquake in Japan and thus may not be applicable in other countries and may not capture features associated with the time of occurrence (day of the year or time of the day), which is thought to affect the occurrence of post-earthquake ignitions.(11)

Finally, the analysis suggests a few notes about the process. In any statistical analysis like this, it is important to make sure that the proposed model makes sense given what is known about the phenomenon—post-earthquake ignitions in this case. Thus, the conceptual framework is a useful tool for guiding the choice of covariates and ensuring that the contribution of each is reasonable in terms of parameter sign for GLMs or smooth shape for GAMs. In particular, although GAMs provide an excellent option, care must be taken to ensure the smooths are not overfitted. The analysis also shows the value of comparing models across multiple criteria—total region and prefecture-level predictive error, ease of application and use, and goodness-of-fit to the sample data. No single model performs best across all, and thus the choice will depend on the intended use.

REFERENCES

1. Lee S, Davidson R, Ohnishi N, Scawthorn C. Fire following earthquake—Reviewing the state-of-the-art of modeling. Earthquake Spectra, 2008; 24(4):1-35.

2. Mohammadi J, Alyasin S, Bak D. Investigation of Cause and Effects of Fires Following the Loma Prieta Earthquake. Chicago, IL: Illinois Institute of Technology Civil Engineering, IIT-CE-92-01, 1992.

3. Williamson R, Groner N. Ignition of Fires Following Earthquakes Associated with Natural Gas and Electric Distribution Systems. Berkeley, CA: Pacific Earthquake Engineering Research Center Report, University of California, 2000.

4. Zolfaghari MR, Peyghaleh E, Nasirzadeh G. Fire following earthquake, infrastructure ignition modeling, Journal of Fire Sciences, 2009; 27:45–79.

5. Yildiz S, Karaman H. Post-earthquake ignition vulnerability assessment of Küçükçekmece District. Natural Hazards and Earth System Sciences, 2013; 13:3357–3368.

6. Kawasumi H. Examination of Earthquake-Fire Damage in Tokyo Metropolis, Technical Report. Tokyo, Japan: Tokyo Fire Department, 1961.

7. Trifunac MD, Todorovaska MI. The Northridge, California, Earthquake of 1994: Fire ignition by strong shaking. Soil Dynamics and Earthquake Engineering, 1998; 17:165–175.

8. Architectural Institute of Japan (AIJ). Report on the Hanshin-Awaji Earthquake Disaster, Vol.6. Maruzen Publishing, 1998 (in Japanese).

9. Himoto K, Yamada M, Nishino T. Analysis of ignitions following the 2011 Tohoku earthquake using Kawasumi model. In: Proceedings of the 11th International Symposium on Fire Safety Science; 2014 February 10-14; Christchurch, New Zealand. Available at: www.iafss.org/publications/fss/11/24

10. Ren, A, Xie X. The simulation of post-earthquake fire-prone area based on GIS. Journal of Fire Sciences, 2004; 22(5):421-439.

11. Scawthorn C, Eidinger J, Schiff A. Fire Following Earthquake, Technical Council on Lifeline Earthquake Engineering Monograph No. 26. Reston, VA: American Society of Civil Engineers, 2005.

12. Li J, Jiang J, Li M. Hazard analysis system of urban post-earthquake fire based in GIS. Acta Seismologica Sinica, 2001; 14(4):448-455.

13. Zhao S, Xiong L, Ren A. A spatial-temporal stochastic simulation of fire outbreaks following earthquake based on GIS. Journal of Fire Sciences, 2006; 24:313-339.

14. Cousins WJ, Smith W. Estimated losses due to post-earthquake fire in three New Zealand cities. In: Proceedings of the 2004 New Zealand Society of Earthquake Engineering (NZSEE) Technical Conference; 2004 March 19-21; Rotorua, New Zealand. NZSEE, paper 28.

15. Davidson R. Modeling post-earthquake fire ignitions using generalized linear (mixed) models. Journal of Infrastructure Systems, 2009; 15(4):351-360.

16. Murata A, Hokugo A. Questionnaires survey on fires after The Great East Japan Earthquake 2011—Part 1: Summary of questionnaires survey and the cause of the fire. Kasai, 2013; 63(1):1-6.

17. Baraldi A, Enders C. An introduction to modern missing data analyses. Journal of School Psychology, 2010; 48:5–37.

18. Tanaka T. Characteristics and problems of fires following the Great East Japan earthquake in March 2011. Fire Safety Journal, 2012; 54:197-202.

19. Wald D, Worden B, Quitoriano V, Pankow K. ShakeMap Manual: Technical Manual, Users' Guide, and Software Guide, version 1.0. Reston, VA: U.S. Geological Survey, 2006.

20. Geospatial Information Authority of Japan (GIAJ). Provision of Information on the 2011 off the Pacific Coast of Japan Earthquake, 1/25,000 scale inundation area, 2011. Available at: www.gsi.go.jp/kikaku/kikaku40014.html, Accessed on April 2012.

21. Japan Statistics Bureau, Ministry of Internal Affairs and Communications, 2009 and 2010. Available at: www.stat.go.jp/english/, Accessed on November 2013.

22. Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Housing and Land Survey, 2008. Available at: www.stat.go.jp/data/jyutaku/2008/, Accessed on January 2013.

23. Ministry of Land, Infrastructure, Transport and Tourism (MLIT). National Land Numerical Information download service, 2011. Available at: http://nlftp.mlit.go.jp/ksj-e/, Accessed on January 2013.

24. Fire and Disaster Management Agency (FDMA). 148th Report on the 2011 Off the Pacific Coast of Tohoku Earthquake, 2013. Available at: www.fdma.go.jp/bn/higaihou/pdf/jishin/148.pdf, Accessed on September 2013

25. R Core Team. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing, 2013, Available at: www.R-project.org.

26. Venables WN, Ripley BD. Modern Applied Statistics with S. 4th ed. New York, NY: Springer, 2002.

27. Wood S. Generalized Additive Models: An Introduction with R. Boca Raton, FL: Chapmen & Hall, 2006.

28. Ridgeway, G. with contributions from others (2013). gbm: Generalized Boosted Regression Models. R package version 2.1-0.3. http://code.google.com/p/gradientboostedmodels/

29. Ridgeway, G. 2012. Generalized Boosted Models: A Guide to the gbm Package. R Package Vignette, http://CRAN.R-project.org/package=gbm.

30. McCullagh P, Nelder J. Generalized Linear Models, 2nd ed. London, U.K.: Chapman & Hall, 1989.

31. Cameron A, Trivedi P. Regression Analysis of Count Data. Cambridge, U.K.: Cambridge University, 1998.

32. Elith J, Graham CH, Anderson RP, et al. Novel methods improve prediction of species' distributions from occurrence data. Ecography, 2006; 29:129–151.

33. Elith J, Leathwick J, Hastie T. A working guide to boosted regression trees. Journal of Animal Ecology, 2008; 77:802–813.

34. Hastie T, Tibshirani R, Friedman JH. The Elements of Statistical Learning: Data Mining, Inference, and Prediction. New York, NY: Springer-Verlag, 2001.

35. Breiman L, Friedman JH, Olshen RA, Stone CJ. Classification and Regression Trees. Belmont, CA: Wadsworth International Group, 1984.

36. Friedman JH. Stochastic gradient boosting. Computational Statistics and Data Analysis, 2002; 38:367–378.

37. Cameron A, Windmeijer F. R-squared measures for count data regression models with applications to health-care utilization. Journal of Business and Economic Statistics, 1996; 14(2):209–220.

38. Akaike H. A new look at statistical model identification. IEEE Transactions on Automatic Control, 1974; AU-19:716–722.

39. Wald DJ, Quitoriano V, Heaton TH, Kanamori H. Relationship between Peak Ground Acceleration, Peak Ground Velocity, and Modified Mercalli Intensity for earthquakes in California, Earthquake Spectra, 1999; (15)3:557-564.

40. Liu H, Davidson R, Apanasovich T. Spatial generalized linear mixed models of electric power outages due to hurricanes and ice storms. Reliability Engineering and System Safety, 2008; 93(6):897-912.

41. Paradis E, Claude J, Strimmer K. APE: analyses of phylogenetics and evolution in R language. Bioinformatics, 2004; 20:289-290.

Appendix A

GROUND MOTION FULL DATASET

Table A.1: Full Data set, ground motion

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
13361	Shizuoka	Izu_Islands	None	0	0.07	0.03	0.01	4	0.03	1.84	15877	806.25	1343	0	0	0	2656.173
20201	Nagano	Nagano	None	0	0.13	0.05	0.03	8.33	0.03	4.44	381511	45422.76	21926	4434.13	11246.49	0.37	167635.9334
20218	Nagano	Chikuma	None	0	0.08	0.06	0.03	6	0.03	4.23	62068	11030.31	3195	1357.36	2274.12	0.31	27272.6792
20220	Nagano	Azumino	None	0	0.07	0.03	0.03	6.8	0.03	3.98	96479	5934.13	4024	456.17	1926.98	0.4	42392.8726
20382	Nagano	Tatsuno	None	0	0.07	0.06	0.03	6	0.03	3.9	20909	3082.74	1063	201.15	921.51	0.24	9187.4146
20409	Nagano	Hiraya	None	0	0.08	0.04	0.02	6	0.03	4.2	563	0	64	0	0	0	247.3822
20410	Nagano	Neba	None	0	0.07	0.04	0.02	7	0.03	3.9	1129	0	93	0	0	0	496.0826
20413	Nagano	Tenryu	None	0	0.06	0.04	0.02	7	0.03	4	1657	0	134	0	0	0	728.0858
20425	Nagano	Kiso_Village	None	0	0.04	0.04	0.02	5	0.03	3.8	3134	0	275	0	0	0	1377.0796
20429	Nagano	Otaki	None	0	0.09	0.06	0.03	6	0.03	4.4	965	0	123	0	0	0	424.021
20432	Nagano	Kiso	None	0	0.08	0.04	0.03	5	0.03	4.1	12743	1647.6	1068	102.41	196.89	0	5599.2742
20451	Nagano	Asahi	None	0	0.04	0.04	0.02	5	0.03	4	4741	0	165	0	0	0	2083.1954
20583	Nagano	Shinano	None	0	0.05	0.07	0.04	9.33	0.03	4.2	9238	1430.49	628	201.2	566.63	0	4059.1772
22131	Shizuoka	Hamamatsu	Naka	0	0.04	0.04	0.03	6	0.03	3.8	238477	21036.04	14056	6196.65	3378.44	0.24	104786.7938
22132	Shizuoka	Hamamatsu	Higashi	0	0.06	0.04	0.03	7	0.03	4.2	126609	6978.84	6716	462.91	4729.47	0.35	55631.9946
22133	Shizuoka	Hamamatsu	Nishi	0	0.04	0.04	0.03	6	0.03	3.68	113654	9122.41	4436	1018.99	1685.78	0.39	49939.5676
22134	Shizuoka	Hamamatsu	Minami	0	0.08	0.04	0.04	7	0.03	4.1	102381	4727.78	4434	96.34	2215.23	0.37	44986.2114
22135	Shizuoka	Hamamatsu	Kita	0	0.03	0.03	0.03	5.33	0.03	3.4	94680	6700.02	4010	462.76	2615.74	0.45	41602.392
22136	Shizuoka	Hamamatsu	Hamakita	0	0.06	0.03	0.03	6.5	0.03	3.9	91108	6031.72	3985	314.33	1786.26	0.39	40032.8552

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
22214	Shizuoka	Fujieda	None	0	0.10	0.06	0.03	7.5	0.03	4.1	142151	14754.68	6603	1368.22	3612.85	0.35	62461.1494
22221	Shizuoka	Kosai	None	0	0.06	0.03	0.02	5	0.03	3.7	60107	6351.5	2621	591.76	3366.85	0.43	26411.0158
22224	Shizuoka	Kikugawa	None	0	0.05	0.07	0.03	7.2	0.03	4.1	47041	5498.75	1970	437.33	3462.13	0.47	20669.8154
15216	Niigata	Itoigawa	None	0	0.10	0.04	0.03	6.4	0.04	4.21	47702	5121.46	2825	596.54	4599.17	0.49	20960.2588
20202	Nagano	Matsumoto	None	0	0.09	0.06	0.03	5.67	0.04	4.22	243037	28953.26	14533	2749.25	8486.37	0.21	167635.9334
20210	Nagano	Komagane	None	0	0.09	0.06	0.04	7	0.04	4.52	33693	4681.45	2036	243.33	1029.82	0.38	14804.7042
20384	Nagano	Iijima	None	0	0.10	0.06	0.04	7	0.04	4.6	9902	1016.11	471	125.93	1027.18	0	4350.9388
20385	Nagano	Minamiminowa	None	0	0.06	0.06	0.03	7	0.04	4.3	14543	3447.45	653	103.55	507.21	0	6390.1942
20386	Nagano	Nakagawa	None	0	0.10	0.06	0.04	7	0.04	4.6	5074	680.14	223	127.47	169.95	0	2229.5156
20388	Nagano	Miyada	None	0	0.05	0.04	0.04	7	0.04	4.3	8974	1022.67	444	92.85	258.95	0	3943.1756
20402	Nagano	Matsukawa_machi	None	0	0.10	0.06	0.03	7	0.04	4.5	13676	1410.53	668	40.74	166.17	0	6009.2344
20403	Nagano	Takamori	None	0	0.10	0.06	0.04	7	0.04	4.4	13216	1185.71	574	93.38	566.28	0	5807.1104
20404	Nagano	Anan	None	0	0.08	0.04	0.02	7	0.04	4.4	5455	0	358	0	0	0	2396.927
20407	Nagano	Achi	None	0	0.08	0.04	0.03	6	0.04	4.43	7036	0	531	0	0	0	3091.6184
20411	Nagano	Shimojo	None	0	0.12	0.04	0.02	6	0.04	4.7	4200	0	209	0	0	0	1845.48
20412	Nagano	Urugi	None	0	0.07	0.04	0.02	7	0.04	4.05	656	0	79	0	0	0	288.2464
20415	Nagano	Takagi	None	0	0.06	0.04	0.03	6	0.04	4.4	6692	0	354	0	0	0	2940.4648
20416	Nagano	Toyooka	None	0	0.08	0.04	0.03	6	0.04	4.2	6819	0	270	0	0	0	2996.2686
20423	Nagano	Nagiso	None	0	0.08	0.04	0.02	6	0.04	4.4	4810	0	425	0	0	0	2113.514
20446	Nagano	Omi	None	0	0.08	0.04	0.02	5	0.04	4.3	2970	0	177	0	0	0	1305.018
20448	Nagano	Ikusaka	None	0	0.06	0.04	0.02	5	0.04	4.2	1953	0	133	0	0	0	858.1482
20450	Nagano	Yamagata	None	0	0.04	0.04	0.02	6	0.04	3.9	8425	0	354	0	0	0	3701.945
20481	Nagano	Ikeda	None	0	0.06	0.04	0.03	6	0.04	4.25	10329	0	521	0	0	0	4538.5626
20482	Nagano	Matsukawa	None	0	0.06	0.04	0.03	5.5	0.04	4.4	10093	0	433	0	0	0	4434.8642
20521	Nagano	Sakaki	None	0	0.10	0.06	0.03	6	0.04	4.48	15730	3609.82	815	89.23	1349.63	0.39	6911.762
22137	Shizuoka	Hamamatsu	Tenryu	0	0.08	0.03	0.02	6	0.04	3.65	33957	3042.54	1935	350.82	334.95	0.72	14920.7058
22212	Shizuoka	Yaizu	None	0	0.10	0.06	0.03	8	0.04	4.5	143249	12504.47	7193	1022.91	6309.83	0.39	62943.6106
22226	Shizuoka	Makinohara	None	0	0.07	0.10	0.03	8.67	0.04	4.3	49019	5290.52	2846	668.69	3010.56	0.52	21538.9486
22341	Shizuoka	Shimizu	None	0	0.10	0.08	0.04	12	0.04	4.7	32302	4070.12	1661	264.54	1011.08	0.34	14193.4988
22424	Shizuoka	Yoshida	None	0	0.10	0.10	0.04	11	0.04	4.6	29815	3601.16	1379	153.52	1586.62	0.4	13100.711
15213	Niigata	Tsubame	None	0	0.13	0.08	0.06	13	0.05	5.06	81876	9558.49	6384	1308.22	8047.94	0.43	35976.3144
15224	Niigata	Sado	None	0	0.10	0.05	0.03	9	0.05	4.58	62727	1731.04	4610	141.91	117.1	0.73	27562.2438
19201	Yamanashi	Kofu	None	0	0.15	0.14	0.04	11	0.05	4.93	198992	26944.65	12930	3614.58	3721.52	0.25	87437.0848

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
19209	Yamanashi	Hokuto	None	0	0.16	0.11	0.04	11.2	0.05	5.2	46968	0	2920	0	0	0.56	20637.7392
19365	Yamanashi	Minobu	None	0	0.12	0.10	0.03	11	0.05	4.78	14462	677.28	1029	177.47	0	0.68	6354.6028
20213	Nagano	Iiyama	None	0	0.09	0.06	0.03	8.8	0.05	4.3	23545	2632.99	1410	287.37	438.67	0.38	10345.673
20215	Nagano	Shiojiri	None	0	0.10	0.05	0.03	6.5	0.05	4.2	67670	5966.65	3239	297.03	3283.2	0.2	29734.198
20563	Nagano	Nozawaonsen	None	0	0.10	0.06	0.03	8	0.05	4.3	3853	0	526	0	0	0	1693.0082
22101	Shizuoka	Shizuoka	Aoi	0	0.10	0.10	0.04	8.4	0.05	4.37	255375	19462.31	15938	4094.98	3245.65	0.32	112211.775
22211	Shizuoka	Iwata	None	0	0.10	0.06	0.03	6.5	0.05	4.4	168625	16637.46	7543	1162.6	9591.88	0.39	74093.825
22223	Shizuoka	Omaezaki	None	0	0.10	0.06	0.04	7.5	0.05	4.3	34700	2357.08	1815	143.96	383.86	0.5	15247.18
22302	Shizuoka	Kawazu	None	0	0.10	0.06	0.03	8	0.05	4.29	7998	883.99	673	179.92	0	0	3514.3212
22304	Shizuoka	Minamiizu	None	0	0.10	0.06	0.03	8	0.05	4.3	9516	0	805	0	0	0	4181.3304
2202	Aomori	Hirosaki	None	0	0.16	0.09	0.06	14	0.06	5.22	183473	21182.7	9321	2285.79	3965.02	0.15	75960
5303	Akita	Kosaka	None	0	0.18	0.12	0.03	14.33	0.06	5.26	6054	1178.4	340	183.08	591.46	0	2660.1276
10425	Gumma	Tsumagoi	None	0	0.18	0.10	0.04	11	0.06	5.2	10183	0	732	0	0	0	4474.4102
14208	Kanagawa	Zushi	None	0	0.14	0.10	0.08	17	0.06	4.9	58302	6521.49	2001	547.17	21.77	0.22	25617.8988
14301	Kanagawa	Hayama	None	0	0.14	0.10	0.06	16	0.06	4.9	32766	4515.37	1082	69.83	0	0.36	14397.3804
14384	Kanagawa	Yugawara	None	0	0.14	0.10	0.06	12	0.06	5.3	26848	2418.44	1487	1576.57	22.49	0.19	11797.0112
15208	Niigata	Ojiya	None	0	0.12	0.05	0.04	13	0.06	4.6	38600	5058.18	2080	450.73	2322.59	0.32	16960.84
15209	Niigata	Kamo	None	0	0.16	0.08	0.04	12.33	0.06	5.03	29762	4032.06	1668	341.9	1648.99	0.51	13077.4228
15217	Niigata	Myoko	None	0	0.07	0.06	0.03	9.2	0.06	4.31	35457	4004.13	2140	423.92	1202.92	0.38	15579.8058
15222	Niigata	Joetsu	None	0	0.14	0.08	0.03	11	0.06	4.84	203899	30459.44	10994	3140.99	16318.01	0.35	89593.2206
15342	Niigata	Yahiko	None	0	0.13	0.10	0.04	12	0.06	4.9	8582	444.24	458	102.68	272.08	0	3770.9308
15361	Niigata	Tagami	None	0	0.18	0.10	0.04	13	0.06	5.1	12791	1653.56	514	0	503.82	0	5620.3654
15482	Niigata	Tsunan	None	1	0.16	0.08	0.04	11	0.06	5.18	10881	0	622	0	0	0	4781.1114
19202	Yamanashi	Fujiyoshida	None	0	0.16	0.10	0.06	12	0.06	5.1	50619	11778.15	3791	696.97	2049.4	0.24	22241.9886
19204	Yamanashi	Tsuru	None	0	0.14	0.06	0.04	11.5	0.06	5	33588	4280.33	2382	232.38	942.32	0.33	14758.5672
19205	Yamanashi	Yamanashi	None	1	0.18	0.17	0.04	11	0.06	5.28	36832	2995.53	1675	267.56	108.64	0.49	16183.9808
19207	Yamanashi	Nirasaki	None	0	0.14	0.08	0.04	10	0.06	5	32477	2685.55	1521	414.95	158.55	0.36	14270.3938
19208	Yamanashi	Minami_Alps	None	0	0.13	0.10	0.04	11	0.06	4.76	72635	3624.47	3084	317.06	1047.29	0.32	31915.819
19210	Yamanashi	Kai	None	0	0.14	0.12	0.04	11	0.06	5	73807	13365.21	3105	140.41	1465.85	0.32	32430.7958

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
19211	Yamanashi	Fuefuki	None	0	0.18	0.14	0.04	12.67	0.06	5.34	70529	1338.32	3401	999.49	0	0.39	30990.4426
19214	Yamanashi	Chuo	None	0	0.16	0.13	0.04	12	0.06	5.1	31322	5164.34	1557	58.54	1256.03	0.34	13762.8868
19364	Yamanashi	Hayakawa	None	0	0.14	0.06	0.03	7.2	0.06	4.55	1246	0	114	0	0	0	547.4924
19366	Yamanashi	Nanbu	None	0	0.10	0.05	0.03	9	0.06	4.5	9011	0	546	0	0	0	3959.4334
19368	Yamanashi	Fujikawa	None	0	0.14	0.10	0.04	12	0.06	5.02	16307	2075.14	837	311.99	104.13	0	7165.2958
19424	Yamanashi	Oshino	None	0	0.14	0.10	0.04	12	0.06	4.9	8635	0	452	0	0	0	3794.219
19425	Yamanashi	Yamanakako	None	0	0.14	0.10	0.06	13	0.06	4.95	5324	0	529	0	0	0	2339.3656
19429	Yamanashi	Narusawa	None	0	0.19	0.10	0.04	11	0.06	5.1	2964	0	187	0	0	0	1302.3816
19430	Yamanashi	Fujikawaguchiko	None	0	0.17	0.11	0.04	11.2	0.06	5.08	25471	3896.75	1835	1049.62	242.84	0.23	11191.9574
20203	Nagano	Ueda	None	0	0.15	0.08	0.03	9	0.06	4.95	159597	10539.52	8551	1988.13	3550.03	0.29	70126.9218
20204	Nagano	Okaya	None	0	0.14	0.10	0.03	10	0.06	4.7	52841	8241.68	3099	727.22	3368.36	0.2	23218.3354
20205	Nagano	Iida	None	0	0.11	0.07	0.03	7.33	0.06	4.44	105335	9672.61	7095	1946.36	3919.05	0.44	46284.199
20206	Nagano	Suwa	None	0	0.14	0.12	0.06	12	0.06	4.9	51200	9164.9	3798	647.54	3975.28	0.19	22497.28
20208	Nagano	Komoro	None	0	0.14	0.11	0.04	11.2	0.06	5	43997	4525.54	2314	546.1	1863.67	0.47	19332.2818
20209	Nagano	Ina	None	0	0.12	0.07	0.03	8	0.06	4.62	71093	7764.93	3798	657.78	1108.17	0.41	31238.2642
20211	Nagano	Nakano	None	0	0.09	0.06	0.03	8	0.06	4.46	45638	2622.93	2355	301.86	492.27	0.39	20053.3372
20212	Nagano	Omachi	None	0	0.10	0.05	0.03	6	0.06	4.43	29801	6288.87	1751	201.38	1817.55	0.49	13094.5594
20214	Nagano	Chino	None	0	0.16	0.10	0.04	9	0.06	5	56391	6736.71	3014	630.17	2414.75	0.38	24778.2054
20219	Nagano	Tomi	None	0	0.16	0.08	0.03	9.33	0.06	5.1	30696	4736.48	1464	211.37	1668.43	0.3	13487.8224
20303	Nagano	Koumi	None	0	0.14	0.06	0.03	8	0.06	5	5180	0	368	0	0	0	2276.092
20304	Nagano	Kawakami	None	0	0.18	0.10	0.03	10	0.06	5.2	4972	0	225	0	0	0	2184.6968
20306	Nagano	Minamiaiki	None	0	0.16	0.08	0.03	9	0.06	5.2	1121	0	76	0	0	0	492.5674
20309	Nagano	Sakuho	None	0	0.12	0.06	0.03	8	0.06	5	12069	0	623	0	0	0	5303.1186
20323	Nagano	Miyota	None	0	0.18	0.10	0.04	11	0.06	5.2	14738	6580.26	569	57.22	689.6	0	6475.8772
20324	Nagano	Tateshina	None	0	0.14	0.06	0.03	8	0.06	4.8	7707	0	469	0	0	0	3386.4558
20349	Nagano	Aoki	None	0	0.16	0.06	0.03	7	0.06	5	4609	0	220	0	0	0	2025.1946
20350	Nagano	Nagawa	None	0	0.14	0.06	0.03	8	0.06	4.88	6780	0	456	0	0	0	2979.132
20362	Nagano	Fujimi	None	0	0.17	0.10	0.04	10	0.06	4.96	15338	3545.01	777	148.28	1087.56	0.48	6739.5172
20363	Nagano	Hara	None	0	0.16	0.08	0.04	9	0.06	5	7573	0	476	0	0	0	3327.5762
20383	Nagano	Minowa	None	0	0.10	0.06	0.03	7	0.06	4.6	26214	2255.49	1234	188.17	1248.84	0.18	11518.4316
20414	Nagano	Yasuoka	None	0	0.12	0.06	0.02	7	0.06	4.5	1910	0	112	0	0	0	839.254
20417	Nagano	Oshika	None	0	0.10	0.06	0.03	7	0.06	4.4	1160	0	113	0	0	0	509.704
20422	Nagano	Agematsu	None	0	0.10	0.06	0.03	7	0.06	4.54	5245	1000.44	385	121.29	397.79	0	2304.653
20452	Nagano	Chikuhoku	None	0	0.12	0.06	0.03	6	0.06	4.6	5172	0	242	0	0	0	2272.5768
20485	Nagano	Hakuba	None	0	0.10	0.06	0.04	6.67	0.06	4.5	9205	0	1372	0	0	0	4044.677
20486	Nagano	Otari	None	0	0.12	0.06	0.03	6.67	0.06	4.87	3221	0	391	0	0	0	1415.3074
20541	Nagano	Obuse	None	0	0.14	0.06	0.03	9	0.06	4.9	11072	1360.68	542	126.62	131.58	0	4865.0368
20543	Nagano	Takayama	None	0	0.18	0.06	0.03	9	0.06	5.2	7563	0	349	0	0	0	3323.1822
20561	Nagano	Yamanouchi	None	0	0.17	0.06	0.03	8	0.06	5.1	13678	1447.75	1003	655.51	0	0	6010.1132

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
20562	Nagano	Kijimadaira	None	0	0.17	0.06	0.03	9.33	0.06	4.9	4939	0	286	0	0	0	2170.1966
20588	Nagano	Ogawa	None	0	0.12	0.06	0.03	7	0.06	4.8	3041	0	168	0	0	0	1336.2154
20590	Nagano	Iizuna	None	0	0.14	0.07	0.04	9.33	0.06	4.7	11865	0	484	0	0	0	5213.481
22102	Shizuoka	Shizuoka	Suruga	0	0.10	0.10	0.03	8.8	0.06	4.5	213059	21036.14	10897	2135.71	8193.19	0.26	93618.1246
22103	Shizuoka	Shizuoka	Shimizu	0	0.14	0.16	0.03	11.75	0.06	5	247763	23377.85	12767	2873.02	11782.33	0.25	108867.0622
22203	Shizuoka	Numazu	None	0	0.16	0.08	0.03	10	0.06	5.06	202304	22091.23	11971	2960.89	6421.09	0.27	88892.3776
22205	Shizuoka	Atami	None	0	0.14	0.08	0.03	10.5	0.06	5.13	39611	10580.29	3238	1677.9	0	0.28	17405.0734
22206	Shizuoka	Mishima	None	0	0.10	0.11	0.06	12.4	0.06	4.8	111838	10493.89	5790	1449.13	1765.24	0.19	49141.6172
22208	Shizuoka	Ito	None	0	0.16	0.08	0.03	9	0.06	4.8	71437	4737.39	5019	1909.17	58.63	0.31	31389.4178
22210	Shizuoka	Fuji	None	0	0.18	0.10	0.04	13	0.06	5.04	254027	37359.89	12939	3186.62	18248.14	0.28	111619.4638
22215	Shizuoka	Gotemba	None	1	0.14	0.14	0.14	20	0.06	5.3	89030	7274.6	3985	265.24	3513.85	0.34	39119.782
22219	Shizuoka	Shimoda	None	0	0.14	0.06	0.03	8	0.06	4.64	25013	2527.92	2398	552.18	79.38	0.52	10990.7122
22220	Shizuoka	Susono	None	0	0.14	0.10	0.08	14	0.06	4.89	54546	5532.56	2127	219.31	4469.52	0.35	23967.5124
22222	Shizuoka	Izu	None	0	0.11	0.06	0.03	8	0.06	4.47	34202	1518.98	2152	361.96	157.33	0.59	15028.3588
22225	Shizuoka	Izunokuni	None	0	0.12	0.06	0.03	10.5	0.06	4.53	49269	4617.82	2680	1059.71	307.17	0.45	21648.7986
22301	Shizuoka	Higashiizu	None	0	0.16	0.06	0.03	9	0.06	4.9	14064	0	989	0	0	0.47	6179.7216
22325	Shizuoka	Kannami	None	0	0.11	0.08	0.06	11.2	0.06	4.7	38571	3816.77	1503	132.63	312.75	0.37	16948.0974
22342	Shizuoka	Nagaizumi	None	0	0.12	0.10	0.04	12	0.06	4.88	40763	4542.42	1609	373.31	2736.79	0.01	17911.2622
22344	Shizuoka	Oyama	None	0	0.16	0.12	0.10	17	0.06	5.2	20629	4193.27	885	151.25	1070.57	0.37	9064.3826
2209	Aomori	Tsugaru	None	0	0.16	0.08	0.06	13.33	0.07	5.25	37243	1646.72	1449	151.73	183.95	0.25	12490
12223	Chiba	Kamogawa	None	0	0.16	0.12	0.07	18	0.07	5.36	35766	2940.04	2277	333.93	49.09	0.57	19320
14211	Kanagawa	Hadano	None	0	0.16	0.15	0.06	14.29	0.07	5.33	170145	17703.79	5323	857.82	4593.95	0.22	74761.713
15202	Niigata	Nagaoka	None	0	0.14	0.07	0.04	12.09	0.07	4.95	282674	25267.01	15554	4199.16	14428.68	0.35	18493.9066
15204	Niigata	Sanjo	None	0	0.16	0.09	0.06	12.29	0.07	5.27	102292	8621.11	6726	1689.34	3659.25	0.36	44947.1048
15206	Niigata	Shibata	None	0	0.19	0.10	0.04	13.6	0.07	5.31	101202	11225.84	4990	1889.51	2737.85	0.59	44468.1588
20217	Nagano	Saku	None	0	0.19	0.10	0.03	10.86	0.07	5.28	100552	9055.57	5261	1171.46	3751.42	0.37	44182.5488
20430	Nagano	Okuwa	None	0	0.13	0.07	0.03	7.33	0.07	4.77	4145	0	280	0	0	0	1821.313
2343	Aomori	Nishimeya	None	0	0.20	0.08	0.03	12.33	0.08	5.22	1594	0	99	0	0	0	700.4036
2362	Aomori	Owani	None	0	0.17	0.08	0.04	13	0.08	5.3	10978	1277.4	484	271.06	187.86	0	4823.7332

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
2423	Aomori	Oma	None	0	0.16	0.06	0.03	10	0.08	5.1	6340	0	393	0	0	0	2785.796
2425	Aomori	Kazamaura	None	0	0.20	0.10	0.04	12.5	0.08	5.38	2463	0	125	0	0	0	1082.2422
5206	Akita	Oga	None	0	0.22	0.12	0.04	14.67	0.08	5.6	32294	5255.27	1577	1031.98	802.08	0.49	14189.9836
5211	Akita	Katagami	None	0	0.20	0.11	0.04	14.29	0.08	5.51	34442	4683.36	1332	326.33	1093.12	0.22	15133.8148
5346	Akita	Fujisato	None	0	0.22	0.10	0.04	13	0.08	5.24	3848	0	208	0	0	0	1690.8112
5349	Akita	Happo	None	0	0.20	0.10	0.05	11.71	0.08	5.64	8220	0	397	0	0	0	3611.868
5368	Akita	Ogata	None	0	0.22	0.12	0.04	13	0.08	5.5	3218	0	155	0	0	0	1413.9892
7445	Fukushima	Kaneyama	None	0	0.25	0.10	0.04	12	0.08	5.6	2462	0	201	0	0	0	1081.8028
10421	Gumma	Nakanojo	None	0	0.16	0.11	0.03	10	0.08	5.24	18216	2203.67	1230	255.25	281.85	0.6	8004.1104
10426	Gumma	Kusatsu	None	0	0.16	0.10	0.04	9	0.08	5.3	7160	2133.07	752	446.74	48.71	0	3146.104
10428	Gumma	Takayama	None	0	0.16	0.10	0.03	10	0.08	5.2	3911	0	163	0	0	0	1718.4934
12205	Chiba	Tateyama	None	0	0.18	0.12	0.06	16.55	0.08	5.3	49290	6168.59	3213	552.72	462.64	0.48	25350
12218	Chiba	Katsuura	None	0	0.16	0.09	0.06	16.86	0.08	5.38	20788	4289.93	1387	475.05	167.08	0.51	14370
12234	Chiba	Minamiboso	None	0	0.16	0.16	0.07	19.25	0.08	5.32	42104	0	2588	0	0	0.54	19800
12443	Chiba	Onjuku	None	0	0.14	0.12	0.06	19.2	0.08	5.2	7738	3400.77	462	57.84	0	0	3400.0772
14201	Kanagawa	Yokosuka	None	0	0.20	0.12	0.06	17	0.08	5.5	418325	40885.77	14901	3370.42	6429.58	0.2	183812.005
14361	Kanagawa	Nakai	None	0	0.16	0.17	0.08	14.67	0.08	5.47	10010	897.74	509	0	1242.9	0	4398.394
14364	Kanagawa	Yamakita	None	0	0.16	0.14	0.08	14	0.08	5.24	11764	2509.68	539	94.59	834.54	0	5169.1016
15205	Niigata	Kashiwazaki	None	0	0.18	0.11	0.04	12.89	0.08	5.24	91451	7446.5	4879	1408.45	2435.84	0.27	40183.5694
15210	Niigata	Tokamachi	None	0	0.19	0.10	0.04	12.4	0.08	5.2	58911	3796.26	3804	480.45	2086.62	0.45	25885.4934
15212	Niigata	Murakami	None	0	0.21	0.08	0.05	12.2	0.08	5.37	66427	4221.52	3916	764.98	1010.52	0.62	29188.0238
15218	Niigata	Gosen	None	0	0.20	0.08	0.05	13.5	0.08	5.24	54550	5727.47	2715	609.15	1616.8	0.64	23969.27
15225	Niigata	Uonuma	None	0	0.20	0.08	0.04	12.29	0.08	5.33	40361	2817.16	2616	608.52	1317.58	0.37	17734.6234
15226	Niigata	Minamiuonuma	None	0	0.20	0.09	0.03	10.18	0.08	5.3	61624	4086.5	3935	862.23	1126.19	0.36	27077.5856
15227	Niigata	Tainai	None	0	0.20	0.10	0.04	13	0.08	5.4	31424	3301.85	1510	399.07	3942.1	0.61	13807.7056
15307	Niigata	Seiro	None	0	0.16	0.10	0.06	17	0.08	5.3	13724	1383.38	682	76.61	8376.07	0	6030.3256
15581	Niigata	Sekikawa	None	0	0.20	0.10	0.04	13.6	0.08	5.5	6438	0	413	0	0	0	2828.8572
19213	Yamanashi	Koshu	None	0	0.23	0.18	0.04	12	0.08	5.6	33927	2231.22	1749	179.82	0	0.27	14907.5238
19346	Yamanashi	Ichikawamisato	None	0	0.16	0.14	0.04	12.8	0.08	5.31	17111	1756.83	931	88.67	734.82	0.58	7518.5734

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
19384	Yamanashi	Showa	None	0	0.18	0.14	0.04	14	0.08	5.4	17653	3219.47	1408	320.58	1335.38	0.26	7756.7282
19422	Yamanashi	Doshi	None	0	0.16	0.06	0.06	13	0.08	5.2	1919	0	169	0	0	0	843.2086
19423	Yamanashi	Nishikatsura	None	0	0.18	0.08	0.04	11	0.08	5.2	4541	0	300	0	0	0	1995.3154
20207	Nagano	Suzaka	None	0	0.18	0.08	0.04	9.33	0.08	5.36	52168	6086.47	2818	558.79	2285.85	0.44	22922.6192
20305	Nagano	Minamimak	None	0	0.16	0.10	0.03	10	0.08	5.1	3528	0	181	0	0	0	1550.2032
20307	Nagano	Kitaaiki	None	0	0.16	0.06	0.03	9	0.08	5.2	842	0	47	0	0	0	369.9748
20361	Nagano	Shimosuwa	None	0	0.16	0.12	0.04	11	0.08	5.1	21532	3900.8	1310	488.32	1108.92	0.34	9461.1608
20602	Nagano	Sakae	None	0	0.18	0.06	0.04	10	0.08	5.2	2215	0	153	0	0	0	973.271
2210	Aomori	Hirakawa	None	0	0.20	0.08	0.04	14	0.09	5.26	33764	2546.57	1353	72.17	407.5	0.21	11050
2426	Aomori	Sai	None	0	0.16	0.09	0.03	11.14	0.09	5.06	2422	0	164	0	0	0	1064.2268
5204	Akita	Odate	None	0	0.24	0.13	0.04	15.44	0.09	5.54	78946	9872.77	4270	1580.59	1400.16	0.14	34688.8724
5213	Akita	Kitaakita	None	0	0.26	0.13	0.03	15.4	0.09	5.86	36387	2996.21	2132	474.42	313.56	0.29	15988.4478
7367	Fukushima	Tadami	None	0	0.27	0.10	0.04	12.67	0.09	5.81	4932	0	350	0	0	0	2167.1208
10208	Gumma	Shibukawa	None	0	0.22	0.15	0.04	13	0.09	5.6	83330	5890.05	4631	1421.48	3410.49	0.46	36615.202
10449	Gumma	Minakami	None	0	0.22	0.09	0.03	10.4	0.09	5.58	21345	1360.93	1418	226.06	399.58	0.46	9378.993
12441	Chiba	Otaki	None	0	0.25	0.15	0.06	19.56	0.09	6.04	10671	0	630	0	0	0	4688.8374
14110	Kanagawa	Yokohama	Totsuka	0	0.23	0.18	0.06	20	0.09	6.05	274324	18749.52	6242	626.44	3251.01	0.1	120537.9656
15101	Niigata	Niigata	None	0	0.20	0.11	0.05	16.75	0.09	5.51	811901	89453.9	38794	11177.54	29636.4	0.38	18493.9066
15223	Niigata	Agano	None	0	0.24	0.11	0.06	15	0.09	5.71	45560	4255.08	2260	310.79	1691.39	0.6	20019.064
15385	Niigata	Aga	None	0	0.23	0.15	0.08	13.38	0.09	5.64	13303	609.11	766	133.22	0	0	5845.3382
15461	Niigata	Yuzawa	None	0	0.22	0.06	0.03	10	0.09	5.31	8396	1382.44	930	819.19	143.63	0	3689.2024
2208	Aomori	Mutsu	None	0	0.24	0.10	0.03	12.94	0.1	5.53	61066	12010.65	3180	1066.67	2459.08	0.31	28320
2367	Aomori	Inakadate	None	0	0.24	0.12	0.04	17	0.1	5.8	8153	1067.11	285	54.09	299.28	0	3582.4282
5348	Akita	Mitane	None	0	0.22	0.13	0.06	14.5	0.1	5.6	18876	0	900	0	0	0.63	8294.1144
5361	Akita	Gojome	None	0	0.24	0.14	0.04	14.33	0.1	5.7	10516	2261.01	545	467.24	938.86	0	4620.7304
5366	Akita	Ikawa	None	0	0.22	0.12	0.04	14.5	0.1	5.73	5493	0	232	0	0	0	2413.6242
10210	Gumma	Tomioka	None	0	0.24	0.08	0.03	10	0.1	5.6	52070	3801.54	3255	429.53	591.63	0.4	22879.558
10211	Gumma	Annaka	None	0	0.22	0.12	0.03	12.75	0.1	5.64	61077	10706.79	2637	668.6	3132.32	0.41	26837.2338
10345	Gumma	Yoshioka	None	0	0.28	0.16	0.04	15	0.1	6.1	19801	741.52	684	36.51	128.45	0.11	8700.5594

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
10366	Gumma	Ueno	None	0	0.22	0.08	0.03	10	0.1	5.6	1306	0	129	0	0	0	573.8564
10382	Gumma	Shimonita	None	0	0.22	0.08	0.03	9.6	0.1	5.4	8911	0	653	0	0	0	3915.4934
10383	Gumma	Nanmoku	None	0	0.20	0.08	0.03	10	0.1	5.47	2423	0	148	0	0	0	1064.6662
10424	Gumma	Naganohara	None	0	0.20	0.10	0.04	10	0.1	5.6	6017	0	501	0	0	0	2643.8698
12422	Chiba	Mutsuzawa	None	0	0.28	0.18	0.06	21	0.1	6.3	7340	0	249	0	0	0	3225.196
12427	Chiba	Chonan	None	0	0.27	0.15	0.08	21.56	0.1	6	9073	0	368	0	0	0	3986.6762
12463	Chiba	Kyonan	None	0	0.20	0.20	0.06	21	0.1	5.7	8950	0	458	0	0	0	3932.63
13221	Tokyo	Kiyose	None	0	0.32	0.14	0.08	17	0.1	6	74104	8570.8	2016	343.27	570.66	0.07	32561.2976
13307	Tokyo	Hinohara	None	0	0.16	0.08	0.03	10	0.1	5.4	2558	0	183	0	0	0	1123.9852
13308	Tokyo	Okutama	None	0	0.22	0.06	0.03	10	0.1	5.4	6045	0	344	0	0	0	2656.173
14108	Kanagawa	Yokohama	Kanazawa	0	0.24	0.20	0.08	21	0.1	5.9	209274	16395.03	5915	1091	1709.16	0.11	91954.9956
14111	Kanagawa	Yokohama	Konan	1	0.24	0.20	0.06	21	0.1	6.2	221411	14969.41	6312	609.78	726.13	0.07	97287.9934
14115	Kanagawa	Yokohama	Sakae	0	0.20	0.16	0.08	20	0.1	5.7	124866	9483.9	2467	239.22	1188.48	0.22	54866.1204
14210	Kanagawa	Miura	None	0	0.24	0.09	0.06	15.6	0.1	5.64	48352	6780.92	2074	539.29	0	0.37	21245.8688
14214	Kanagawa	Isehara	None	0	0.22	0.24	0.06	18	0.1	5.9	101039	8426.38	4058	612.44	2161.34	0.18	44396.5366
14217	Kanagawa	Minamiashigara	None	0	0.18	0.26	0.14	23	0.1	6.1	44020	4146.68	1682	158.51	1432.65	0.33	19342.388
14341	Kanagawa	Oiso	None	0	0.22	0.18	0.06	17	0.1	5.8	33032	4238.03	1291	468.75	385.4	0.3	14514.2608
14362	Kanagawa	Oi	None	0	0.16	0.24	0.12	20	0.1	5.9	17972	2677.8	786	23.07	174.53	0.25	7896.8968
14363	Kanagawa	Matsuda	None	0	0.16	0.20	0.10	17	0.1	5.6	11676	1856.85	673	156.92	24.93	0	5130.4344
14366	Kanagawa	Kaisei	None	0	0.18	0.26	0.12	21	0.1	6	16369	2222.18	721	186.9	436.24	0.29	7192.5386
14382	Kanagawa	Hakone	None	0	0.14	0.16	0.10	17	0.1	5.7	13853	12226.4	1639	1373.26	0	0	6087.0082
14383	Kanagawa	Manazuru	None	0	0.20	0.14	0.06	13	0.1	5.6	8212	864.36	396	172.13	161.8	0	3608.3528
14401	Kanagawa	Aikawa	None	0	0.30	0.14	0.04	14	0.1	6	42089	3225.24	1872	125.09	3941.7	0.27	18493.9066
15405	Niigata	Izumozaki	None	0	0.22	0.10	0.04	11.5	0.1	5.64	4907	0	318	0	0	0	2156.1358
15504	Niigata	Kariwa	None	0	0.20	0.10	0.04	12	0.1	5.4	4800	0	253	0	0	0	2109.12
20321	Nagano	Karuizawa	None	0	0.22	0.11	0.04	12	0.1	5.6	19018	64073.48	1769	1063.6	0	0.47	8356.5092
2204	Aomori	Kuroishi	None	0	0.24	0.10	0.04	15.2	0.11	5.57	36132	4847.51	1668	513.56	650.93	0.32	13630
5202	Akita	Noshiro	None	0	0.23	0.13	0.08	15.14	0.11	5.85	59084	12888.8	3590	2902.27	4551.88	0.23	25961.5096
5209	Akita	Kazuno	None	0	0.30	0.14	0.04	17.08	0.11	6.03	34473	6104.33	1861	1792.21	1114.63	0.45	15147.4362

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
5212	Akita	Daisen	None	1	0.29	0.14	0.06	15.75	0.11	5.88	88301	6575.42	5096	1311.21	1324.32	0.14	38799.4594
5214	Akita	Nikaho	None	0	0.24	0.12	0.06	17	0.11	5.7	27544	3836.46	1414	587.25	2433.79	0.21	12102.8336
5363	Akita	Hachirogata	None	0	0.22	0.12	0.04	15	0.11	5.8	6623	735.31	342	144.08	83.78	0	2910.1462
5463	Akita	Ugo	None	0	0.30	0.12	0.04	16.86	0.11	6.1	16792	0	722	0	0	0.35	7378.4048
6401	Yamagata	Oguni	None	0	0.27	0.12	0.04	15.2	0.11	5.83	8862	1508.29	525	42.21	753.03	0	3893.9628
10429	Gumma	Higashiagatsuma	None	1	0.21	0.09	0.04	12	0.11	5.77	15622	1254.67	809	220.62	610.71	0.69	6864.3068
15211	Niigata	Mitsuke	None	0	0.25	0.11	0.04	13.2	0.11	5.78	41862	4675.79	2127	694.66	3290.23	0.44	18394.1628
19212	Yamanashi	Uenohara	None	0	0.22	0.10	0.04	13	0.11	5.6	27114	2289.56	1452	109.72	1011.61	0.47	11913.8916
2361	Aomori	Fujisaki	None	0	0.28	0.14	0.04	17	0.12	6.1	16021	1512.86	605	124.94	145.91	0.55	4900
2381	Aomori	Itayanagi	None	0	0.30	0.14	0.06	17	0.12	6.2	15227	2043.68	691	120.05	185.72	0.24	5480
5207	Akita	Yuzawa	None	0	0.31	0.12	0.06	15	0.12	5.8	50849	4675.99	3161	1367.89	1088.42	0.33	22343.0506
5210	Akita	Yurihonjo	None	0	0.27	0.14	0.05	17.05	0.12	6	85229	8076.95	4481	1363.53	2147.47	0.36	37449.6226
6203	Yamagata	Tsuruoka	None	0	0.25	0.10	0.03	14.2	0.12	5.61	136623	15124.34	7538	2238.42	5166.1	0.35	60032.1462
6204	Yamagata	Sakata	None	0	0.25	0.13	0.08	19.44	0.12	5.81	111151	14989.53	6616	1780.44	6717.52	0.34	48839.7494
6205	Yamagata	Shinjo	None	0	0.30	0.15	0.06	19.14	0.12	6.4	38850	4302.12	2670	600.66	2011.72	0.3	17070.69
6209	Yamagata	Nagai	None	0	0.28	0.10	0.04	15	0.12	6.1	29473	4068.84	1888	379.55	1184.15	0.18	12950.4362
6426	Yamagata	Mikawa	None	0	0.30	0.14	0.06	19	0.12	6.3	7731	0	511	0	0	0	3397.0014
7364	Fukushima	Hinoemata	None	0	0.20	0.08	0.03	10	0.12	5.8	636	0	108	0	0	0	279.4584
10344	Gumma	Shinto	None	0	0.26	0.14	0.04	13	0.12	5.9	14370	918.57	478	26.65	0	0	6314.178
11207	Saitama	Chichibu	None	0	0.28	0.08	0.03	10.29	0.12	5.78	66955	5204.69	3958	854.77	1776.04	0.44	29420.027
11208	Saitama	Tokorozawa	None	0	0.42	0.13	0.06	16	0.12	6.15	341924	22893.73	10525	1351.6	950.15	0.14	150241.4056
11230	Saitama	Niiza	None	0	0.30	0.16	0.08	19	0.12	6.1	158777	7845.01	5285	428.71	977.88	0.18	69766.6138
11365	Saitama	Ogano	None	0	0.31	0.08	0.03	10	0.12	5.83	13436	0	769	0	0	0	5903.7784
12206	Chiba	Kisarazu	None	0	0.30	0.28	0.07	25.54	0.12	6.51	129312	24010.03	5366	2484.19	5332.77	0.41	54530
12210	Chiba	Mobara	None	1	0.36	0.19	0.08	22.25	0.12	6.4	93015	13186.91	3807	812.86	2496.73	0.39	40930
12226	Chiba	Futtsu	None	0	0.26	0.16	0.06	18	0.12	5.78	48073	9057.09	2291	540.01	1349.85	0.57	19150
13205	Tokyo	Ome	None	0	0.38	0.07	0.03	11.67	0.12	5.78	139339	14723.44	5092	1362.11	3221.96	0.17	61225.5566
13210	Tokyo	Koganei	None	0	0.34	0.20	0.08	21	0.12	6.5	118852	8565.97	3103	468.6	123.67	0.07	52223.5688
13214	Tokyo	Kokubunji	None	0	0.36	0.20	0.08	21	0.12	6.6	120650	8223.82	3772	650.57	470.03	0.12	53013.61

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
5327	Akita	Kamikoani	None	0	0.27	0.14	0.04	15.33	0.14	6.09	2727	0	140	0	0	0	1198.2438
6206	Yamagata	Sagae	None	0	0.41	0.15	0.07	19.56	0.14	6.65	42373	5446	2231	567.76	2808.93	0.35	18618.6962
6213	Yamagata	Nanyo	None	0	0.38	0.20	0.04	16	0.14	6.2	33658	5803.47	2023	876.09	1400.91	0.33	14789.3252
6322	Yamagata	Nishikawa	None	0	0.29	0.15	0.04	17.67	0.14	6.37	6270	1139.72	374	211.64	226.07	0	2755.038
6324	Yamagata	Oe	None	0	0.34	0.15	0.06	17.78	0.14	6.49	9227	2026.83	434	269.21	554.59	0	4054.3438
6361	Yamagata	Kaneyama	None	0	0.36	0.15	0.06	18	0.14	6.5	6365	657.77	298	59.58	115.75	0	2796.781
6364	Yamagata	Mamurogawa	None	0	0.34	0.15	0.06	18.8	0.14	6.46	9165	852.12	448	34.52	17.05	0	4027.101
6365	Yamagata	Okura	None	0	0.32	0.14	0.06	17	0.14	6.4	3762	0	223	0	0	0	1653.0228
6402	Yamagata	Shirataka	None	0	0.34	0.12	0.04	16.33	0.14	6.3	15314	1839.73	793	60.25	538.83	0.62	6728.9716
7368	Fukushima	Minamiaizu	None	0	0.27	0.10	0.03	14.59	0.14	6.06	17864	1342.19	1330	152.3	332.61	0	7410
7423	Fukushima	Yanaizu	None	0	0.40	0.16	0.04	15	0.14	6.4	4009	0	239	0	0	0	1761.5546
7444	Fukushima	Mishima	None	0	0.34	0.14	0.04	15	0.14	6.3	1926	0	143	0	0	0	846.2844
7446	Fukushima	Showa	None	0	0.33	0.11	0.04	16	0.14	6.3	1500	0	113	0	0	0	659.1
10367	Gumma	Kanna	None	0	0.44	0.06	0.03	9.5	0.14	5.75	2352	0	263	0	0	0	1033.4688
10384	Gumma	Kanra	None	0	0.38	0.10	0.03	11	0.14	5.9	13618	1520.74	790	50.12	686.8	0	5983.7492
10444	Gumma	Kawaba	None	0	0.28	0.12	0.03	10	0.14	5.88	3898	0	153	0	0	0	1712.7812
10448	Gumma	Showa	None	0	0.30	0.14	0.04	13	0.14	6.13	7620	0	266	0	0	0	3348.228
10464	Gumma	Tamamura	None	0	0.44	0.22	0.04	23	0.14	6.9	37536	2342.87	1320	156.1	712.63	0.31	16493.3184
11209	Saitama	Hanno	None	0	0.52	0.08	0.03	11.67	0.14	5.91	83549	5519.73	3352	673.48	1757.13	0.26	36711.4306
11211	Saitama	Honjo	None	0	0.34	0.14	0.03	15	0.14	6.31	81889	10717.82	3998	759.21	3690.28	0.27	35982.0266
11212	Saitama	Higashimatsuyama	None	0	0.36	0.12	0.04	14.8	0.14	6.3	90099	7980.49	3663	755.88	872.47	0.28	39589.5006
11227	Saitama	Asaka	None	2	0.36	0.22	0.08	22	0.14	6.7	129691	6447.11	4018	692.46	1344.97	0.12	56986.2254
11228	Saitama	Shiki	None	0	0.32	0.20	0.08	21	0.14	6.6	69611	4798.24	2309	211	853.02	0.17	30587.0734
11235	Saitama	Fujimi	None	1	0.36	0.20	0.08	20	0.14	6.5	106736	6933.94	3111	394.86	45.92	0.25	46899.7984
11239	Saitama	Sakado	None	0	0.40	0.12	0.04	17	0.14	6.5	101700	6997.86	3233	600.25	1759.64	0.21	44686.98
11241	Saitama	Tsurugashima	None	0	0.32	0.12	0.04	17	0.14	6.4	69990	5628.05	2347	161.78	1147.63	0.06	30753.606
11324	Saitama	Miyoshi	None	0	0.38	0.14	0.08	19	0.14	6.3	38706	1450.18	1653	0	838.18	0.22	17007.4164
11327	Saitama	Ogose	None	0	0.42	0.10	0.03	12	0.14	6.1	12537	1299.43	563	196.17	191.78	0	5508.7578
11341	Saitama	Namegawa	None	0	0.36	0.14	0.04	15	0.14	6.4	17323	1532.21	569	114.5	632.21	0.31	7611.7262

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
11348	Saitama	Hatoyama	None	0	0.38	0.10	0.04	14	0.14	6.27	15305	1894.09	468	29.87	0	0.52	6725.017
11349	Saitama	Tokigawa	None	0	0.32	0.10	0.03	13	0.14	6.2	12418	0	648	0	0	0	5456.4692
11361	Saitama	Yokoze	None	0	0.32	0.10	0.03	12	0.14	6.2	9039	381.23	382	0	235.72	0	3971.7366
11362	Saitama	Minano	None	0	0.24	0.10	0.03	9.5	0.14	5.9	10888	1372.18	656	129.13	453.93	0	4784.1872
11383	Saitama	Kamikawa	None	0	0.28	0.12	0.03	13	0.14	6.2	14470	0	540	0	0	0.38	6358.118
12229	Chiba	Sodegaura	None	0	0.30	0.22	0.10	22.75	0.14	6.56	60355	8020.77	2077	288.99	2118.76	0.36	22560
12426	Chiba	Nagara	None	0	0.34	0.20	0.08	23.71	0.14	6.49	8035	0	290	0	0	0	3530.579
13202	Tokyo	Tachikawa	None	0	0.36	0.17	0.06	18	0.14	6.4	179668	12449.38	8204	1635.76	2011.29	0.1	78946.1192
13203	Tokyo	Musashino	None	0	0.36	0.20	0.08	21	0.14	6.7	138734	7392.45	8124	1279.01	343.97	0.06	60959.7196
13204	Tokyo	Mitaka	None	1	0.36	0.20	0.08	20.67	0.14	6.7	186083	10542.23	5833	560.57	881.97	0.11	81764.8702
13206	Tokyo	Fuchu	None	1	0.33	0.20	0.10	20.8	0.14	6.47	255506	19692.07	8249	1828.12	3407.2	0.1	112269.3364
13208	Tokyo	Chofu	None	0	0.36	0.20	0.08	20.67	0.14	6.6	223593	15849.64	7181	1335.6	1115.89	0.13	98246.7642
13211	Tokyo	Kodaira	None	0	0.36	0.18	0.08	19	0.14	6.5	187035	16087.73	4983	664.03	1197.35	0.09	82183.179
13212	Tokyo	Hino	None	0	0.36	0.19	0.06	19.2	0.14	6.4	180052	19776.8	4896	896.97	2449.84	0.08	79114.8488
13213	Tokyo	Higashimurayama	None	1	0.44	0.18	0.08	19	0.14	6.5	153557	10512.94	4112	822.92	830.09	0.1	67472.9458
13218	Tokyo	Fussa	None	0	0.40	0.14	0.04	16	0.14	6.4	59796	4926.64	2300	589.64	214.5	0.16	26274.3624
13220	Tokyo	Higashiyamato	None	0	0.44	0.16	0.06	18	0.14	6.5	83068	7316.34	2835	362.19	750.5	0.12	36500.0792
13223	Tokyo	Musashimurayama	None	0	0.40	0.14	0.06	15	0.14	6.3	70053	8288.95	2680	242.34	2.07	0.05	30781.2882
13225	Tokyo	Inagi	None	1	0.32	0.20	0.10	22	0.14	6.5	84835	11588.02	2273	507.65	534.85	0.11	37276.499
13229	Tokyo	Nishitokyo	None	0	0.33	0.18	0.08	20	0.14	6.5	196511	12730.36	5697	895.65	736.24	0.12	86346.9334
13303	Tokyo	Mizuho	None	0	0.44	0.14	0.04	14.8	0.14	6.2	33497	4996.32	1682	185.35	1796.89	0.25	14718.5818
14104	Kanagawa	Yokohama	Naka	0	0.36	0.32	0.08	28	0.14	7	146033	6743.43	14853	3664.58	995.18	0.1	64166.9002
14105	Kanagawa	Yokohama	Minami	0	0.32	0.30	0.08	26	0.14	6.8	196153	8367.42	6254	2272.88	430.47	0.12	86189.6282
14106	Kanagawa	Yokohama	Hodogaya	0	0.30	0.23	0.05	22.57	0.14	6.5	206634	12267.07	5414	954.78	658.83	0.12	90794.9796
14116	Kanagawa	Yokohama	Izumi	0	0.30	0.16	0.06	21	0.14	6.4	155698	10662.66	3885	241.58	200.48	0.03	68413.7012
14135	Kanagawa	Kawasaki	Tama	0	0.36	0.17	0.06	19.5	0.14	6.6	213894	15832.54	5262	927.63	304.68	0.12	93985.0236
14209	Kanagawa	Sagamihara	None	2	0.32	0.16	0.06	16.55	0.14	5.88	717544	47580.99	25287	4798.75	11498.05	0.17	315288.8336
14216	Kanagawa	Zama	None	0	0.40	0.18	0.06	19	0.14	6.6	129436	8484.43	3679	528.94	1989.07	0.14	56874.1784
14218	Kanagawa	Ayase	None	0	0.36	0.20	0.06	21	0.14	6.8	83167	6190.84	3237	162.83	3114.21	0.21	36543.5798

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
6382	Yamagata	Kawanishi	None	0	0.46	0.22	0.06	20.86	0.15	6.67	17313	1211.15	765	132.23	227.46	0.56	7607.3322
6461	Yamagata	Yuza	None	0	0.31	0.14	0.04	15.67	0.15	6.2	15480	893.79	721	141.83	1258.66	0.34	6801.912
10201	Gumma	Maebashi	None	0	0.40	0.18	0.04	19	0.15	6.51	340291	33527.91	18129	6521.94	11839.93	0.31	149523.8654
10209	Gumma	Fujioka	None	0	0.43	0.14	0.03	15	0.15	6.3	67975	5485.64	3334	457.93	2149.37	0.4	29868.215
2402	Aomori	Shichinohe	None	0	0.37	0.17	0.07	19	0.16	6.49	16759	2801.2	808	392.01	173.67	0.28	6850
2441	Aomori	Sannohe	None	0	0.38	0.22	0.07	19	0.16	6.57	11299	1803.61	534	181.98	257.22	0	4964.7806
2445	Aomori	Nanbu	None	0	0.42	0.21	0.04	17.45	0.16	6.64	19853	933.25	813	44.69	94.9	0.51	7370
5434	Akita	Misato	None	0	0.42	0.18	0.04	19.33	0.16	6.7	21674	1645.84	1023	209.85	232.4	0.23	9523.5556
6207	Yamagata	Kaminoyama	None	0	0.38	0.30	0.06	18.2	0.16	6.57	33836	4953.7	1644	568.33	1352.42	0.36	14867.5384
6301	Yamagata	Yamanobe	None	0	0.48	0.18	0.10	25	0.16	6.9	15139	1716.36	586	0	425.71	0.72	6652.0766
6302	Yamagata	Nakayama	None	0	0.45	0.16	0.08	22	0.16	6.7	12015	1895.06	447	0	200.04	0	5279.391
6321	Yamagata	Kahoku	None	0	0.42	0.16	0.06	19	0.16	6.7	19959	2235.44	1079	322.39	937.18	0.52	8769.9846
6323	Yamagata	Asahi	None	0	0.39	0.16	0.04	18	0.16	6.6	7856	672.48	416	86.27	242.35	0	3451.9264
10206	Gumma	Numata	None	0	0.27	0.10	0.03	11	0.16	5.93	51265	5533.26	3088	544.69	1722.4	0.38	22525.841
11101	Saitama	Saitama	Nishi	0	0.38	0.24	0.06	23	0.16	6.9	84029	6994.41	2348	39.6	806.53	0.17	36922.3426
11106	Saitama	Saitama	Sakura	0	0.38	0.26	0.08	24	0.16	6.9	96911	2178.93	2628	0	255.84	0.11	42582.6934
11201	Saitama	Kawagoe	None	0	0.38	0.15	0.06	19	0.16	6.5	342670	23830.57	11657	1906.58	4352.49	0.21	150569.198
11202	Saitama	Kumagaya	None	0	0.46	0.18	0.04	18	0.16	6.64	203180	15890.17	9423	2474.36	7528.1	0.3	89277.292
11215	Saitama	Sayama	None	1	0.44	0.12	0.06	16	0.16	6.4	155727	10516.88	5164	607.28	3233.76	0.21	68426.4438
11217	Saitama	Konosu	None	1	0.40	0.16	0.04	19	0.16	6.7	119639	12054.57	4026	786.97	2348.59	0.27	52569.3766
11229	Saitama	Wako	None	0	0.40	0.24	0.08	24	0.16	6.8	80745	4549.41	1965	193.99	1699.45	0.11	35479.353
11233	Saitama	Kitamoto	None	0	0.40	0.16	0.04	20	0.16	6.7	68888	6339.38	2089	180.47	526.65	0.13	30269.3872
11242	Saitama	Hidaka	None	0	0.56	0.08	0.03	15	0.16	6.15	57473	5092.94	1917	182.72	1068.97	0.38	25253.6362
11245	Saitama	Fujimino	None	0	0.42	0.18	0.08	20	0.16	6.7	105695	7382.1	3386	435.86	375.32	0.17	46442.383
11342	Saitama	Ranzan	None	0	0.36	0.12	0.04	13.67	0.16	6.3	18887	1376.11	859	180.28	193.93	0.3	8298.9478
11343	Saitama	Ogawa	None	0	0.31	0.12	0.03	13	0.16	6.2	32913	3777.98	1526	329.92	1190.48	0.2	14461.9722
11346	Saitama	Kawajima	None	0	0.40	0.16	0.04	19	0.16	6.7	22147	1897.47	964	0	1213.81	0.5	9731.3918
11347	Saitama	Yoshimi	None	0	0.40	0.14	0.04	18	0.16	6.6	21079	1042.12	787	0	573.61	0.38	9262.1126
11369	Saitama	Higashichichibu	None	0	0.25	0.10	0.03	11	0.16	6.1	3348	0	180	0	0	0	1471.1112
11385	Saitama	Kamisato	None	0	0.40	0.18	0.04	20	0.16	6.7	30998	830.48	1032	110.55	1031.64	0.52	13620.5212

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
13120	Tokyo	Nerima	None	3	0.46	0.24	0.08	23	0.16	6.8	716124	38538.45	22183	3886.87	1426.11	0.11	314664.8856
13219	Tokyo	Komae	None	0	0.38	0.18	0.06	21	0.16	6.7	78751	3224.98	2327	77.28	250.38	0.1	34603.1894
13227	Tokyo	Hamura	None	0	0.46	0.14	0.04	15	0.16	6.3	57032	5303.81	2241	248.53	786.17	0.16	25059.8608
14101	Kanagawa	Yokohama	Tsurumi	0	0.36	0.26	0.10	26.33	0.16	6.96	272178	11611.68	9672	4648.56	6633.46	0.14	119595.0132
14102	Kanagawa	Yokohama	Kanagawa	0	0.36	0.26	0.06	24.86	0.16	6.88	233429	10859.47	9337	2885.74	1796.54	0.12	102568.7026
14103	Kanagawa	Yokohama	Nishi	0	0.36	0.32	0.08	28	0.16	7.1	94867	2600.24	8226	3502.56	282.95	0.1	41684.5598
14109	Kanagawa	Yokohama	Kohoku	0	0.38	0.24	0.10	25.6	0.16	7	329471	14655.62	11797	2239.45	3352.08	0.11	144769.5574
14131	Kanagawa	Kawasaki	Kawasaki	2	0.38	0.24	0.12	27	0.16	7	217328	6428.62	11971	3295.95	18159.38	0.13	95493.9232
14132	Kanagawa	Kawasaki	Saiwai	0	0.40	0.28	0.14	29	0.16	7.1	154212	4421.33	5112	1430.76	1107.98	0.1	67760.7528
14133	Kanagawa	Kawasaki	Nakahara	0	0.42	0.26	0.10	27	0.16	7	233925	9624.01	7303	1975.58	961.92	0.13	102786.645
14134	Kanagawa	Kawasaki	Takatsu	0	0.38	0.20	0.06	23	0.16	6.8	217360	10967.95	6302	904.53	2175.88	0.07	95507.984
14136	Kanagawa	Kawasaki	Miyamae	0	0.38	0.20	0.06	21	0.16	6.7	218867	15405.18	4508	987.17	274.83	0.08	96170.1598
14137	Kanagawa	Kawasaki	Asao	0	0.38	0.20	0.10	20.8	0.16	6.64	169926	14388.7	3652	625.68	334.97	0.14	74665.4844
2442	Aomori	Gonohe	None	0	0.41	0.27	0.07	19.09	0.17	6.68	18712	2713.45	744	174.36	625.49	0.46	6770
11363	Saitama	Nagatoro	None	0	0.26	0.10	0.03	12	0.17	6.07	7908	0	479	0	0	0	3474.7752
2408	Aomori	Tohoku	None	0	0.42	0.18	0.08	19.83	0.18	6.74	19106	2877.35	880	324.94	520.37	0.37	6360
2450	Aomori	Shingo	None	0	0.40	0.28	0.06	20.8	0.18	6.66	2851	0	142	0	0	0	1252.7294
3214	Iwate	Hachimantai	None	0	0.37	0.22	0.06	19.45	0.18	6.3	28680	1896.27	1435	499.43	834.37	0.35	12260
3301	Iwate	Shizukuishi	None	0	0.46	0.21	0.07	19.4	0.18	6.73	18033	1305.41	834	273.7	0	0.5	6100
3501	Iwate	Karumai	None	0	0.56	0.17	0.03	18.18	0.18	6.57	10209	0	469	0	0	0	4485.8346
6201	Yamagata	Yamagata	None	0	0.50	0.18	0.10	23.82	0.18	6.93	254244	28552.15	14618	3370.83	8053.99	0.29	111714.8136
6202	Yamagata	Yonezawa	None	0	0.55	0.28	0.06	21.43	0.18	6.83	89401	15496.11	5193	1398.43	7060.52	0.15	39282.7994
6208	Yamagata	Murayama	None	0	0.47	0.17	0.07	20.33	0.18	6.83	26811	2935.18	1433	386.51	1074.91	0.47	11780.7534
6210	Yamagata	Tendo	None	3	0.57	0.18	0.06	21	0.18	6.8	62214	6959.15	3260	981.94	2856	0.43	27336.8316
6363	Yamagata	Funagata	None	0	0.41	0.16	0.06	18.4	0.18	6.7	6164	0	279	0	0	0	2708.4616
6381	Yamagata	Takahata	None	0	0.60	0.34	0.06	20	0.18	6.8	25025	2725.68	1220	187.92	621.71	0.45	10995.985
7362	Fukushima	Shimogo	None	0	0.42	0.15	0.04	15.56	0.18	6.43	6461	0	427	0	0	0	2838.9634
7421	Fukushima	Aizubange	None	0	0.48	0.21	0.07	19.75	0.18	6.7	17360	1566.1	1072	335.69	721.39	0	5910

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
9367	Tochigi	Iwafune	None	0	0.46	0.16	0.06	18	0.18	6.6	18241	3327.42	984	65.81	315.14	0.55	8015.0954
10204	Gumma	Isesaki	None	0	0.54	0.22	0.04	22	0.18	6.96	207221	24397.51	9631	2428.22	10869.58	0.32	91052.9074
10523	Gumma	Chiyoda	None	0	0.50	0.20	0.06	20	0.18	6.8	11473	1388.72	556	218.93	524.39	0	5041.2362
11102	Saitama	Saitama	Kita	1	0.40	0.26	0.06	25	0.18	7	138630	10164.33	4934	698.76	2255.02	0.1	60914.022
11103	Saitama	Saitama	Omiya	0	0.32	0.30	0.08	26	0.18	7.1	108488	6482.2	7514	1918.62	344.71	0.2	47669.6272
11105	Saitama	Saitama	Chuo	0	0.36	0.30	0.08	26	0.18	7.1	96055	5042.35	3106	435.21	1370.19	0.11	42206.567
11107	Saitama	Saitama	Urawa	0	0.38	0.34	0.08	27	0.18	7.1	144786	5691.39	6304	2283.65	323.3	0.13	63618.9684
11108	Saitama	Saitama	Minami	0	0.42	0.30	0.08	26	0.18	7.1	174988	8323.38	4768	672.76	1093.33	0.12	76889.7272
11210	Saitama	Kazo	None	0	0.45	0.22	0.06	23	0.18	7	115002	8632.13	4659	865.95	3765.5	0.25	50531.8788
11219	Saitama	Ageo	None	0	0.40	0.24	0.06	23	0.18	7	223926	18325.53	6799	614.02	4694.07	0.15	98393.0844
11224	Saitama	Toda	None	0	0.42	0.30	0.08	27	0.18	7.1	123079	5656.21	5827	707.73	4947.89	0.17	54080.9126
11231	Saitama	Okegawa	None	0	0.42	0.18	0.06	21	0.18	6.9	74711	4215.72	2638	282.58	1252.96	0.22	32828.0134
11238	Saitama	Hasuda	None	0	0.48	0.28	0.06	25	0.18	7	63309	4728.23	1800	187.12	744.87	0.11	27817.9746
11301	Saitama	Ina	None	0	0.46	0.24	0.06	24	0.18	7	42494	4361.43	1365	480.61	838.17	0.3	18671.8636
11381	Saitama	Misato	None	0	0.32	0.12	0.04	15.2	0.18	6.45	11605	0	476	0	0	0	5099.237
13106	Tokyo	Taito	None	0	0.44	0.42	0.08	27	0.18	7.1	175928	1972.62	26484	7373.46	66.39	0.08	77302.7632
13107	Tokyo	Sumida	None	2	0.43	0.42	0.08	28	0.18	7	247606	781.2	18084	4864.12	5376.73	0.09	108798.0764
13108	Tokyo	Koto	None	1	0.48	0.44	0.12	31	0.18	7.2	460819	6899.17	20294	3557.78	24383.87	0.03	202483.8686
13109	Tokyo	Shinagawa	None	1	0.46	0.32	0.12	28	0.18	7.3	365302	8901.72	22584	4026.36	6173.41	0.07	160513.6988
13110	Tokyo	Meguro	None	0	0.48	0.28	0.10	26	0.18	7.1	268330	11137.58	12707	1094.8	813.7	0.07	117904.202
13111	Tokyo	Ota	None	0	0.42	0.28	0.12	28.33	0.18	7.2	693373	21503.68	33931	4778.03	10602.53	0.12	304668.0962
13112	Tokyo	Setagaya	None	1	0.44	0.24	0.10	24	0.18	6.9	877138	47207.22	24766	4092.53	585.67	0.07	385414.4372
13114	Tokyo	Nakano	None	1	0.52	0.26	0.08	25	0.18	7.1	314750	9581.84	14367	1829.18	215.73	0.07	138301.15
13115	Tokyo	Suginami	None	1	0.48	0.22	0.08	23	0.18	6.9	549569	27582.79	21762	4312.2	530.18	0.09	241480.6186
13118	Tokyo	Arakawa	None	1	0.42	0.38	0.08	25	0.18	7.1	203296	1155.02	10951	2055.18	6268.68	0.01	89328.2624
13119	Tokyo	Itabashi	None	0	0.46	0.30	0.08	27	0.18	7.1	535824	17767.67	21062	3799.71	6702.82	0.09	235441.0656
13209	Tokyo	Machida	None	0	0.41	0.18	0.06	19.5	0.18	6.55	426987	35552.3	12855	1949.29	1658.29	0.12	187618.0878
14112	Kanagawa	Yokohama	Asahi	2	0.40	0.19	0.05	23.5	0.18	6.6	251086	16964.03	5867	559.5	1142	0.14	110327.1884
14114	Kanagawa	Yokohama	Seya	0	0.42	0.20	0.08	25	0.18	6.9	126913	9944.3	3573	325.34	219.46	0.14	55765.5722

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
14117	Kanagawa	Yokohama	Aoba	0	0.42	0.20	0.06	23	0.18	6.9	304297	22510.35	7389	963.96	0	0.11	133708.1018
14118	Kanagawa	Yokohama	Tsuzuki	0	0.39	0.21	0.05	22.4	0.18	6.8	201271	12875.11	7501	1197.69	1372.09	0.1	88438.4774
14213	Kanagawa	Yamato	None	1	0.40	0.22	0.08	23	0.18	6.9	228186	12939.47	8232	1481.09	3641.31	0.18	100264.9284
2405	Aomori	Rokunohe	None	0	0.45	0.28	0.08	21	0.19	6.8	10241	3182.76	415	166.34	1009.3	0	4499.8954
9204	Tochigi	Sano	None	0	0.40	0.13	0.06	17.5	0.19	6.63	121249	18224.25	7193	1670.01	9718.13	0.28	53276.8106
3302	Iwate	Kuzumaki	None	0	0.46	0.11	0.03	14.77	0.2	6.19	7304	0	346	0	0	0	3209.3776
3366	Iwate	Nishiwaga	None	1	0.53	0.15	0.04	18.43	0.2	6.65	6602	0	444	0	0	0	2900.9188
5203	Akita	Yokote	None	0	0.70	0.13	0.06	17.13	0.2	6.33	98367	10596.07	5637	2317.09	4166.88	0.33	43222.4598
6211	Yamagata	Higashine	None	0	0.55	0.18	0.06	20	0.2	6.85	46414	6516.12	1985	747.03	3089.36	0.41	20394.3116
6212	Yamagata	Obanazawa	None	0	0.56	0.17	0.06	22.29	0.2	6.97	18955	1784.14	1119	325.28	867.15	0.51	8328.827
6341	Yamagata	Oishida	None	0	0.52	0.18	0.06	20	0.2	6.9	8160	1127.14	438	209.75	185.13	0	3585.504
6362	Yamagata	Mogami	None	0	0.40	0.18	0.08	24	0.2	7	9847	859.54	540	51.43	95.1	0	4326.7718
7407	Fukushima	Bandai	None	0	0.54	0.30	0.10	25	0.2	7.1	3761	0	165	0	0	0	1652.5834
10207	Gumma	Tatebayashi	None	0	0.46	0.18	0.06	21	0.2	6.9	78608	11690.76	4121	1345.2	3727.6	0.42	34540.3552
10212	Gumma	Midori	None	0	0.42	0.15	0.04	18.73	0.2	6.6	51899	0	2723	0	0	0.49	22804.4206
10443	Gumma	Katashina	None	0	0.24	0.08	0.03	11.6	0.2	5.84	4904	0	484	0	0	0	2154.8176
10521	Gumma	Itakura	None	0	0.47	0.22	0.08	21	0.2	6.9	15706	2821.67	686	149.55	1053.83	0.56	6901.2164
10522	Gumma	Meiwa	None	0	0.46	0.20	0.08	21	0.2	6.9	11209	860.49	461	6.59	1129.2	0	4925.2346
10524	Gumma	Oizumi	None	0	0.56	0.22	0.04	21	0.2	6.8	40257	6475.51	1737	1118.99	4065.95	0.48	17688.9258
10525	Gumma	Ora	None	0	0.52	0.20	0.06	21	0.2	6.9	27023	2282.5	1055	57.16	1380.22	0.42	11873.9062
11104	Saitama	Saitama	Minuma	1	0.40	0.32	0.08	27	0.2	7.1	157143	16530.57	4444	263.11	703.26	0.15	69048.6342
11109	Saitama	Saitama	Midori	0	0.48	0.34	0.08	28	0.2	7.2	110118	11047.69	3062	367.6	836.36	0.15	48385.8492
11110	Saitama	Saitama	Iwatsuki	0	0.56	0.36	0.08	27	0.2	7.3	111286	8425.96	4629	513.11	1522.19	0.13	48899.0684
11232	Saitama	Kuki	None	0	0.54	0.28	0.08	26	0.2	7.2	154310	11752.97	5453	653.66	3726.29	0.14	67803.814
11445	Saitama	Shiraoka	None	0	0.52	0.30	0.10	26	0.2	7.2	50272	4430.62	1529	222.73	208.85	0.21	22089.5168
13101	Tokyo	Chiyoda	None	2	0.46	0.40	0.08	27	0.2	7.2	47115	4434.57	35566	5653.54	0	0.02	20702.331
13102	Tokyo	Chuo	None	0	0.48	0.44	0.10	29	0.2	7.3	122762	1345.21	41454	5571.61	667.69	0.03	53941.6228
13103	Tokyo	Minato	None	7	0.46	0.38	0.10	29	0.2	7.3	205131	9216.86	42664	5206.13	3175.5	0.03	90134.5614
13104	Tokyo	Shinjuku	None	1	0.54	0.32	0.08	25	0.2	7.1	326309	10023.11	35154	4742.07	926	0.03	143380.1746

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
13105	Tokyo	Bunkyo	None	0	0.48	0.38	0.08	26	0.2	7.2	206626	6676.94	15960	2098.99	667.46	0.07	90791.4644
13113	Tokyo	Shibuya	None	0	0.52	0.30	0.10	26	0.2	7.1	204492	8875.74	26520	3846.57	335.59	0.07	89853.7848
13116	Tokyo	Toshima	None	2	0.52	0.32	0.08	25	0.2	7.2	284678	7431.03	18934	4100.3	499.13	0.07	125087.5132
13117	Tokyo	Kita	None	0	0.48	0.36	0.08	28	0.2	7.3	335544	9934.53	15060	3651.37	4242.29	0.06	147438.0336
13121	Tokyo	Adachi	None	3	0.48	0.34	0.08	26	0.2	7.1	683426	28078.18	28943	5738.99	12791.51	0.16	300297.3844
13123	Tokyo	Edogawa	None	1	0.48	0.37	0.10	29	0.2	7.1	678967	29094.46	23599	3806.13	7901.98	0.14	298338.0998
12213	Chiba	Togane	None	0	0.68	0.25	0.08	23	0.21	7	61751	5996.29	2491	412.64	1443.23	0.3	27900
3305	Iwate	Takizawa	None	0	0.54	0.21	0.06	22	0.22	6.9	53857	6327.28	1558	0	470.76	0.34	21920
3322	Iwate	Yahaba	None	0	0.63	0.24	0.04	20	0.22	6.8	27205	3367.88	1324	159.45	2324.9	0.29	9210
4302	Miyagi	Shichikashuku	None	0	0.50	0.20	0.06	20	0.22	6.7	1694	0	117	0	0	0	744.3436
7422	Fukushima	Yugawa	None	0	0.58	0.24	0.08	24	0.22	7	3364	0	113	0	0	0	1478.1416
9202	Tochigi	Ashikaga	None	1	0.51	0.18	0.06	19.75	0.22	6.77	154530	19825.62	9214	2195.14	10148.24	0.43	67900.482
9203	Tochigi	Tochigi	None	0	0.55	0.16	0.05	20	0.22	6.75	145783	20422.21	7317	1389.27	9155.56	0.43	67900.482
11203	Saitama	Kawaguchi	None	2	0.52	0.36	0.08	28	0.22	7.33	561506	20238.38	24569	2884.14	3494.52	0.16	246725.7364
11442	Saitama	Miyashiro	None	0	0.62	0.36	0.10	29	0.22	7.3	33641	3089.64	1158	96.99	71.86	0.28	14781.8554
12347	Chiba	Tako	None	0	0.52	0.22	0.06	25	0.22	7.1	16002	1760.8	912	131.13	467.53	0.8	6230
12409	Chiba	Shibayama	None	0	0.50	0.22	0.06	25	0.22	7.1	7920	1133.22	510	159.08	1373.59	0	3480.048
13122	Tokyo	Katsushika	None	0	0.52	0.30	0.08	26	0.22	7	442586	16873.85	20112	2483.95	9932.98	0.09	194472.2884
14113	Kanagawa	Yokohama	Midori	0	0.46	0.22	0.06	25	0.22	7	177631	12382.15	4065	590.12	791.93	0.1	78051.0614
3213	Iwate	Ninohe	None	0	0.78	0.22	0.06	18.53	0.23	6.72	29702	5414.74	1578	925.28	1245.33	0.47	12420
7408	Fukushima	Inawashiro	None	0	0.56	0.43	0.18	28	0.23	7	15805	2892.65	944	397.07	215.62	0	7030
3524	Iwate	Ichinohe	None	0	0.80	0.25	0.06	20.2	0.24	6.93	14187	2024.14	688	185.7	510.49	0.76	6410
7447	Fukushima	Aizumisato	None	0	0.62	0.26	0.06	21.2	0.24	7	22737	2558.3	977	231.37	590.71	0	7360
9205	Tochigi	Kanuma	None	0	0.78	0.13	0.04	19	0.24	6.7	102348	12909.28	5429	1087.24	6845.57	0.23	44971.7112
9361	Tochigi	Mibu	None	0	0.66	0.22	0.06	24	0.24	7.1	39605	4641.14	1825	358.36	1220.66	0.32	17402.437
10203	Gumma	Kiryu	None	0	0.47	0.18	0.04	21.43	0.24	6.73	121704	11112.34	7308	1981.47	7265.61	0.53	53476.7376
10205	Gumma	Ota	None	0	0.62	0.21	0.04	21.75	0.24	6.92	216465	23622.97	11297	3231.98	12625.09	0.37	95114.721
11234	Saitama	Yashio	None	0	0.66	0.30	0.08	27	0.24	7.3	82977	6409.56	4868	551.79	4566.24	0.17	36460.0938
11240	Saitama	Satte	None	0	0.66	0.36	0.10	30	0.24	7.5	54012	3947.21	2267	341.47	1018.02	0.29	23732.8728

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
12349	Chiba	Tonosho	None	0	0.58	0.20	0.06	23.5	0.24	7.07	15154	3683.25	648	87.97	299.3	0.77	5170
3321	Iwate	Shiwa	None	0	0.67	0.23	0.06	22	0.25	7.05	33288	5140.91	1247	321.42	542.69	0.37	10960
4301	Miyagi	Zao	None	0	0.56	0.29	0.07	28.67	0.25	7.3	12882	0	703	0	0	0	5660.3508
4324	Miyagi	Kawasaki	None	0	0.66	0.22	0.07	25	0.25	7.17	9978	332.74	514	0	0	0	4384.3332
3506	Iwate	Kunohe	None	0	0.75	0.20	0.06	21.78	0.26	6.89	6507	0	280	0	0	0	2859.1758
4322	Miyagi	Murata	None	1	0.64	0.30	0.06	30.6	0.26	7.47	11995	1661.18	584	202.94	1073.53	0	5270.603
7201	Fukushima	Fukushima	None	2	0.75	0.31	0.06	26.8	0.26	7.15	292590	34838.42	13816	4970.37	10559.31	0	130050
9216	Tochigi	Shimotsuke	None	0	0.64	0.26	0.06	27	0.26	7.15	59483	6911.74	2286	526.71	2829.95	0.33	26136.8302
9364	Tochigi	Nogi	None	0	0.74	0.30	0.08	26	0.26	7.2	25720	3482.26	814	178.44	625.29	0.41	11301.368
11214	Saitama	Kasukabe	None	1	0.76	0.38	0.10	28	0.26	7.3	237171	17316.9	8321	1156.41	2682.4	0.24	104212.9374
11237	Saitama	Misato_City	None	1	0.72	0.28	0.08	27	0.26	7.3	131415	11019.31	5831	1176	2249.05	0.15	57743.751
12207	Chiba	Matsudo	None	0	0.70	0.26	0.08	27.33	0.26	7.3	484457	37796.75	14331	2490.57	3589.57	0.15	224380
12216	Chiba	Narashino	None	1	0.68	0.34	0.10	29	0.26	7.4	164530	13123.88	4383	637.65	4849.49	0.14	74110
3381	Iwate	Kanegasaki	None	0	0.80	0.30	0.12	26	0.27	7.3	16325	5165.33	592	342.87	4265.15	0.25	4670
7481	Fukushima	Tanagura	None	0	0.64	0.26	0.07	25.82	0.27	7.23	15062	2140.47	889	191.05	113.01	0	5160
7483	Fukushima	Hanawa	None	0	0.73	0.24	0.07	25.6	0.27	7.16	9884	0	634	0	0	0	4343.0296
4206	Miyagi	Shiroishi	None	1	0.64	0.37	0.08	31.08	0.28	7.37	37422	6366.44	1775	550.17	1630.66	0.36	16443.2268
7322	Fukushima	Otama	None	0	0.72	0.19	0.04	27	0.28	7.2	8574	0	276	0	0	0	3767.4156
7344	Fukushima	Tenei	None	0	0.73	0.38	0.08	28	0.28	7.29	6291	0	263	0	0	0	2764.2654
9211	Tochigi	Yaita	None	1	0.74	0.28	0.08	28.63	0.28	7.18	35343	4835.42	1656	466.04	1582.82	0.22	15529.7142
12204	Chiba	Funabashi	None	1	0.82	0.33	0.10	28	0.28	7.3	609040	44470.45	16976	2498.4	8366.89	0.17	271120
12236	Chiba	Katori	None	0	0.63	0.23	0.10	25.78	0.28	7.23	82866	8604.38	4158	772.45	1095.71	0.64	30450
12329	Chiba	Sakae	None	0	0.68	0.24	0.08	27	0.28	7.2	22580	2972.1	604	118.6	367.63	0.65	8740
12342	Chiba	Kozaki	None	0	0.66	0.34	0.16	33	0.28	7.6	6454	0	264	0	0	0	2835.8876
3215	Iwate	Oshu	None	5	0.82	0.26	0.07	26.38	0.29	7.21	124746	14261.25	6457	2484.3	4696.12	0.42	47740
3303	Iwate	Iwate	None	2	0.50	0.20	0.07	24.24	0.29	7.16	14984	1704.82	625	248.2	131.28	0.31	5650
7202	Fukushima	Aizuwakamatsu	None	0	0.74	0.40	0.12	30.11	0.29	7.15	126220	17227.67	7554	3194.5	4971.33	0	57120
7482	Fukushima	Yamatsuri	None	0	0.82	0.22	0.04	24	0.29	7.1	6348	0	383	0	0	0	2789.3112
3205	Iwate	Hanamaki	None	0	0.99	0.25	0.07	24.44	0.3	7.04	101438	14589.63	4823	1611.9	5831.81	0.29	38770

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
4321	Miyagi	Ogawara	None	0	0.70	0.38	0.10	35.8	0.3	7.7	23530	3846.08	1345	639.98	1348.65	0.18	10339.082
5464	Akita	Higashinaruse	None	0	0.90	0.12	0.04	17.6	0.3	6.5	2872	0	135	0	0	0	1261.9568
7301	Fukushima	Kori	None	0	0.70	0.25	0.06	25	0.3	7.1	12853	1329.45	550	221.42	957.56	0	5647.6082
8207	Ibaraki	Yuki	None	2	0.82	0.30	0.08	27.6	0.3	7.3	52494	5705.72	2579	423.83	2218.68	0.43	18290
9208	Tochigi	Oyama	None	1	0.88	0.32	0.08	28.33	0.3	7.3	164454	23454.09	7425	2118.49	7474.53	0.23	72261.0876
9301	Tochigi	Kaminokawa	None	0	0.78	0.32	0.06	29	0.3	7.3	31621	3338.1	1170	87.57	4311.43	0.2	13894.2674
9384	Tochigi	Shioya	None	0	0.80	0.24	0.07	23.47	0.3	7.06	12560	1701.48	551	66.87	370.71	0	5518.864
11243	Saitama	Yoshikawa	None	0	0.88	0.30	0.08	27	0.3	7.3	65298	5239.07	2202	362.71	1094.11	0.23	28691.9412
11465	Saitama	Matsubushi	None	0	0.90	0.30	0.08	27	0.3	7.3	31153	2505.05	1170	30.4	103.9	0.18	13688.6282
12220	Chiba	Nagareyama	None	0	0.81	0.26	0.08	27	0.3	7.3	163984	19061.21	4101	969.17	824.84	0.21	66290
12221	Chiba	Yachiyo	None	2	0.85	0.30	0.10	28	0.3	7.3	189781	18290.47	5505	857.31	3086.73	0.19	78070
12224	Chiba	Kamagaya	None	1	0.86	0.30	0.08	27	0.3	7.3	107853	9420	3141	522.83	504.3	0.19	42790
7308	Fukushima	Kawamata	None	0	0.92	0.22	0.04	28.67	0.31	7.27	15569	2079.15	812	294.66	340.91	0	5640
9213	Tochigi	Nasushiobara	None	0	0.73	0.24	0.08	26	0.31	7	117812	16232.66	5966	2510.2	5421.77	0.24	51766.5928
4323	Miyagi	Shibata	None	0	0.80	0.38	0.10	41	0.32	7.96	39341	6784.73	1348	415.96	3303.25	0.3	17286.4354
7303	Fukushima	Kunimi	None	0	0.74	0.26	0.06	26	0.32	7.3	10086	1117.4	414	111.53	310.52	0	4431.7884
7484	Fukushima	Samegawa	None	0	0.67	0.22	0.07	26.36	0.32	7.2	3989	0	198	0	0	0	1752.7666
7501	Fukushima	Ishikawa	None	0	0.70	0.35	0.07	30.17	0.32	7.4	17775	2141.85	1056	376.25	373.15	0	5720
7504	Fukushima	Asakawa	None	0	0.69	0.31	0.07	28	0.32	7.32	6888	0	381	0	0	0	3026.5872
9407	Tochigi	Nasu	None	0	0.85	0.23	0.08	26.14	0.32	7.1	26765	2495.42	1730	480.63	185	0.51	11760.541
3201	Iwate	Morioka	None	2	0.58	0.26	0.07	24.96	0.33	7.23	298348	39237.67	15625	6706.66	5971.49	0.18	140330
9206	Tochigi	Nikko	None	0	1.00	0.10	0.03	15.56	0.33	6.29	90066	10643.34	5171	2312.02	2126.61	0.39	39575.0004
3208	Iwate	Tono	None	0	0.68	0.20	0.07	26.86	0.34	7.3	29331	2389.26	1436	481.65	651.04	0.64	11130
7505	Fukushima	Furudono	None	0	0.80	0.23	0.07	27.38	0.34	7.29	6030	0	335	0	0	0	2649.582
8220	Ibaraki	Tsukuba	None	0	0.76	0.38	0.07	28.17	0.34	7.38	214590	41747.99	8542	3440.96	8455.7	0.22	104070
8223	Ibaraki	Itako	None	1	0.75	0.24	0.08	27.2	0.34	7.2	30534	6025.59	1422	670.9	876.94	0.67	12000
9210	Tochigi	Otawara	None	0	0.95	0.33	0.08	37.33	0.34	7.62	77729	10338.48	3673	660.15	3814.69	0.31	34154.1226
12222	Chiba	Abiko	None	1	0.90	0.26	0.06	25	0.34	7.2	134017	14633.05	3424	761.78	416.78	0.19	56920
12232	Chiba	Shiroi	None	0	1.04	0.28	0.08	27	0.34	7.3	60345	6069.09	1565	357.29	2117.72	0.13	21600

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
8205	Ibaraki	Ishioka	None	0	0.95	0.38	0.08	27.33	0.35	7.23	79687	11868.38	3621	569.34	3960.11	0.59	29800
12217	Chiba	Kashiwa	None	0	0.97	0.26	0.06	26	0.35	7.3	404012	43708.27	12468	1789.26	5681.28	0.14	180970
3441	Iwate	Sumita	None	0	0.76	0.20	0.06	26.5	0.36	7.35	6190	0	289	0	0	0	2719.886
4341	Miyagi	Marumori	None	1	0.99	0.37	0.08	33.86	0.36	7.57	15501	0	595	0	0	0.67	6811.1394
7210	Fukushima	Nihonmatsu	None	0	1.03	0.22	0.04	32.35	0.36	7.51	59871	4769.76	2896	672.96	2067.33	0	20090
7502	Fukushima	Tamakawa	None	0	0.76	0.38	0.08	32	0.36	7.5	7231	0	408	0	0	0	3177.3014
8302	Ibaraki	Ibaraki	None	0	0.88	0.26	0.08	29	0.36	7.44	34513	2265.2	1368	81.95	2657.29	0.6	11760
12228	Chiba	Yotsukaido	None	0	0.90	0.30	0.08	29	0.36	7.4	86726	11497.99	2555	394.63	664.16	0.22	34580
7213	Fukushima	Date	None	0	0.94	0.28	0.07	27.25	0.37	7.35	66027	5770.58	3086	626.45	2496.26	0	22240
3206	Iwate	Kitakami	None	1	1.38	0.35	0.09	27.33	0.38	7.22	93138	12270.82	4730	1617.59	9493.94	0.41	39370
4424	Miyagi	Ohira	None	0	0.72	0.40	0.10	36	0.38	7.6	5334	819.41	288	0	4527.75	0	2343.7596
7214	Fukushima	Motomiya	None	0	0.98	0.25	0.06	32.5	0.38	7.5	31489	2803.78	1552	208.9	2803.25	0	10250
7544	Fukushima	Kawauchi	None	0	0.96	0.30	0.06	30.29	0.38	7.5	2820	0	139	0	0	0	1239.108
8227	Ibaraki	Chikusei	None	2	0.95	0.32	0.12	30	0.38	7.48	108527	10295.62	5289	855.53	4092.56	0.53	38870
7564	Fukushima	Iitate	None	0	0.93	0.20	0.06	27.67	0.39	7.3	6209	0	255	0	0	0	2728.2346
7465	Fukushima	Nakajima	None	0	0.86	0.54	0.10	37	0.4	7.8	5154	0	197	0	0	0	2264.6676
7503	Fukushima	Hirata	None	0	1.04	0.26	0.06	32.2	0.4	7.5	6921	0	305	0	0	0	3041.0874
8203	Ibaraki	Tsuchiura	None	0	0.86	0.42	0.12	30.36	0.4	7.48	143839	23257.17	7239	2997.78	6554.37	0.35	66820
8364	Ibaraki	Daigo	None	2	1.15	0.25	0.04	29.38	0.4	7.4	20073	841.15	1226	132.45	0	0.87	8190
8443	Ibaraki	Ami	None	0	0.85	0.38	0.13	31	0.4	7.5	47940	9621.25	1576	129.12	4287.85	0.33	20920
9201	Tochigi	Utsunomiya	None	2	1.12	0.31	0.06	30.7	0.4	7.27	511739	73116.86	23841	4769.9	16204.76	0.22	224858.1166
9214	Tochigi	Sakura	None	0	1.12	0.43	0.10	40	0.4	7.89	44768	5791.16	1706	298.51	3636.49	0.4	19671.0592
7207	Fukushima	Sukagawa	None	1	0.83	0.40	0.08	35.14	0.41	7.46	79267	8328.42	3455	749.06	4939.24	0	27250
4208	Miyagi	Kakuda	None	0	1.14	0.50	0.12	41	0.42	7.9	31336	5202.42	1424	515.03	3376.1	0.58	13769.0384
7466	Fukushima	Yabuki	None	0	0.94	0.74	0.12	41	0.42	7.9	18407	2832.97	826	165.33	825.25	0	6460
12231	Chiba	Inzai	None	0	1.03	0.26	0.05	24.86	0.43	7.2	88176	13216.07	2450	1464	3891.65	0.22	23190
7548	Fukushima	Katsurao	None	0	0.98	0.28	0.04	36	0.46	7.7	1531	0	67	0	0	0	672.7214
8236	Ibaraki	Omitama	None	1	1.42	0.38	0.10	35.75	0.47	7.7	52279	4251.49	2015	89.61	723.73	0.62	18600
4101	Miyagi	Sendai	Aoba	11	0.91	0.48	0.08	34.18	0.48	7.45	291436	38426.4	18887	5704.39	1765.32	0.13	128056.9784

Table A.1 Continued

Code	Prefecture	Municipality	Ku	ground_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xpop	xres	xestab	xcom	xindus	xpwood	xh
7464	Fukushima	Izumizaki	None	1	1.22	0.52	0.10	36	0.48	7.7	6802	0	279	0	0	0	2988.7988
3209	Iwate	Ichinoseki	None	2	1.04	0.25	0.05	30.83	0.49	7.54	127642	9868.48	6420	1823.44	5756.44	0.48	11130
8233	Ibaraki	Namegata	None	0	1.53	0.31	0.10	31.67	0.49	7.5	37611	2094.11	1802	109.09	257.56	0.84	11600
9411	Tochigi	Nakagawa	None	0	1.85	0.36	0.08	51	0.49	7.99	18446	1024.09	967	69.81	233.34	0.68	8105.1724
3402	Iwate	Hiraizumi	None	0	1.12	0.31	0.05	30.91	0.52	7.53	8345	1392.18	464	138.47	0	0	3666.793
7342	Fukushima	Kagamiishi	None	1	1.06	0.70	0.10	44.4	0.52	7.9	12815	2395.7	591	86.59	1072.65	0	5630.911
4421	Miyagi	Taiwa	None	0	0.80	0.37	0.10	34.38	0.54	7.49	24894	4375.88	1189	278.35	4945.69	0.36	10938.4236
7203	Fukushima	Koriyama	None	4	1.19	0.42	0.10	36.73	0.54	7.68	338712	42515.97	17557	5427.14	19139.83	0	145870
4212	Miyagi	Tome	None	4	1.10	0.43	0.10	39.17	0.55	7.85	83969	2991.69	4729	755.84	1268.73	0.49	36895.9786
8216	Ibaraki	Kasama	None	1	1.60	0.29	0.06	35.33	0.56	7.57	79409	6435.42	3893	520.9	2592.12	0.58	31350
9209	Tochigi	Moka	None	0	1.64	0.46	0.06	41.53	0.56	7.9	82289	9892.74	3784	1106.28	5472.56	0.28	36157.7866
8212	Ibaraki	Hitachiota	None	0	1.60	0.30	0.08	34.33	0.57	7.65	56250	4759.56	2332	323.39	971.91	0.62	22640
4422	Miyagi	Osato	None	0	0.84	0.48	0.10	42	0.58	8	8927	0	407	0	0	0	3922.5238
7205	Fukushima	Shirakawa	None	1	1.67	0.41	0.08	32.82	0.58	7.6	64704	9901.82	3352	1124.46	2626.48	0	26740
7522	Fukushima	Ono	None	0	1.24	0.26	0.04	36.62	0.58	7.7	11202	0	627	0	0	0	4922.1588
8231	Ibaraki	Sakuragawa	None	2	1.42	0.33	0.05	37.82	0.58	7.7	45673	5134.81	2400	198.65	3372.38	0.73	15200
8310	Ibaraki	Shirosato	None	2	1.40	0.31	0.07	36.93	0.58	7.71	21491	1544.54	825	47.54	0	0.75	7550
9215	Tochigi	Nasukarasuyama	None	0	1.86	0.39	0.08	50.36	0.58	8.14	29206	1214	1551	219.21	188.64	0.45	12833.1164
9386	Tochigi	Takanezawa	None	0	1.76	0.46	0.10	46	0.58	8.1	30436	3746.9	1084	270.73	1594.91	0.36	13373.5784
4105	Miyagi	Sendai	Izumi	4	0.79	0.48	0.08	33.07	0.6	7.49	211183	36951.63	7159	1284.64	4008.26	0.11	92793.8102
4423	Miyagi	Tomiya	None	2	0.85	0.46	0.11	38.91	0.6	7.8	47042	8822.61	1187	419.59	1743.97	0.13	20670.2548
8226	Ibaraki	Naka	None	0	1.12	0.32	0.10	35	0.6	7.7	54240	6445.21	2119	173.18	2968.69	0.52	20210
7211	Fukushima	Tamura	None	2	1.20	0.30	0.06	40.26	0.61	7.91	40422	1686.44	1951	214	1172.39	0	13530
7461	Fukushima	Nishigou	None	2	1.70	0.28	0.06	30.14	0.61	7.36	19767	1481.22	827	72.6	3633.09	0	7650
7521	Fukushima	Miharu	None	0	1.44	0.31	0.04	39.54	0.62	7.9	18191	2295.22	753	228.21	1337.14	0	6500
8225	Ibaraki	Hitachiomiya	None	0	1.36	0.32	0.08	36.2	0.68	7.7	45178	3291.52	2234	144.18	1621.94	0.61	16850
9342	Tochigi	Mashiko	None	2	2.10	0.48	0.06	47.6	0.75	8.2	24348	2249.35	1207	134.63	551.78	0.5	10698.5112
9343	Tochigi	Motegi	None	0	2.03	0.44	0.07	50.69	0.79	8.24	15018	1648.52	723	62.37	171.24	0.56	6598.9092
9345	Tochigi	Haga	None	0	2.76	0.54	0.10	57	0.82	8.4	16030	674.17	732	0	3706.82	0.48	7043.582
9344	Tochigi	Ichikai	None	0	2.61	0.52	0.08	56.18	0.85	8.4	12094	869.04	484	0	380.07	0	5314.1036
4213	Miyagi	Kurihara	None	0	2.31	0.38	0.11	45.89	1.01	7.77	74932	4935.86	3703	556.13	2857.88	0.6	32925.1208

Appendix B

TSUNAMI FULL DATASET

Table B.1: Full Data set, tsunami

Code	Prefecture	Municipality	Ku	yt	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xarea	xdepth	xpop	xres	xestab	xcom	xindus	xpwood	xpdam3	xpdam2	xpdam1	xpdam123	xdam3	xdam2	xdam1	xdam123	xh
2424	Aomori	Higashidori	None	0.00	0.30	0.13	0.03	14.8	0.13	5.83	24.06	0.03	7252.0	0.0	326	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	0	3187
12238	Chiba	Isumi	None	0.00	0.25	0.20	0.06	19.0	0.09	5.90	6587.97	0.15	40962.0	5270.9	1975	265	244	0.70	0.00	0.00	0.00	0.00	0	1	51	52	18370
4406	Miyagi	Rifu	None	0.00	1.14	0.60	0.10	48.7	1.00	8.10	184706.78	0.70	33994.0	7934.9	1038	373	1135	0.43	0.00	0.00	0.00	0.00	0	0	0	0	14937
2446	Aomori	Hashikami	None	0.00	0.53	0.20	0.06	22.3	0.23	7.00	313471.45	4.88	14699.0	3104.1	462	192	0	0.84	0.00	0.00	0.01	0.01	12	9	33	54	6500
12402	Chiba	Oamishirasato	None	0.00	0.56	0.25	0.08	24.0	0.16	6.92	356642.37	0.47	50113.0	5722.3	1409	184	326	0.44	0.00	0.00	0.00	0.00	0	1	56	57	20360
12423	Chiba	Chosei	None	0.00	0.34	0.22	0.08	23.0	0.14	6.60	407082.73	0.19	14752.0	4166.2	468	0	675	0.00	0.00	0.00	0.00	0.00	0	0	0	0	6482
8201	Ibaraki	Mito	None	0.00	1.06	0.29	0.06	29.8	0.48	7.48	488598.35	0.36	268750.0	34926.4	14605	4580	3441	0.33	0.00	0.01	0.21	0.23	164	1903	27987	30054	132010
12421	Chiba	Ichinomiya	None	0.00	0.32	0.24	0.08	23.0	0.14	6.60	522652.87	0.31	12034.0	1674.4	556	85	0	0.00	0.00	0.00	0.00	0.00	0	0	17	17	5288
3485	Iwate	Fudai	None	0.00	0.66	0.26	0.08	30.0	0.30	7.50	630902.44	6.50	3088.0	0.0	184	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	0	1357
12424	Chiba	Shirako	None	0.00	0.42	0.22	0.08	23.0	0.14	6.80	705615.21	0.40	12151.0	2335.0	494	126	0	0.00	0.00	0.00	0.00	0.00	1	0	0	1	5339
7541	Fukushima	Hirono	None	2.00	0.64	0.26	0.08	30.0	0.30	7.40	888414.60	2.07	5418.0	0.0	289	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	0	2381
3483	Iwate	Iwazumi	None	0.00	0.51	0.19	0.06	22.0	0.25	6.86	949549.86	5.07	10804.0	1044.7	652	233	153	0.00	0.04	0.00	0.00	0.04	177	23	8	208	4747
8234	Ibaraki	Hokota	None	0.00	2.04	0.30	0.10	33.4	0.62	7.60	1032762.53	2.94	50156.0	2309.2	1966	141	529	0.83	0.01	0.05	0.15	0.20	98	735	2240	3073	15370
3484	Iwate	Tanohata	None	0.00	0.64	0.24	0.06	28.0	0.28	7.30	1331234.45	9.10	3843.0	0.0	175	0	0	0.00	0.13	0.03	0.01	0.17	225	45	11	281	1689
4104	Miyagi	Sendai	Taihaku	0.00	0.85	0.41	0.08	33.0	0.42	7.46	1435857.47	0.72	220588.0	30052.8	6218	3398	1967	0.16	0.00	0.00	0.00	0.00	0	0	0	0	96926
7543	Fukushima	Tomioka	None	0.00	0.70	0.26	0.06	30.6	0.30	7.48	1451290.01	2.27	16001.0	2316.2	915	219	133	0.00	0.00	0.00	0.00	0.00	0	0	0	0	6880
8221	Ibaraki	Hitachinaka	None	1.00	1.28	0.30	0.06	32.0	0.47	7.50	1502387.67	2.32	157060.0	26156.8	6034	2167	13533	0.31	0.00	0.01	0.10	0.11	86	801	6099	6986	62360
3507	Iwate	Hirono	None	0.00	0.46	0.14	0.06	18.8	0.18	6.55	1513225.01	4.20	17913.0	0.0	779	0	0	0.69	0.00	0.00	0.01	0.01	10	16	35	61	6650
4401	Miyagi	Matsushima	None	0.00	0.78	0.34	0.08	34.0	0.50	7.60	1682543.36	0.67	15085.0	2495.5	689	586	0	0.47	0.00	0.00	0.00	0.00	0	0	0	0	6628
12410	Chiba	Yokoshibahikari	None	0.00	0.44	0.26	0.08	28.0	0.18	7.20	1686082.67	0.27	24675.0	4631.6	1179	236	1351	0.61	0.00	0.00	0.03	0.03	6	8	282	296	10040
7545	Fukushima	Okuma	None	0.00	0.74	0.27	0.06	30.6	0.30	7.48	1728604.51	4.61	11515.0	951.3	582	104	854	0.00	0.01	0.00	0.00	0.01	48	0	0	48	5060
2412	Aomori	Oirase	None	0.00	0.46	0.34	0.11	21.0	0.18	6.80	1940501.04	1.81	24211.0	2076.3	977	345	602	0.24	0.00	0.01	0.01	0.02	23	46	76	145	9140
8215	Ibaraki	Kitaibaraki	None	1.00	0.86	0.45	0.08	34.3	0.33	7.49	1951864.92	3.19	47026.0	7908.1	1986	480	3916	0.48	0.01	0.07	0.24	0.32	188	1335	4728	6251	19840
12235	Chiba	Sosa	None	0.00	0.46	0.26	0.08	25.0	0.20	7.10	2000832.96	0.17	39814.0	2725.5	2025	173	745	0.65	0.00	0.00	0.12	0.12	7	20	1693	1720	14160
8341	Ibaraki	Tokai	None	2.00	0.90	0.26	0.08	32.0	0.34	7.50	2113499.21	3.61	37438.0	4108.2	1327	206	3390	0.28	0.00	0.01	0.26	0.27	28	158	3855	4041	14790
3503	Iwate	Noda	None	1.00	0.58	0.22	0.08	27.0	0.26	7.20	2333672.08	5.41	4632.0	429.3	218	99	32	0.00	0.15	0.08	0.02	0.25	311	168	35	514	2035
12202	Chiba	Choshi	None	2.00	0.50	0.20	0.05	21.1	0.20	6.87	2519288.28	0.35	70210.0	9150.8	4532	1248	3563	0.39	0.00	0.00	0.09	0.09	25	137	2644	2806	30070
7542	Fukushima	Naraha	None	2.00	0.70	0.26	0.06	30.6	0.30	7.48	2566519.21	3.29	7700.0	0.0	372	0	0	0.00	0.01	0.00	0.00	0.01	50	0	0	50	3383
2411	Aomori	Rokkasho	None	0.00	0.32	0.15	0.04	16.2	0.15	6.16	2640728.81	1.17	11095.0	3575.0	625	807	32338	0.00	0.00	0.00	0.00	0.00	0	0	0	0	4875

Table B.1 continued

Code	Prefecture	Municipality	Ku	all_31	all_10	ground_31	ground_10	tsun_31	tsun_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xdepth	xarea	xvol2	xpop	xestab	xwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123	xhouses
13303	Tokyo	Mizuho	None	0	0	0	0	0	0	0.44	0.14	0.04	14.8	0.14	6.2	4996.32	185.35	1796.89	0	0	0	33497	1682	0.25	0	0	0	0	0.00	0.00	0.00	0.00	14718.5818
14104	Kanagawa	Yokohama	Naka	0	0	0	0	0	0	0.36	0.32	0.08	28	0.14	7	6743.43	3664.58	995.18	0	0	0	146033	14853	0.1	0	0	0	0	0.00	0.00	0.00	0.00	64166.9002
14105	Kanagawa	Yokohama	Minami	0	0	0	0	0	0	0.32	0.30	0.08	26	0.14	6.8	8367.42	2272.88	430.47	0	0	0	196153	6254	0.12	0	0	0	0	0.00	0.00	0.00	0.00	86189.6282
14106	Kanagawa	Yokohama	Hodogaya	0	0	0	0	0	0	0.30	0.23	0.05	22.57	0.14	6.5	12267.07	954.78	658.83	0	0	0	206634	5414	0.12	0	0	0	0	0.00	0.00	0.00	0.00	90794.9796
14116	Kanagawa	Yokohama	Izumi	0	0	0	0	0	0	0.30	0.16	0.06	21	0.14	6.4	10662.66	241.58	200.48	0	0	0	155698	3885	0.03	0	0	0	0	0.00	0.00	0.00	0.00	68413.7012
14135	Kanagawa	Kawasaki	Tama	0	0	0	0	0	0	0.36	0.17	0.06	19.5	0.14	6.6	15832.54	927.63	304.68	0	0	0	213894	5262	0.12	0	0	0	0	0.00	0.00	0.00	0.00	93985.0236
14209	Kanagawa	Sagamihara	None	2	2	2	2	0	0	0.32	0.16	0.06	16.55	0.14	5.88	47580.99	4798.75	11498.05	0	0	0	717544	25287	0.17	0	0	0	0	0.00	0.00	0.00	0.00	315288.8336
14216	Kanagawa	Zama	None	0	0	0	0	0	0	0.40	0.18	0.06	19	0.14	6.6	8484.43	528.94	1989.07	0	0	0	129436	3679	0.14	0	0	0	0	0.00	0.00	0.00	0.00	56874.1784
14218	Kanagawa	Ayase	None	0	0	0	0	0	0	0.36	0.20	0.06	21	0.14	6.8	6190.84	162.83	3114.21	0	0	0	83167	3237	0.21	0	0	0	0	0.00	0.00	0.00	0.00	36543.5798
6382	Yamagata	Kawanishi	None	0	0	0	0	0	0	0.46	0.22	0.06	20.86	0.15	6.67	1211.15	132.23	227.46	0	0	0	17313	765	0.56	0	0	0	0	0.00	0.00	0.00	0.00	7607.3322
6461	Yamagata	Yuza	None	0	0	0	0	0	0	0.31	0.14	0.04	15.67	0.15	6.2	893.79	141.83	1258.66	0	0	0	15480	721	0.34	0	0	0	0	0.00	0.00	0.00	0.00	6801.912
10201	Gumma	Maebashi	None	0	0	0	0	0	0	0.40	0.18	0.04	19	0.15	6.51	33527.91	6521.94	11839.93	0	0	0	340291	18129	0.31	0	0	0	0	0.00	0.00	0.00	0.00	149523.8654
10209	Gumma	Fujioka	None	0	0	0	0	0	0	0.43	0.14	0.03	15	0.15	6.3	5485.64	457.93	2149.37	0	0	0	67975	3334	0.4	0	0	0	0	0.00	0.00	0.00	0.00	29868.215
2402	Aomori	Shichinohe	None	0	0	0	0	0	0	0.37	0.17	0.07	19	0.16	6.49	2801.2	392.01	173.67	0	0	0	16759	808	0.28	0	0	3	3	0.00	0.00	0.00	0.00	6850
2441	Aomori	Sannohe	None	0	0	0	0	0	0	0.38	0.22	0.07	19	0.16	6.57	1803.61	181.98	257.22	0	0	0	11299	534	0	0	0	0	0	0.00	0.00	0.00	0.00	4964.7806
2445	Aomori	Nanbu	None	0	0	0	0	0	0	0.42	0.21	0.04	17.45	0.16	6.64	933.25	44.69	94.9	0	0	0	19853	813	0.51	0	0	0	0	0.00	0.00	0.00	0.00	7370
5434	Akita	Misato	None	0	0	0	0	0	0	0.42	0.18	0.04	19.33	0.16	6.7	1645.84	209.85	232.4	0	0	0	21674	1023	0.23	0	0	0	0	0.00	0.00	0.00	0.00	9523.5556
6207	Yamagata	Kaminoyama	None	0	0	0	0	0	0	0.38	0.30	0.06	18.2	0.16	6.57	4953.7	568.33	1352.42	0	0	0	33836	1644	0.36	0	0	0	0	0.00	0.00	0.00	0.00	14867.5384
6301	Yamagata	Yamanobe	None	0	0	0	0	0	0	0.48	0.18	0.10	25	0.16	6.9	1716.36	0	425.71	0	0	0	15139	586	0.72	0	0	0	0	0.00	0.00	0.00	0.00	6652.0766
6302	Yamagata	Nakayama	None	0	0	0	0	0	0	0.45	0.16	0.08	22	0.16	6.7	1895.06	0	200.04	0	0	0	12015	447	0	0	0	0	0	0.00	0.00	0.00	0.00	5279.391
6321	Yamagata	Kahoku	None	0	0	0	0	0	0	0.42	0.16	0.06	19	0.16	6.7	2235.44	322.39	937.18	0	0	0	19959	1079	0.52	0	0	0	0	0.00	0.00	0.00	0.00	8769.9846
6323	Yamagata	Asahi	None	0	0	0	0	0	0	0.39	0.16	0.04	18	0.16	6.6	672.48	86.27	242.35	0	0	0	7856	416	0	0	0	0	0	0.00	0.00	0.00	0.00	3451.9264
10206	Gumma	Numata	None	0	0	0	0	0	0	0.27	0.10	0.03	11	0.16	5.93	5533.26	544.69	1722.4	0	0	0	51265	3088	0.38	0	0	0	0	0.00	0.00	0.00	0.00	22525.841
11101	Saitama	Saitama	Nishi	0	0	0	0	0	0	0.38	0.24	0.06	23	0.16	6.9	6994.41	39.6	806.53	0	0	0	84029	2348	0.17	0	0	0	0	0.00	0.00	0.00	0.00	36922.3426
11106	Saitama	Saitama	Sakura	0	0	0	0	0	0	0.38	0.26	0.08	24	0.16	6.9	2178.93	0	255.84	0	0	0	96911	2628	0.11	0	0	0	0	0.00	0.00	0.00	0.00	42582.6934
11201	Saitama	Kawagoe	None	0	0	0	0	0	0	0.38	0.15	0.06	19	0.16	6.5	23830.57	1906.58	4352.49	0	0	0	342670	11657	0.21	0	0	0	0	0.00	0.00	0.00	0.00	150569.198
11202	Saitama	Kumagaya	None	0	0	0	0	0	0	0.46	0.18	0.04	18	0.16	6.64	15890.17	2474.36	7528.1	0	0	0	203180	9423	0.3	0	0	0	0	0.00	0.00	0.00	0.00	89277.292
11215	Saitama	Sayama	None	1	1	1	1	0	0	0.44	0.12	0.06	16	0.16	6.4	10516.88	607.28	3233.76	0	0	0	155727	5164	0.21	0	0	0	0	0.00	0.00	0.00	0.00	68426.4438
11217	Saitama	Konosu	None	1	1	1	1	0	0	0.40	0.16	0.04	19	0.16	6.7	12054.57	786.97	2348.59	0	0	0	119639	4026	0.27	0	0	0	0	0.00	0.00	0.00	0.00	52569.3766
11229	Saitama	Wako	None	0	0	0	0	0	0	0.40	0.24	0.08	24	0.16	6.8	4549.41	193.99	1699.45	0	0	0	80745	1965	0.11	0	0	0	0	0.00	0.00	0.00	0.00	35479.353
11233	Saitama	Kitamoto	None	0	0	0	0	0	0	0.40	0.16	0.04	20	0.16	6.7	6339.38	180.47	526.65	0	0	0	68888	2089	0.13	0	0	0	0	0.00	0.00	0.00	0.00	30269.3872
11242	Saitama	Hidaka	None	0	0	0	0	0	0	0.56	0.08	0.03	15	0.16	6.15	5092.94	182.72	1068.97	0	0	0	57473	1917	0.38	0	0	0	0	0.00	0.00	0.00	0.00	25253.6362
11245	Saitama	Fujimino	None	0	0	0	0	0	0	0.42	0.18	0.08	20	0.16	6.7	7382.1	435.86	375.32	0	0	0	105695	3386	0.17	0	0	0	0	0.00	0.00	0.00	0.00	46442.383
11342	Saitama	Ranzan	None	0	0	0	0	0	0	0.36	0.12	0.04	13.67	0.16	6.3	1376.11	180.28	193.93	0	0	0	18887	859	0.3	0	0	0	0	0.00	0.00	0.00	0.00	8298.9478
11343	Saitama	Ogawa	None	0	0	0	0	0	0	0.31	0.12	0.03	13	0.16	6.2	3777.98	329.92	1190.48	0	0	0	32913	1526	0.2	0	0	0	0	0.00	0.00	0.00	0.00	14461.9722
11346	Saitama	Kawajima	None	0	0	0	0	0	0	0.40	0.16	0.04	19	0.16	6.7	1897.47	0	1213.81	0	0	0	22147	964	0.5	0	0	0	0	0.00	0.00	0.00	0.00	9731.3918
11347	Saitama	Yoshimi	None	0	0	0	0	0	0	0.40	0.14	0.04	18	0.16	6.6	1042.12	0	573.61	0	0	0	21079	787	0.38	0	0	0	0	0.00	0.00	0.00	0.00	9262.1126
11369	Saitama	Higashichichibu	None	0	0	0	0	0	0	0.25	0.10	0.03	11	0.16	6.1	0	0	0	0	0	0	3348	180	0	0	0	0	0	0.00	0.00	0.00	0.00	1471.1112
11385	Saitama	Kamisato	None	0	0	0	0	0	0	0.40	0.18	0.04	20	0.16	6.7	830.48	110.55	1031.64	0	0	0	30998	1032	0.52	0	0	0	0	0.00	0.00	0.00	0.00	13620.5212
13120	Tokyo	Nerima	None	3	3	3	3	0	0	0.46	0.24	0.08	23	0.16	6.8	38538.45	3886.87	1426.11	0	0	0	716124	22183	0.11	0	0	0	0	0.00	0.00	0.00	0.00	314664.8856
13219	Tokyo	Komae	None	0	0	0	0	0	0	0.38	0.18	0.06	21	0.16	6.7	3224.98	77.28	250.38	0	0	0	78751	2327	0.1	0	0	0	0	0.00	0.00	0.00	0.00	34603.1894
13227	Tokyo	Hamura	None	0	0	0	0	0	0	0.46	0.14	0.04	15	0.16	6.3	5303.81	248.53	786.17	0	0	0	57032	2241	0.16	0	0	0	0	0.00	0.00	0.00	0.00	25059.8608
14101	Kanagawa	Yokohama	Tsurumi	0	0	0	0	0	0	0.36	0.26	0.10	26.33	0.16	6.96	11611.68	4648.56	6633.46	0	0	0	272178	9672	0.14	0	0	0	0	0.00	0.00	0.00	0.00	119595.0132
14102	Kanagawa	Yokohama	Kanagawa	0	0	0	0	0	0	0.36	0.26	0.06	24.86	0.16	6.88	10859.47	2885.74	1796.54	0	0	0	233429	9337	0.12	0	0	0	0	0.00	0.00	0.00	0.00	102568.7026
14103	Kanagawa	Yokohama	Nishi	0	0	0	0	0	0	0.36	0.32	0.08	28	0.16	7.1	2600.24	3502.56	282.95	0	0	0	94867	8226	0.1	0	0	0	0	0.00	0.00	0.00	0.00	41684.5598
14109	Kanagawa	Yokohama	Kohoku	0	0	0	0	0	0	0.38	0.24	0.10	25.6	0.16	7	14655.62	2239.45	3352.08	0	0	0	329471	11797	0.11	0	0	0	0	0.00	0.00	0.00	0.00	144769.5574
14131	Kanagawa	Kawasaki	Kawasaki	2	2	2	2	0	0	0.38	0.24	0.12	27	0.16	7	6428.62	3295.95	18159.38	0	0	0	217328	11971	0.13	0	0	0	0	0.00	0.00	0.00	0.00	95493.9232
14132	Kanagawa	Kawasaki	Saiwai	0	0	0	0	0	0	0.40	0.28	0.14	29	0.16	7.1	4421.33	1430.76	1107.98	0	0	0	154212	5112	0.1	0	0	0	0	0.00	0.00	0.00	0.00	67760.7528
14133	Kanagawa	Kawasaki	Nakahara	0	0	0	0	0	0	0.42	0.26	0.10	27	0.16	7	9624.01	1975.58	961.92	0	0	0	233925	7303	0.13	0	0	0	0	0.00	0.00	0.00	0.00	102786.645

Table B.1 continued

Code	Prefecture	Municipality	Ku	all_31	all_10	ground_31	ground_10	tsun_31	tsun_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xdepth	xarea	xvol2	xpop	xestab	xwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123	xhouses
14134	Kanagawa	Kawasaki	Takatsu	0	0	0	0	0	0	0.38	0.20	0.06	23	0.16	6.8	10967.95	904.53	2175.88	0	0	0	217360	6302	0.07	0	0	0	0	0.00	0.00	0.00	0.00	95507.984
14136	Kanagawa	Kawasaki	Miyamae	0	0	0	0	0	0	0.38	0.20	0.06	21	0.16	6.7	15405.18	987.17	274.83	0	0	0	218867	4508	0.08	0	0	0	0	0.00	0.00	0.00	0.00	96170.1598
14137	Kanagawa	Kawasaki	Asao	0	0	0	0	0	0	0.38	0.20	0.10	20.8	0.16	6.64	14388.7	625.68	334.97	0	0	0	169926	3652	0.14	0	0	0	0	0.00	0.00	0.00	0.00	74665.4844
2442	Aomori	Gonohe	None	0	0	0	0	0	0	0.41	0.27	0.07	19.09	0.17	6.68	2713.45	174.36	625.49	0	0	0	18712	744	0.46	0	0	0	0	0.00	0.00	0.00	0.00	6770
11363	Saitama	Nagatoro	None	0	0	0	0	0	0	0.26	0.10	0.03	12	0.17	6.07	0	0	0	0	0	0	7908	479	0	0	0	0	0	0.00	0.00	0.00	0.00	3474.7752
2408	Aomori	Tohoku	None	0	0	0	0	0	0	0.42	0.18	0.08	19.83	0.18	6.74	2877.35	324.94	520.37	0	0	0	19106	880	0.37	0	0	0	0	0.00	0.00	0.00	0.00	6360
2450	Aomori	Shingo	None	0	0	0	0	0	0	0.40	0.28	0.06	20.8	0.18	6.66	0	0	0	0	0	0	2851	142	0	0	0	0	0	0.00	0.00	0.00	0.00	1252.7294
3214	Iwate	Hachimantai	None	0	0	0	0	0	0	0.37	0.22	0.06	19.45	0.18	6.3	1896.27	499.43	834.37	0	0	0	28680	1435	0.35	0	0	0	0	0.00	0.00	0.00	0.00	12260
3301	Iwate	Shizukuishi	None	0	0	0	0	0	0	0.46	0.21	0.07	19.4	0.18	6.73	1305.41	273.7	0	0	0	0	18033	834	0.5	0	0	2	2	0.00	0.00	0.00	0.00	6100
3501	Iwate	Karumai	None	0	0	0	0	0	0	0.56	0.17	0.03	18.18	0.18	6.57	0		0	0	0	0	10209	469	0	0	0	0	0	0.00	0.00	0.00	0.00	4485.8346
6201	Yamagata	Yamagata	None	0	0	0	0	0	0	0.50	0.18	0.10	23.82	0.18	6.93	28552.15	3370.83	8053.99	0	0	0	254244	14618	0.29	0	0	0	0	0.00	0.00	0.00	0.00	111714.8136
6202	Yamagata	Yonezawa	None	0	0	0	0	0	0	0.55	0.28	0.06	21.43	0.18	6.83	15496.11	1398.43	7060.52	0	0	0	89401	5193	0.15	0	0	0	0	0.00	0.00	0.00	0.00	39282.7994
6208	Yamagata	Murayama	None	1	0	1	0	0	0	0.47	0.17	0.07	20.33	0.18	6.83	2935.18	386.51	1074.91	0	0	0	26811	1433	0.47	0	0	0	0	0.00	0.00	0.00	0.00	11780.7534
6210	Yamagata	Tendo	None	3	3	3	3	0	0	0.57	0.18	0.06	21	0.18	6.8	6959.15	981.94	2856	0	0	0	62214	3260	0.43	0	0	0	0	0.00	0.00	0.00	0.00	27336.8316
6363	Yamagata	Funagata	None	0	0	0	0	0	0	0.41	0.16	0.06	18.4	0.18	6.7	0	0	0	0	0	0	6164	279	0	0	0	0	0	0.00	0.00	0.00	0.00	2708.4616
6381	Yamagata	Takahata	None	0	0	0	0	0	0	0.60	0.34	0.06	20	0.18	6.8	2725.68	187.92	621.71	0	0	0	25025	1220	0.45	0	0	0	0	0.00	0.00	0.00	0.00	10995.985
7362	Fukushima	Shimogo	None	0	0	0	0	0	0	0.42	0.15	0.04	15.56	0.18	6.43	0	0	0	0	0	0	6461	427	0	0	0	0	0	0.00	0.00	0.00	0.00	2838.9634
7421	Fukushima	Aizubange	None	0	0	0	0	0	0	0.48	0.21	0.07	19.75	0.18	6.7	1566.1	335.69	721.39	0	0	0	17360	1072	0	2	7	32	41	0.00	0.00	0.01	0.01	5910
9367	Tochigi	Iwafune	None	0	0	0	0	0	0	0.46	0.16	0.06	18	0.18	6.6	3327.42	65.81	315.14	0	0	0	18241	984	0.55	0	0	0	0	0.00	0.00	0.00	0.00	8015.0954
10204	Gumma	Isesaki	None	0	0	0	0	0	0	0.54	0.22	0.04	22	0.18	6.96	24397.51	2428.22	10869.58	0	0	0	207221	9631	0.32	0	0	0	0	0.00	0.00	0.00	0.00	91052.9074
10523	Gumma	Chiyoda	None	0	0	0	0	0	0	0.50	0.20	0.06	20	0.18	6.8	1388.72	218.93	524.39	0	0	0	11473	556	0	0	0	0	0	0.00	0.00	0.00	0.00	5041.2362
11102	Saitama	Saitama	Kita	1	1	1	1	0	0	0.40	0.26	0.06	25	0.18	7	10164.33	698.76	2255.02	0	0	0	138630	4934	0.1	0	0	0	0	0.00	0.00	0.00	0.00	60914.022
11103	Saitama	Saitama	Omiya	0	0	0	0	0	0	0.32	0.30	0.08	26	0.18	7.1	6482.2	1918.62	344.71	0	0	0	108488	7514	0.2	0	0	0	0	0.00	0.00	0.00	0.00	47669.6272
11105	Saitama	Saitama	Chuo	0	0	0	0	0	0	0.36	0.30	0.08	26	0.18	7.1	5042.35	435.21	1370.19	0	0	0	96055	3106	0.11	0	0	0	0	0.00	0.00	0.00	0.00	42206.567
11107	Saitama	Saitama	Urawa	0	0	0	0	0	0	0.38	0.34	0.08	27	0.18	7.1	5691.39	2283.65	323.3	0	0	0	144786	6304	0.13	0	0	0	0	0.00	0.00	0.00	0.00	63618.9684
11108	Saitama	Saitama	Minami	0	0	0	0	0	0	0.42	0.30	0.08	26	0.18	7.1	8323.38	672.76	1093.33	0	0	0	174988	4768	0.12	0	0	0	0	0.00	0.00	0.00	0.00	76889.7272
11210	Saitama	Kazo	None	0	0	0	0	0	0	0.45	0.22	0.06	23	0.18	7	8632.13	865.95	3765.5	0	0	0	115002	4659	0.25	0	0	0	0	0.00	0.00	0.00	0.00	50531.8788
11219	Saitama	Ageo	None	0	0	0	0	0	0	0.40	0.24	0.06	23	0.18	7	18325.53	614.02	4694.07	0	0	0	223926	6799	0.15	0	0	0	0	0.00	0.00	0.00	0.00	98393.0844
11224	Saitama	Toda	None	0	0	0	0	0	0	0.42	0.30	0.08	27	0.18	7.1	5656.21	707.73	4947.89	0	0	0	123079	5827	0.17	0	0	0	0	0.00	0.00	0.00	0.00	54080.9126
11231	Saitama	Okegawa	None	0	0	0	0	0	0	0.42	0.18	0.06	21	0.18	6.9	4215.72	282.58	1252.96	0	0	0	74711	2638	0.22	0	0	0	0	0.00	0.00	0.00	0.00	32828.0134
11238	Saitama	Hasuda	None	0	0	0	0	0	0	0.48	0.28	0.06	25	0.18	7	4728.23	187.12	744.87	0	0	0	63309	1800	0.11	0	0	0	0	0.00	0.00	0.00	0.00	27817.9746
11301	Saitama	Ina	None	0	0	0	0	0	0	0.46	0.24	0.06	24	0.18	7	4361.43	480.61	838.17	0	0	0	42494	1365	0.3	0	0	0	0	0.00	0.00	0.00	0.00	18671.8636
11381	Saitama	Misato	None	0	0	0	0	0	0	0.32	0.12	0.04	15.2	0.18	6.45	0	0	0	0	0	0	11605	476	0	0	0	0	0	0.00	0.00	0.00	0.00	5099.237
13106	Tokyo	Taito	None	0	0	0	0	0	0	0.44	0.42	0.08	27	0.18	7.1	1972.62	7373.46	66.39	0	0	0	175928	26484	0.08	0	0	0	0	0.00	0.00	0.00	0.00	77302.7632
13107	Tokyo	Sumida	None	2	2	2	2	0	0	0.43	0.42	0.08	28	0.18	7	781.2	4864.12	5376.73	0	0	0	247606	18084	0.09	0	0	0	0	0.00	0.00	0.00	0.00	108798.0764
13108	Tokyo	Koto	None	2	1	2	1	0	0	0.48	0.44	0.12	31	0.18	7.2	6899.17	3557.78	24383.87	0	0	0	460819	20294	0.03	0	0	0	0	0.00	0.00	0.00	0.00	202483.8686
13109	Tokyo	Shinagawa	None	1	1	1	1	0	0	0.46	0.32	0.12	28	0.18	7.3	8901.72	4026.36	6173.41	0	0	0	365302	22584	0.07	0	0	0	0	0.00	0.00	0.00	0.00	160513.6988
13110	Tokyo	Meguro	None	0	0	0	0	0	0	0.48	0.28	0.10	26	0.18	7.1	11137.58	1094.8	813.7	0	0	0	268330	12707	0.07	0	0	0	0	0.00	0.00	0.00	0.00	117904.202
13111	Tokyo	Ota	None	0	0	0	0	0	0	0.42	0.28	0.12	28.33	0.18	7.2	21503.68	4778.03	10602.53	0	0	0	693373	33931	0.12	0	0	0	0	0.00	0.00	0.00	0.00	304668.0962
13112	Tokyo	Setagaya	None	1	1	1	1	0	0	0.44	0.24	0.10	24	0.18	6.9	47207.22	4092.53	585.67	0	0	0	877138	24766	0.07	0	0	0	0	0.00	0.00	0.00	0.00	385414.4372
13114	Tokyo	Nakano	None	1	1	1	1	0	0	0.52	0.26	0.08	25	0.18	7.1	9581.84	1829.18	215.73	0	0	0	314750	14367	0.07	0	0	0	0	0.00	0.00	0.00	0.00	138301.15
13115	Tokyo	Suginami	None	1	1	1	1	0	0	0.48	0.22	0.08	23	0.18	6.9	27582.79	4312.2	530.18	0	0	0	549569	21762	0.09	0	0	0	0	0.00	0.00	0.00	0.00	241480.6186
13118	Tokyo	Arakawa	None	1	1	1	1	0	0	0.42	0.38	0.08	25	0.18	7.1	1155.02	2055.18	6268.68	0	0	0	203296	10951	0.01	0	0	0	0	0.00	0.00	0.00	0.00	89328.2624
13119	Tokyo	Itabashi	None	0	0	0	0	0	0	0.46	0.30	0.08	27	0.18	7.1	17767.67	3799.71	6702.82	0	0	0	535824	21062	0.09	0	0	0	0	0.00	0.00	0.00	0.00	235441.0656
13209	Tokyo	Machida	None	0	0	0	0	0	0	0.41	0.18	0.06	19.5	0.18	6.55	35552.3	1949.29	1658.29	0	0	0	426987	12855	0.12	0	0	0	0	0.00	0.00	0.00	0.00	187618.0878
14112	Kanagawa	Yokohama	Asahi	2	2	2	2	0	0	0.40	0.19	0.05	23.5	0.18	6.6	16964.03	559.5	1142	0	0	0	251086	5867	0.14	0	0	0	0	0.00	0.00	0.00	0.00	110327.1884
14114	Kanagawa	Yokohama	Seya	0	0	0	0	0	0	0.42	0.20	0.08	25	0.18	6.9	9944.3	325.34	219.46	0	0	0	126913	3573	0.14	0	0	0	0	0.00	0.00	0.00	0.00	55765.5722
14117	Kanagawa	Yokohama	Aoba	0	0	0	0	0	0	0.42	0.20	0.06	23	0.18	6.9	22510.35	963.96	0	0	0	0	304297	7389	0.11	0	0	0	0	0.00	0.00	0.00	0.00	133708.1018
14118	Kanagawa	Yokohama	Tsuzuki	0	0	0	0	0	0	0.39	0.21	0.05	22.4	0.18	6.8	12875.11	1197.69	1372.09	0	0	0	201271	7501	0.1	0	0	0	0	0.00	0.00	0.00	0.00	88438.4774

Table B.1 continued

Code	Prefecture	Municipality	Ku	all_31	all_10	ground_31	ground_10	tsun_31	tsun_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xdepth	xarea	xvol2	xpop	xestab	xwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123	xhouses
14213	Kanagawa	Yamato	None	1	1	1	1	0	0	0.40	0.22	0.08	23	0.18	6.9	12939.47	1481.09	3641.31	0	0	0	228186	8232	0.18	0	0	0	0	0.00	0.00	0.00	0.00	100264.9284
2405	Aomori	Rokunohe	None	0	0	0	0	0	0	0.45	0.28	0.08	21	0.19	6.8	3182.76	166.34	1009.3	0	0	0	10241	415	0	0	0	0	0	0.00	0.00	0.00	0.00	4499.8954
9204	Tochigi	Sano	None	0	0	0	0	0	0	0.40	0.13	0.06	17.5	0.19	6.63	18224.25	1670.01	9718.13	0	0	0	121249	7193	0.28	0	0	0	0	0.00	0.00	0.00	0.00	53276.8106
3302	Iwate	Kuzumaki	None	0	0	0	0	0	0	0.46	0.11	0.03	14.77	0.2	6.19	0	0	0	0	0	0	7304	346	0	0	0	0	0	0.00	0.00	0.00	0.00	3209.3776
3366	Iwate	Nishiwaga	None	1	1	1	1	0	0	0.53	0.15	0.04	18.43	0.2	6.65	0	0	0	0	0	0	6602	444	0	0	0	0	0	0.00	0.00	0.00	0.00	2900.9188
5203	Akita	Yokote	None	0	0	0	0	0	0	0.70	0.13	0.06	17.13	0.2	6.33	10596.07	2317.09	4166.88	0	0	0	98367	5637	0.33	0	0	0	0	0.00	0.00	0.00	0.00	43222.4598
6211	Yamagata	Higashine	None	0	0	0	0	0	0	0.55	0.18	0.06	20	0.2	6.85	6516.12	747.03	3089.36	0	0	0	46414	1985	0.41	0	0	0	0	0.00	0.00	0.00	0.00	20394.3116
6212	Yamagata	Obanazawa	None	0	0	0	0	0	0	0.56	0.17	0.06	22.29	0.2	6.97	1784.14	325.28	867.15	0	0	0	18955	1119	0.51	0	0	0	0	0.00	0.00	0.00	0.00	8328.827
6341	Yamagata	Oishida	None	0	0	0	0	0	0	0.52	0.18	0.06	20	0.2	6.9	1127.14	209.75	185.13	0	0	0	8160	438	0	0	0	0	0	0.00	0.00	0.00	0.00	3585.504
6362	Yamagata	Mogami	None	0	0	0	0	0	0	0.40	0.18	0.08	24	0.2	7	859.54	51.43	95.1	0	0	0	9847	540	0	0	0	0	0	0.00	0.00	0.00	0.00	4326.7718
7407	Fukushima	Bandai	None	0	0	0	0	0	0	0.54	0.30	0.10	25	0.2	7.1	0	0	0	0	0	0	3761	165	0	0	0	8	8	0.00	0.00	0.00	0.00	1652.5834
10207	Gumma	Tatebayashi	None	0	0	0	0	0	0	0.46	0.18	0.06	21	0.2	6.9	11690.76	1345.2	3727.6	0	0	0	78608	4121	0.42	0	0	0	0	0.00	0.00	0.00	0.00	34540.3552
10212	Gumma	Midori	None	0	0	0	0	0	0	0.42	0.15	0.04	18.73	0.2	6.6	0	0	0	0	0	0	51899	2723	0.49	0	0	0	0	0.00	0.00	0.00	0.00	22804.4206
10443	Gumma	Katashina	None	0	0	0	0	0	0	0.24	0.08	0.03	11.6	0.2	5.84	0	0	0	0	0	0	4904	484	0	0	0	0	0	0.00	0.00	0.00	0.00	2154.8176
10521	Gumma	Itakura	None	0	0	0	0	0	0	0.47	0.22	0.08	21	0.2	6.9	2821.67	149.55	1053.83	0	0	0	15706	686	0.56	0	0	0	0	0.00	0.00	0.00	0.00	6901.2164
10522	Gumma	Meiwa	None	0	0	0	0	0	0	0.46	0.20	0.08	21	0.2	6.9	860.49	6.59	1129.2	0	0	0	11209	461	0	0	0	0	0	0.00	0.00	0.00	0.00	4925.2346
10524	Gumma	Oizumi	None	1	0	1	0	0	0	0.56	0.22	0.04	21	0.2	6.8	6475.51	1118.99	4065.95	0	0	0	40257	1737	0.48	0	0	0	0	0.00	0.00	0.00	0.00	17688.9258
10525	Gumma	Ora	None	0	0	0	0	0	0	0.52	0.20	0.06	21	0.2	6.9	2282.5	57.16	1380.22	0	0	0	27023	1055	0.42	0	0	0	0	0.00	0.00	0.00	0.00	11873.9062
11104	Saitama	Saitama	Minuma	1	1	1	1	0	0	0.40	0.32	0.08	27	0.2	7.1	16530.57	263.11	703.26	0	0	0	157143	4444	0.15	0	0	0	0	0.00	0.00	0.00	0.00	69048.6342
11109	Saitama	Saitama	Midori	0	0	0	0	0	0	0.48	0.34	0.08	28	0.2	7.2	11047.69	367.6	836.36	0	0	0	110118	3062	0.15	0	0	0	0	0.00	0.00	0.00	0.00	48385.8492
11110	Saitama	Saitama	Iwatsuki	1	0	1	0	0	0	0.56	0.36	0.08	27	0.2	7.3	8425.96	513.11	1522.19	0	0	0	111286	4629	0.13	0	0	0	0	0.00	0.00	0.00	0.00	48899.0684
11232	Saitama	Kuki	None	0	0	0	0	0	0	0.54	0.28	0.08	26	0.2	7.2	11752.97	653.66	3726.29	0	0	0	154310	5453	0.14	0	0	0	0	0.00	0.00	0.00	0.00	67803.814
11445	Saitama	Shiraoka	None	0	0	0	0	0	0	0.52	0.30	0.10	26	0.2	7.2	4430.62	222.73	208.85	0	0	0	50272	1529	0.21	0	0	0	0	0.00	0.00	0.00	0.00	22089.5168
13101	Tokyo	Chiyoda	None	3	2	3	2	0	0	0.46	0.40	0.08	27	0.2	7.2	4434.57	5653.54	0	0	0	0	47115	35566	0.02	0	0	0	0	0.00	0.00	0.00	0.00	20702.331
13102	Tokyo	Chuo	None	0	0	0	0	0	0	0.48	0.44	0.10	29	0.2	7.3	1345.21	5571.61	667.69	0	0	0	122762	41454	0.03	0	0	0	0	0.00	0.00	0.00	0.00	53941.6228
13103	Tokyo	Minato	None	7	7	7	7	0	0	0.46	0.38	0.10	29	0.2	7.3	9216.86	5206.13	3175.5	0	0	0	205131	42664	0.03	0	0	0	0	0.00	0.00	0.00	0.00	90134.5614
13104	Tokyo	Shinjuku	None	1	1	1	1	0	0	0.54	0.32	0.08	25	0.2	7.1	10023.11	4742.07	926	0	0	0	326309	35154	0.03	0	0	0	0	0.00	0.00	0.00	0.00	143380.1746
13105	Tokyo	Bunkyo	None	0	0	0	0	0	0	0.48	0.38	0.08	26	0.2	7.2	6676.94	2098.99	667.46	0	0	0	206626	15960	0.07	0	0	0	0	0.00	0.00	0.00	0.00	90791.4644
13113	Tokyo	Shibuya	None	0	0	0	0	0	0	0.52	0.30	0.10	26	0.2	7.1	8875.74	3846.57	335.59	0	0	0	204492	26520	0.07	0	0	0	0	0.00	0.00	0.00	0.00	89853.7848
13116	Tokyo	Toshima	None	2	2	2	2	0	0	0.52	0.32	0.08	25	0.2	7.2	7431.03	4100.3	499.13	0	0	0	284678	18934	0.07	0	0	0	0	0.00	0.00	0.00	0.00	125087.5132
13117	Tokyo	Kita	None	0	0	0	0	0	0	0.48	0.36	0.08	28	0.2	7.3	9934.53	3651.37	4242.29	0	0	0	335544	15060	0.06	0	0	0	0	0.00	0.00	0.00	0.00	147438.0336
13121	Tokyo	Adachi	None	3	3	3	3	0	0	0.48	0.34	0.08	26	0.2	7.1	28078.18	5738.99	12791.51	0	0	0	683426	28943	0.16	0	0	0	0	0.00	0.00	0.00	0.00	300297.3844
13123	Tokyo	Edogawa	None	1	1	1	1	0	0	0.48	0.37	0.10	29	0.2	7.1	29094.46	3806.13	7901.98	0	0	0	678967	23599	0.14	0	0	0	0	0.00	0.00	0.00	0.00	298338.0998
12213	Chiba	Togane	None	0	0	0	0	0	0	0.68	0.25	0.08	23	0.21	7	5996.29	412.64	1443.23	0	0	0	61751	2491	0.3	4	15	163	182	0.00	0.00	0.01	0.01	27900
3305	Iwate	Takizawa	None	0	0	0	0	0	0	0.54	0.21	0.06	22	0.22	6.9	6327.28	0	470.76	0	0	0	53857	1558	0.34	1	14	240	255	0.00	0.00	0.01	0.01	21920
3322	Iwate	Yahaba	None	0	0	0	0	0	0	0.63	0.24	0.04	20	0.22	6.8	3367.88	159.45	2324.9	0	0	0	27205	1324	0.29	0	0	151	151	0.00	0.00	0.02	0.02	9210
4302	Miyagi	Shichikashuku	None	0	0	0	0	0	0	0.50	0.20	0.06	20	0.22	6.7	0	0	0	0	0	0	1694	117	0	0	0	0	0	0.00	0.00	0.00	0.00	744.3436
7422	Fukushima	Yugawa	None	0	0	0	0	0	0	0.58	0.24	0.08	24	0.22	7	0	0	0	0	0	0	3364	113	0	0	3	39	42	0.00	0.00	0.03	0.03	1478.1416
9202	Tochigi	Ashikaga	None	1	1	1	1	0	0	0.51	0.18	0.06	19.75	0.22	6.77	19825.62	2195.14	10148.24	0	0	0	154530	9214	0.43	0	0	0	0	0.00	0.00	0.00	0.00	67900.482
9203	Tochigi	Tochigi	None	0	0	0	0	0	0	0.55	0.16	0.05	20	0.22	6.75	20422.21	1389.27	9155.56	0	0	0	145783	7317	0.43	0	0	0	0	0.00	0.00	0.00	0.00	67900.482
11203	Saitama	Kawaguchi	None	2	2	2	2	0	0	0.52	0.36	0.08	28	0.22	7.33	20238.38	2884.14	3494.52	0	0	0	561506	24569	0.16	0	0	0	0	0.00	0.00	0.00	0.00	246725.7364
11442	Saitama	Miyashiro	None	0	0	0	0	0	0	0.62	0.36	0.10	29	0.22	7.3	3089.64	96.99	71.86	0	0	0	33641	1158	0.28	0	0	0	0	0.00	0.00	0.00	0.00	14781.8554
12347	Chiba	Tako	None	0	0	0	0	0	0	0.52	0.22	0.06	25	0.22	7.1	1760.8	131.13	467.53	0	0	0	16002	912	0.8	2	6	1036	1044	0.00	0.00	0.17	0.17	6230
12409	Chiba	Shibayama	None	0	0	0	0	0	0	0.50	0.22	0.06	25	0.22	7.1	1133.22	159.08	1373.59	0	0	0	7920	510	0	0	3	104	107	0.00	0.00	0.03	0.03	3480.048
13122	Tokyo	Katsushika	None	0	0	0	0	0	0	0.52	0.30	0.08	26	0.22	7	16873.85	2483.95	9932.98	0	0	0	442586	20112	0.09	0	0	0	0	0.00	0.00	0.00	0.00	194472.2884
14113	Kanagawa	Yokohama	Midori	0	0	0	0	0	0	0.46	0.22	0.06	25	0.22	7	12382.15	590.12	791.93	0	0	0	177631	4065	0.1	0	0	0	0	0.00	0.00	0.00	0.00	78051.0614
3213	Iwate	Ninohe	None	0	0	0	0	0	0	0.78	0.22	0.06	18.53	0.23	6.72	5414.74	925.28	1245.33	0	0	0	29702	1578	0.47	2	0	34	36	0.00	0.00	0.00	0.00	12420
7408	Fukushima	Inawashiro	None	0	0	0	0	0	0	0.56	0.43	0.18	28	0.23	7	2892.65	397.07	215.62	0	0	0	15805	944	0	18	63	666	747	0.00	0.01	0.09	0.11	7030
3524	Iwate	Ichinohe	None	0	0	0	0	0	0	0.80	0.25	0.06	20.2	0.24	6.93	2024.14	185.7	510.49	0	0	0	14187	688	0.76	0	3	0	3	0.00	0.00	0.00	0.00	6410

Table B.1 continued

Code	Prefecture	Municipality	Ku	all_31	all_10	ground_31	ground_10	tsun_31	tsun_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xdepth	xarea	xvol2	xpop	xestab	xwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123	xhouses
7447	Fukushima	Aizumisato	None	0	0	0	0	0	0	0.62	0.26	0.06	21.2	0.24	7	2558.3	231.37	590.71	0	0	0	22737	977	0	0	2	331	333	0.00	0.00	0.04	0.05	7360
9205	Tochigi	Kanuma	None	0	0	0	0	0	0	0.78	0.13	0.04	19	0.24	6.7	12909.28	1087.24	6845.57	0	0	0	102348	5429	0.23	0	0	0	0	0.00	0.00	0.00	0.00	44971.7112
9361	Tochigi	Mibu	None	0	0	0	0	0	0	0.66	0.22	0.06	24	0.24	7.1	4641.14	358.36	1220.66	0	0	0	39605	1825	0.32	0	0	0	0	0.00	0.00	0.00	0.00	17402.437
10203	Gumma	Kiryu	None	0	0	0	0	0	0	0.47	0.18	0.04	21.43	0.24	6.73	11112.34	1981.47	7265.61	0	0	0	121704	7308	0.53	0	0	0	0	0.00	0.00	0.00	0.00	53476.7376
10205	Gumma	Ota	None	0	0	0	0	0	0	0.62	0.21	0.04	21.75	0.24	6.92	23622.97	3231.98	12625.09	0	0	0	216465	11297	0.37	0	0	0	0	0.00	0.00	0.00	0.00	95114.721
11234	Saitama	Yashio	None	0	0	0	0	0	0	0.66	0.30	0.08	27	0.24	7.3	6409.56	551.79	4566.24	0	0	0	82977	4868	0.17	0	0	0	0	0.00	0.00	0.00	0.00	36460.0938
11240	Saitama	Satte	None	0	0	0	0	0	0	0.66	0.36	0.10	30	0.24	7.5	3947.21	341.47	1018.02	0	0	0	54012	2267	0.29	0	0	0	0	0.00	0.00	0.00	0.00	23732.8728
12349	Chiba	Tonosho	None	0	0	0	0	0	0	0.58	0.20	0.06	23.5	0.24	7.07	3683.25	87.97	299.3	0	0	0	15154	648	0.77	3	10	1800	1813	0.00	0.00	0.35	0.35	5170
3321	Iwate	Shiwa	None	1	0	1	0	0	0	0.67	0.23	0.06	22	0.25	7.05	5140.91	321.42	542.69	0	0	0	33288	1247	0.37	0	0	113	113	0.00	0.00	0.01	0.01	10960
4301	Miyagi	Zao	None	0	0	0	0	0	0	0.56	0.29	0.07	28.67	0.25	7.3	0	0	0	0	0	0	12882	703	0	0	0	0	0	0.00	0.00	0.00	0.00	5660.3508
4324	Miyagi	Kawasaki	None	1	1	0	0	1	1	0.66	0.22	0.07	25	0.25	7.17	332.74	0	0	0	0	0	9978	514	0	0	0	0	0	0.00	0.00	0.00	0.00	4384.3332
3506	Iwate	Kunohe	None	0	0	0	0	0	0	0.75	0.20	0.06	21.78	0.26	6.89	0	0	0	0	0	0	6507	280	0	0	0	0	0	0.00	0.00	0.00	0.00	2859.1758
4322	Miyagi	Murata	None	1	1	1	1	0	0	0.64	0.30	0.06	30.6	0.26	7.47	1661.18	202.94	1073.53	0	0	0	11995	584	0	0	0	0	0	0.00	0.00	0.00	0.00	5270.603
7201	Fukushima	Fukushima	None	2	2	2	2	0	0	0.75	0.31	0.06	26.8	0.26	7.15	34838.42	4970.37	10559.31	0	0	0	292590	13816	0	204	3980	6549	10733	0.00	0.03	0.05	0.08	130050
9216	Tochigi	Shimotsuke	None	0	0	0	0	0	0	0.64	0.26	0.06	27	0.26	7.15	6911.74	526.71	2829.95	0	0	0	59483	2286	0.33	0	0	0	0	0.00	0.00	0.00	0.00	26136.8302
9364	Tochigi	Nogi	None	0	0	0	0	0	0	0.74	0.30	0.08	26	0.26	7.2	3482.26	178.44	625.29	0	0	0	25720	814	0.41	0	0	0	0	0.00	0.00	0.00	0.00	11301.368
11214	Saitama	Kasukabe	None	1	1	1	1	0	0	0.76	0.38	0.10	28	0.26	7.3	17316.9	1156.41	2682.4	0	0	0	237171	8321	0.24	0	0	0	0	0.00	0.00	0.00	0.00	104212.9374
11237	Saitama	Misato_City	None	1	1	1	1	0	0	0.72	0.28	0.08	27	0.26	7.3	11019.31	1176	2249.05	0	0	0	131415	5831	0.15	0	0	0	0	0.00	0.00	0.00	0.00	57743.751
12207	Chiba	Matsudo	None	0	0	0	0	0	0	0.70	0.26	0.08	27.33	0.26	7.3	37796.75	2490.57	3589.57	0	0	0	484457	14331	0.15	8	132	1765	1905	0.00	0.00	0.01	0.01	224380
12216	Chiba	Narashino	None	1	1	1	1	0	0	0.68	0.34	0.10	29	0.26	7.4	13123.88	637.65	4849.49	0	0	0	164530	4383	0.14	9	717	4566	5292	0.00	0.01	0.06	0.07	74110
3381	Iwate	Kanegasaki	None	0	0	0	0	0	0	0.80	0.30	0.12	26	0.27	7.3	5165.33	342.87	4265.15	0	0	0	16325	592	0.25	0	0	0	0	0.00	0.00	0.00	0.00	4670
7481	Fukushima	Tanagura	None	0	0	0	0	0	0	0.64	0.26	0.07	25.82	0.27	7.23	2140.47	191.05	113.01	0	0	0	15062	889	0	1	24	594	619	0.00	0.00	0.12	0.12	5160
7483	Fukushima	Hanawa	None	0	0	0	0	0	0	0.73	0.24	0.07	25.6	0.27	7.16	0	0	0	0	0	0	9884	634	0	0	0	270	270	0.00	0.00	0.06	0.06	4343.0296
4206	Miyagi	Shiroishi	None	1	1	1	1	0	0	0.64	0.37	0.08	31.08	0.28	7.37	6366.44	550.17	1630.66	0	0	0	37422	1775	0.36	0	0	0	0	0.00	0.00	0.00	0.00	16443.2268
7322	Fukushima	Otama	None	0	0	0	0	0	0	0.72	0.19	0.04	27	0.28	7.2	0	0	0	0	0	0	8574	276	0	2	10	324	336	0.00	0.00	0.09	0.09	3767.4156
7344	Fukushima	Tenei	None	0	0	0	0	0	0	0.73	0.38	0.08	28	0.28	7.29	0	0	0	0	0	0	6291	263	0	72	139	1561	1772	0.03	0.05	0.56	0.64	2764.2654
9211	Tochigi	Yaita	None	1	1	1	1	0	0	0.74	0.28	0.08	28.63	0.28	7.18	4835.42	466.04	1582.82	0	0	0	35343	1656	0.22	0	0	0	0	0.00	0.00	0.00	0.00	15529.7142
12204	Chiba	Funabashi	None	1	1	1	1	0	0	0.82	0.33	0.10	28	0.28	7.3	44470.45	2498.4	8366.89	0	0	0	609040	16976	0.17	13	457	4738	5208	0.00	0.00	0.02	0.02	271120
12236	Chiba	Katori	None	0	0	0	0	0	0	0.63	0.23	0.10	25.78	0.28	7.23	8604.38	772.45	1095.71	0	0	0	82866	4158	0.64	96	2213	1748	4057	0.00	0.07	0.06	0.13	30450
12329	Chiba	Sakae	None	0	0	0	0	0	0	0.68	0.24	0.08	27	0.28	7.2	2972.1	118.6	367.63	0	0	0	22580	604	0.65	10	109	1103	1222	0.00	0.01	0.13	0.14	8740
12342	Chiba	Kozaki	None	0	0	0	0	0	0	0.66	0.34	0.16	33	0.28	7.6	0	0	0	0	0	0	6454	264	0	5	92	193	290	0.00	0.03	0.07	0.10	2835.8876
3215	Iwate	Oshu	None	7	5	7	5	0	0	0.82	0.26	0.07	26.38	0.29	7.21	14261.25	2484.3	4696.12	0	0	0	124746	6457	0.42	51	414	2962	3427	0.00	0.01	0.06	0.07	47740
3303	Iwate	Iwate	None	2	2	2	2	0	0	0.50	0.20	0.07	24.24	0.29	7.16	1704.82	248.2	131.28	0	0	0	14984	625	0.31	0	0	0	0	0.00	0.00	0.00	0.00	5650
7202	Fukushima	Aizuwakamatsu	None	0	0	0	0	0	0	0.74	0.40	0.12	30.11	0.29	7.15	17227.67	3194.5	4971.33	0	0	0	126220	7554	0	4	87	5720	5811	0.00	0.00	0.10	0.10	57120
7482	Fukushima	Yamatsuri	None	0	0	0	0	0	0	0.82	0.22	0.04	24	0.29	7.1	0	0	0	0	0	0	6348	383	0	0	63	251	314	0.00	0.02	0.09	0.11	2789.3112
3205	Iwate	Hanamaki	None	0	0	0	0	0	0	0.99	0.25	0.07	24.44	0.3	7.04	14589.63	1611.9	5831.81	0	0	0	101438	4823	0.29	6	59	719	784	0.00	0.00	0.02	0.02	38770
4321	Miyagi	Ogawara	None	0	0	0	0	0	0	0.70	0.38	0.10	35.8	0.3	7.7	3846.08	639.98	1348.65	0	0	0	23530	1345	0.18	0	0	0	0	0.00	0.00	0.00	0.00	10339.082
5464	Akita	Higashinaruse	None	0	0	0	0	0	0	0.90	0.12	0.04	17.6	0.3	6.5	0	0	0	0	0	0	2872	135	0	0	0	0	0	0.00	0.00	0.00	0.00	1261.9568
7301	Fukushima	Kori	None	0	0	0	0	0	0	0.70	0.25	0.06	25	0.3	7.1	1329.45	221.42	957.56	0	0	0	12853	550	0	55	187	1175	1417	0.01	0.03	0.21	0.25	5647.6082
8207	Ibaraki	Yuki	None	2	2	2	2	0	0	0.82	0.30	0.08	27.6	0.3	7.3	5705.72	423.83	2218.68	0	0	0	52494	2579	0.43	2	31	3134	3167	0.00	0.00	0.17	0.17	18290
9208	Tochigi	Oyama	None	1	1	1	1	0	0	0.88	0.32	0.08	28.33	0.3	7.3	23454.09	2118.49	7474.53	0	0	0	164454	7425	0.23	0	0	0	0	0.00	0.00	0.00	0.00	72261.0876
9301	Tochigi	Kaminokawa	None	0	0	0	0	0	0	0.78	0.32	0.06	29	0.3	7.3	3338.1	87.57	4311.43	0	0	0	31621	1170	0.2	0	0	0	0	0.00	0.00	0.00	0.00	13894.2674
9384	Tochigi	Shioya	None	0	0	0	0	0	0	0.80	0.24	0.07	23.47	0.3	7.06	1701.48	66.87	370.71	0	0	0	12560	551	0	0	0	0	0	0.00	0.00	0.00	0.00	5518.864
11243	Saitama	Yoshikawa	None	0	0	0	0	0	0	0.88	0.30	0.08	27	0.3	7.3	5239.07	362.71	1094.11	0	0	0	65298	2202	0.23	0	0	0	0	0.00	0.00	0.00	0.00	28691.9412
11465	Saitama	Matsubushi	None	0	0	0	0	0	0	0.90	0.30	0.08	27	0.3	7.3	2505.05	30.4	103.9	0	0	0	31153	1170	0.18	0	0	0	0	0.00	0.00	0.00	0.00	13688.6282
12220	Chiba	Nagareyama	None	0	0	0	0	0	0	0.81	0.26	0.08	27	0.3	7.3	19061.21	969.17	824.84	0	0	0	163984	4101	0.21	0	0	995	995	0.00	0.00	0.02	0.02	66290
12221	Chiba	Yachiyo	None	2	2	2	2	0	0	0.85	0.30	0.10	28	0.3	7.3	18290.47	857.31	3086.73	0	0	0	189781	5505	0.19	6	24	1442	1472	0.00	0.00	0.02	0.02	78070
12224	Chiba	Kamagaya	None	1	1	1	1	0	0	0.86	0.30	0.08	27	0.3	7.3	9420	522.83	504.3	0	0	0	107853	3141	0.19	0	9	811	820	0.00	0.00	0.02	0.02	42790
7308	Fukushima	Kawamata	None	0	0	0	0	0	0	0.92	0.22	0.04	28.67	0.31	7.27	2079.15	294.66	340.91	0	0	0	15569	812	0	28	30	1287	1345	0.00	0.01	0.23	0.24	5640

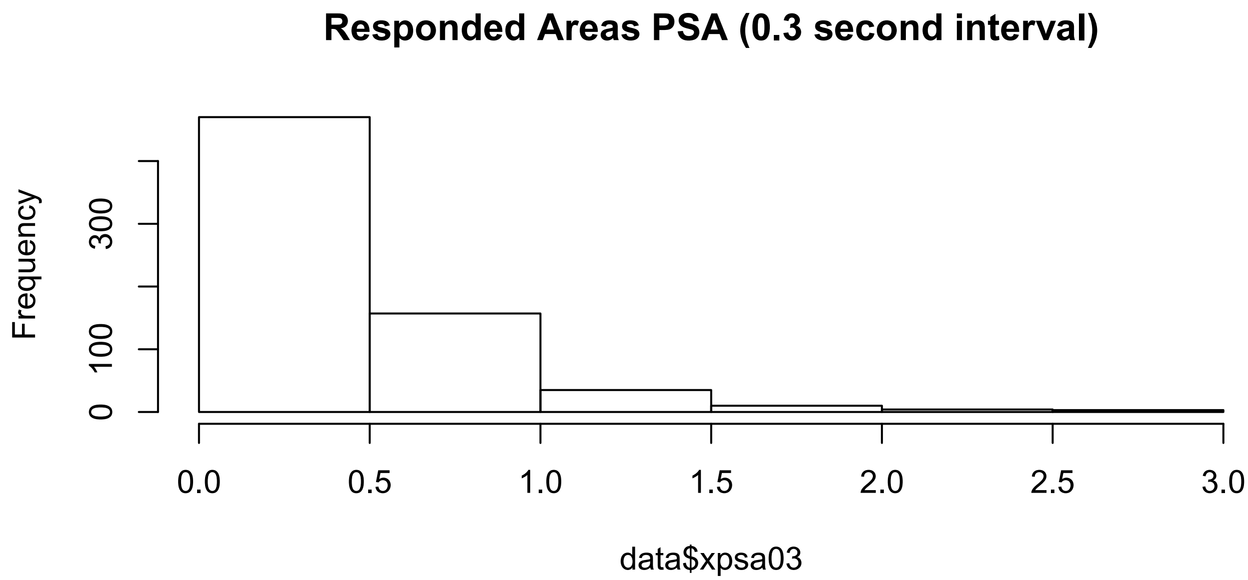
Table B.1 continued

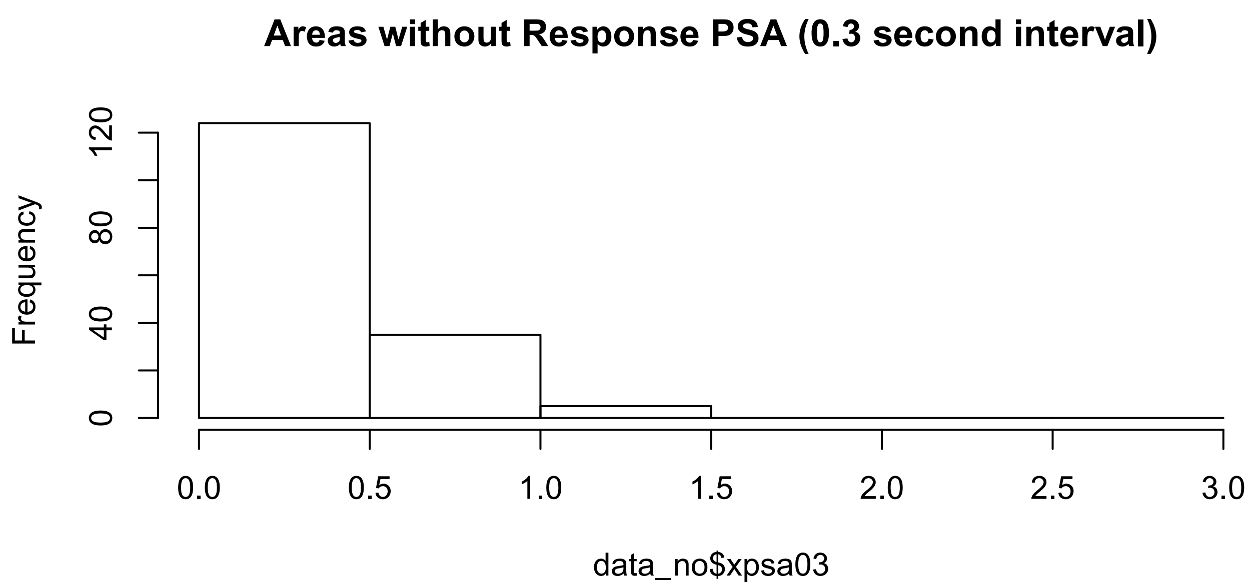
Code	Prefecture	Municipality	Ku	all_31	all_10	ground_31	ground_10	tsun_31	tsun_10	xpsa03	xpsa10	xpsa30	xpgv	xpga	xii	xres	xcom	xindus	xdepth	xarea	xvol2	xpop	xestab	xwood	xdam3	xdam2	xdam1	xdam123	xpdam3	xpdam2	xpdam1	xpdam123	xhouses
9213	Tochigi	Nasushiobara	None	0	0	0	0	0	0	0.73	0.24	0.08	26	0.31	7	16232.66	2510.2	5421.77	0	0	0	117812	5966	0.24	0	0	0	0	0.00	0.00	0.00	0.00	51766.5928
4323	Miyagi	Shibata	None	0	0	0	0	0	0	0.80	0.38	0.10	41	0.32	7.96	6784.73	415.96	3303.25	0	0	0	39341	1348	0.3	0	0	0	0	0.00	0.00	0.00	0.00	17286.4354
7303	Fukushima	Kunimi	None	0	0	0	0	0	0	0.74	0.26	0.06	26	0.32	7.3	1117.4	111.53	310.52	0	0	0	10086	414	0	191	565	508	1264	0.04	0.13	0.11	0.29	4431.7884
7484	Fukushima	Samegawa	None	0	0	0	0	0	0	0.67	0.22	0.07	26.36	0.32	7.2	0	0	0	0	0	0	3989	198	0	0	7	112	119	0.00	0.00	0.06	0.07	1752.7666
7501	Fukushima	Ishikawa	None	0	0	0	0	0	0	0.70	0.35	0.07	30.17	0.32	7.4	2141.85	376.25	373.15	0	0	0	17775	1056	0	1	32	2602	2635	0.00	0.01	0.45	0.46	5720
7504	Fukushima	Asakawa	None	0	0	0	0	0	0	0.69	0.31	0.07	28	0.32	7.32	0	0	0	0	0	0	6888	381	0	0	1	586	587	0.00	0.00	0.19	0.19	3026.5872
9407	Tochigi	Nasu	None	0	0	0	0	0	0	0.85	0.23	0.08	26.14	0.32	7.1	2495.42	480.63	185	0	0	0	26765	1730	0.51	0	0	0	0	0.00	0.00	0.00	0.00	11760.541
3201	Iwate	Morioka	None	2	2	2	2	0	0	0.58	0.26	0.07	24.96	0.33	7.23	39237.67	6706.66	5971.49	0	0	0	298348	15625	0.18	0	10	836	846	0.00	0.00	0.01	0.01	140330
9206	Tochigi	Nikko	None	0	0	0	0	0	0	1.00	0.10	0.03	15.56	0.33	6.29	10643.34	2312.02	2126.61	0	0	0	90066	5171	0.39	0	0	0	0	0.00	0.00	0.00	0.00	39575.0004
3208	Iwate	Tono	None	0	0	0	0	0	0	0.68	0.20	0.07	26.86	0.34	7.3	2389.26	481.65	651.04	0	0	0	29331	1436	0.64	0	4	525	529	0.00	0.00	0.05	0.05	11130
7505	Fukushima	Furudono	None	0	0	0	0	0	0	0.80	0.23	0.07	27.38	0.34	7.29	0	0	0	0	0	0	6030	335	0	0	27	785	812	0.00	0.01	0.30	0.31	2649.582
8220	Ibaraki	Tsukuba	None	0	0	0	0	0	0	0.76	0.38	0.07	28.17	0.34	7.38	41747.99	3440.96	8455.7	0	0	0	214590	8542	0.22	8	268	3796	4072	0.00	0.00	0.04	0.04	104070
8223	Ibaraki	Itako	None	1	1	1	1	0	0	0.75	0.24	0.08	27.2	0.34	7.2	6025.59	670.9	876.94	0	0	0	30534	1422	0.67	96	2742	2771	5609	0.01	0.23	0.23	0.47	12000
9210	Tochigi	Otawara	None	0	0	0	0	0	0	0.95	0.33	0.08	37.33	0.34	7.62	10338.48	660.15	3814.69	0	0	0	77729	3673	0.31	0	0	0	0	0.00	0.00	0.00	0.00	34154.1226
12222	Chiba	Abiko	None	1	1	1	1	0	0	0.90	0.26	0.06	25	0.34	7.2	14633.05	761.78	416.78	0	0	0	134017	3424	0.19	134	99	2706	2939	0.00	0.00	0.05	0.05	56920
12232	Chiba	Shiroi	None	0	0	0	0	0	0	1.04	0.28	0.08	27	0.34	7.3	6069.09	357.29	2117.72	0	0	0	60345	1565	0.13	0	0	422	422	0.00	0.00	0.02	0.02	21600
8205	Ibaraki	Ishioka	None	0	0	0	0	0	0	0.95	0.38	0.08	27.33	0.35	7.23	11868.38	569.34	3960.11	0	0	0	79687	3621	0.59	22	179	4023	4224	0.00	0.01	0.14	0.14	29800
12217	Chiba	Kashiwa	None	0	0	0	0	0	0	0.97	0.26	0.06	26	0.35	7.3	43708.27	1789.26	5681.28	0	0	0	404012	12468	0.14	1	16	4721	4738	0.00	0.00	0.03	0.03	180970
3441	Iwate	Sumita	None	0	0	0	0	0	0	0.76	0.20	0.06	26.5	0.36	7.35	0	0	0	0	0	0	6190	289	0	0	0	40	40	0.00	0.00	0.01	0.01	2719.886
4341	Miyagi	Marumori	None	1	1	1	1	0	0	0.99	0.37	0.08	33.86	0.36	7.57	0	0	0	0	0	0	15501	595	0.67	0	0	0	0	0.00	0.00	0.00	0.00	6811.1394
7210	Fukushima	Nihonmatsu	None	0	0	0	0	0	0	1.03	0.22	0.04	32.35	0.36	7.51	4769.76	672.96	2067.33	0	0	0	59871	2896	0	11	475	5399	5885	0.00	0.02	0.27	0.29	20090
7502	Fukushima	Tamakawa	None	0	0	0	0	0	0	0.76	0.38	0.08	32	0.36	7.5	0	0	0	0	0	0	7231	408	0	0	47	665	712	0.00	0.01	0.21	0.22	3177.3014
8302	Ibaraki	Ibaraki	None	0	0	0	0	0	0	0.88	0.26	0.08	29	0.36	7.44	2265.2	81.95	2657.29	0	0	0	34513	1368	0.6	27	577	3213	3817	0.00	0.05	0.27	0.32	11760
12228	Chiba	Yotsukaido	None	0	0	0	0	0	0	0.90	0.30	0.08	29	0.36	7.4	11497.99	394.63	664.16	0	0	0	86726	2555	0.22	0	1	493	494	0.00	0.00	0.01	0.01	34580
7213	Fukushima	Date	None	0	0	0	0	0	0	0.94	0.28	0.07	27.25	0.37	7.35	5770.58	626.45	2496.26	0	0	0	66027	3086	0	25	215	8067	8307	0.00	0.01	0.36	0.37	22240
3206	Iwate	Kitakami	None	1	1	1	1	0	0	1.38	0.35	0.09	27.33	0.38	7.22	12270.82	1617.59	9493.94	0	0	0	93138	4730	0.41	31	472	1267	1770	0.00	0.01	0.03	0.04	39370
4424	Miyagi	Ohira	None	0	0	0	0	0	0	0.72	0.40	0.10	36	0.38	7.6	819.41	0	4527.75	0	0	0	5334	288	0	0	0	0	0	0.00	0.00	0.00	0.00	2343.7596
7214	Fukushima	Motomiya	None	0	0	0	0	0	0	0.98	0.25	0.06	32.5	0.38	7.5	2803.78	208.9	2803.25	0	0	0	31489	1552	0	16	220	3225	3461	0.00	0.02	0.31	0.34	10250
7544	Fukushima	Kawauchi	None	0	0	0	0	0	0	0.96	0.30	0.06	30.29	0.38	7.5	0	0	0	0	0	0	2820	139	0	8	512	160	680	0.01	0.41	0.13	0.55	1239.108
8227	Ibaraki	Chikusei	None	2	2	2	2	0	0	0.95	0.32	0.12	30	0.38	7.48	10295.62	855.53	4092.56	0	0	0	108527	5289	0.53	5	159	5360	5524	0.00	0.00	0.14	0.14	38870
7564	Fukushima	Iitate	None	0	0	0	0	0	0	0.93	0.20	0.06	27.67	0.39	7.3	0	0	0	0	0	0	6209	255	0	0	0	0	0	0.00	0.00	0.00	0.00	2728.2346
7465	Fukushima	Nakajima	None	0	0	0	0	0	0	0.86	0.54	0.10	37	0.4	7.8	0	0	0	0	0	0	5154	197	0	3	29	954	986	0.00	0.01	0.42	0.44	2264.6676
7503	Fukushima	Hirata	None	0	0	0	0	0	0	1.04	0.26	0.06	32.2	0.4	7.5	0	0	0	0	0	0	6921	305	0	1	15	441	457	0.00	0.00	0.15	0.15	3041.0874
8203	Ibaraki	Tsuchiura	None	0	0	0	0	0	0	0.86	0.42	0.12	30.36	0.4	7.48	23257.17	2997.78	6554.37	0	0	0	143839	7239	0.35	6	274	5787	6067	0.00	0.00	0.09	0.09	66820
8364	Ibaraki	Daigo	None	2	2	2	2	0	0	1.15	0.25	0.04	29.38	0.4	7.4	841.15	132.45	0	0	0	0	20073	1226	0.87	1	1	756	758	0.00	0.00	0.09	0.09	8190
8443	Ibaraki	Ami	None	0	0	0	0	0	0	0.85	0.38	0.13	31	0.4	7.5	9621.25	129.12	4287.85	0	0	0	47940	1576	0.33	0	26	1649	1675	0.00	0.00	0.08	0.08	20920
9201	Tochigi	Utsunomiya	None	2	2	2	2	0	0	1.12	0.31	0.06	30.7	0.4	7.27	73116.86	4769.9	16204.76	0	0	0	511739	23841	0.22	0	0	0	0	0.00	0.00	0.00	0.00	224858.1166
9214	Tochigi	Sakura	None	0	0	0	0	0	0	1.12	0.43	0.10	40	0.4	7.89	5791.16	298.51	3636.49	0	0	0	44768	1706	0.4	0	0	0	0	0.00	0.00	0.00	0.00	19671.0592
7207	Fukushima	Sukagawa	None	1	1	1	1	0	0	0.83	0.40	0.08	35.14	0.41	7.46	8328.42	749.06	4939.24	0	0	0	79267	3455	0	1249	3503	10557	15309	0.05	0.13	0.39	0.56	27250
4208	Miyagi	Kakuda	None	0	0	0	0	0	0	1.14	0.50	0.12	41	0.42	7.9	5202.42	515.03	3376.1	0	0	0	31336	1424	0.58	0	0	0	0	0.00	0.00	0.00	0.00	13769.0384
7466	Fukushima	Yabuki	None	0	0	0	0	0	0	0.94	0.74	0.12	41	0.42	7.9	2832.97	165.33	825.25	0	0	0	18407	826	0	295	1586	1725	3606	0.05	0.25	0.27	0.56	6460
12231	Chiba	Inzai	None	0	0	0	0	0	0	1.03	0.26	0.05	24.86	0.43	7.2	13216.07	1464	3891.65	0	0	0	88176	2450	0.22	11	74	2212	2297	0.00	0.00	0.10	0.10	23190
7548	Fukushima	Katsurao	None	0	0	0	0	0	0	0.98	0.28	0.04	36	0.46	7.7	0	0	0	0	0	0	1531	67	0	0	1	41	42	0.00	0.00	0.06	0.06	672.7214
8236	Ibaraki	Omitama	None	1	1	1	1	0	0	1.42	0.38	0.10	35.75	0.47	7.7	4251.49	89.61	723.73	0	0	0	52279	2015	0.62	17	115	4295	4427	0.00	0.01	0.23	0.24	18600
4101	Miyagi	Sendai	Aoba	11	11	11	11	0	0	0.91	0.48	0.08	34.18	0.48	7.45	38426.4	5704.39	1765.32	0	0	0	291436	18887	0.13	0	0	0	0	0.00	0.00	0.00	0.00	128056.9784
7464	Fukushima	Izumizaki	None	1	1	1	1	0	0	1.22	0.52	0.10	36	0.48	7.7	0	0	0	0	0	0	6802	279	0	46	252	507	805	0.02	0.08	0.17	0.27	2988.7988
3209	Iwate	Ichinoseki	None	2	2	2	2	0	0	1.04	0.25	0.05	30.83	0.49	7.54	9868.48	1823.44	5756.44	0	0	0	127642	6420	0.48	57	734	3367	4158	0.00	0.02	0.07	0.09	11130
8233	Ibaraki	Namegata	None	0	0	0	0	0	0	1.53	0.31	0.10	31.67	0.49	7.5	2094.11	109.09	257.56	0	0	0	37611	1802	0.84	120	843	2487	3450	0.01	0.07	0.21	0.30	11600
9411	Tochigi	Nakagawa	None	0	0	0	0	0	0	1.85	0.36	0.08	51	0.49	7.99	1024.09	69.81	233.34	0	0	0	18446	967	0.68	0	0	0	0	0.00	0.00	0.00	0.00	8105.1724

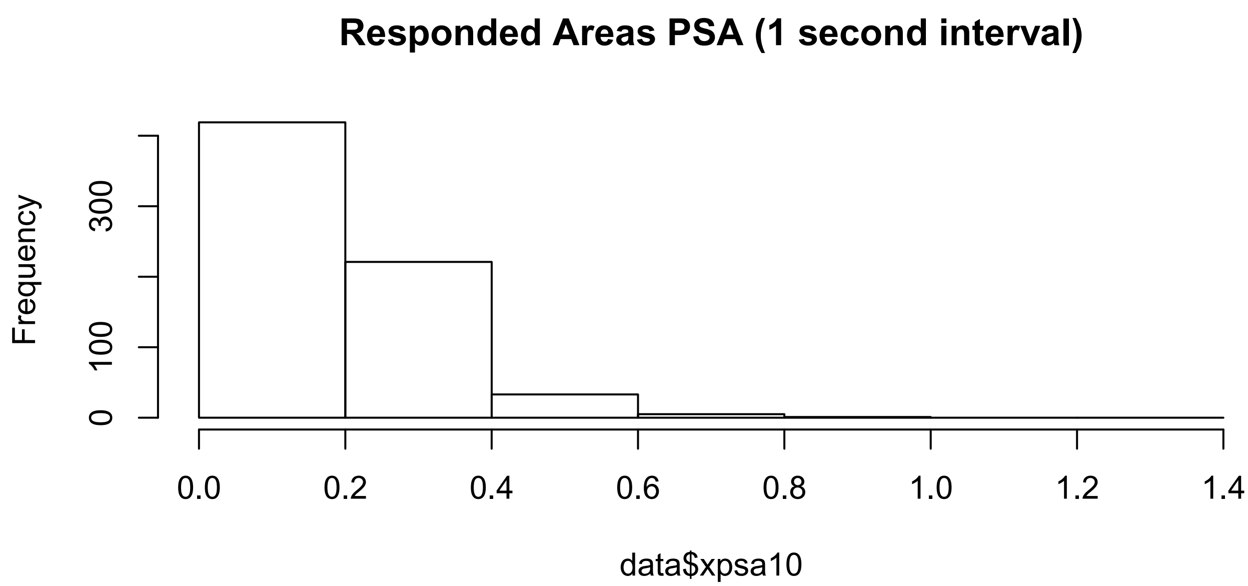
Appendix C

RESPONDED ARES VERSUS NO RESPONSE ARES COVARIATE COMPARISON HISTOGRAMS

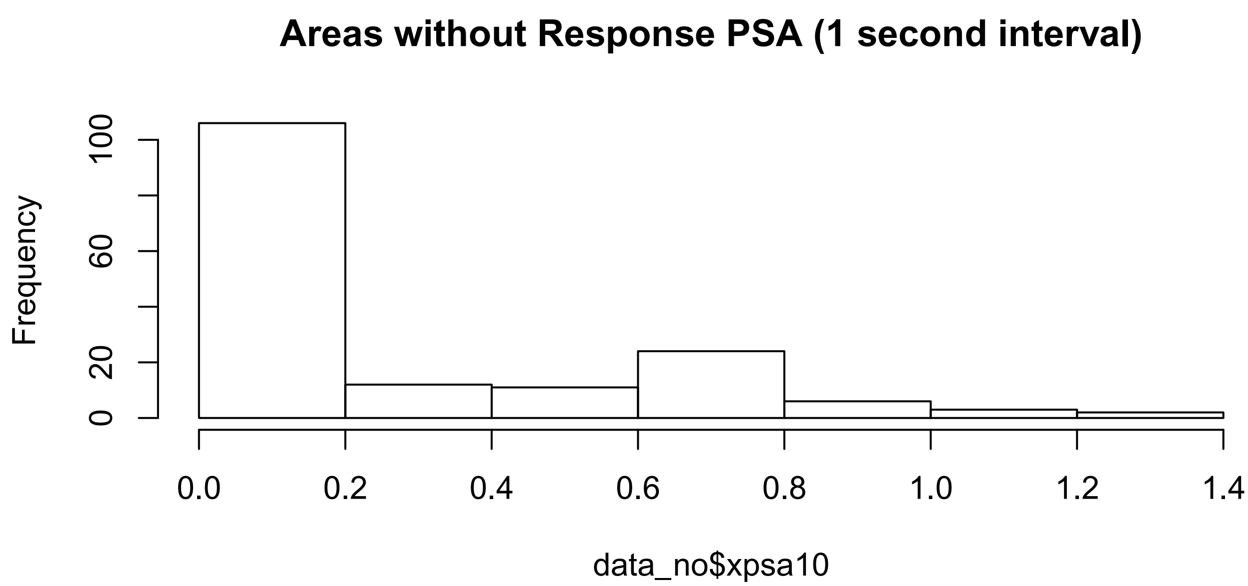
(data for inundation area was not available for areas with no response, and therefore this covariate is skipped. A negative value for other covariates indicates no information available)


Responded Areas PSA (0.3 second interval)
Frequency
0
100
300
0.0
0.5
1.0
1.5
2.0
2.5
3.0
data$xpsa03

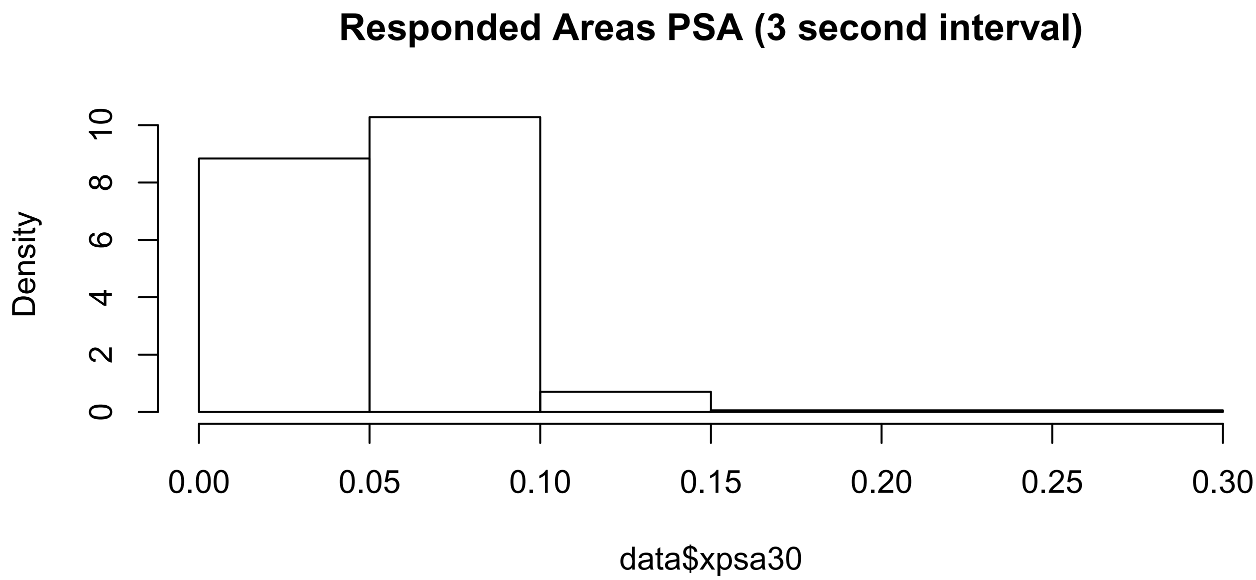

Areas without Response PSA (0.3 second interval)
Frequency
0
40
80
120
0.0
0.5
1.0
1.5
2.0
2.5
3.0
data_no$xpsa03

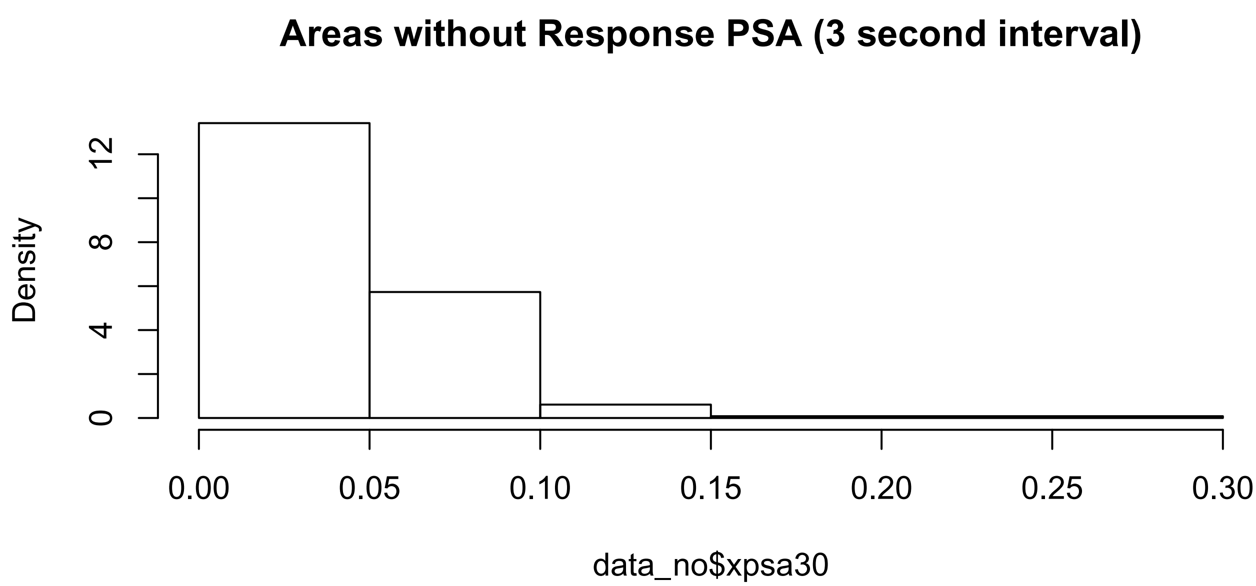


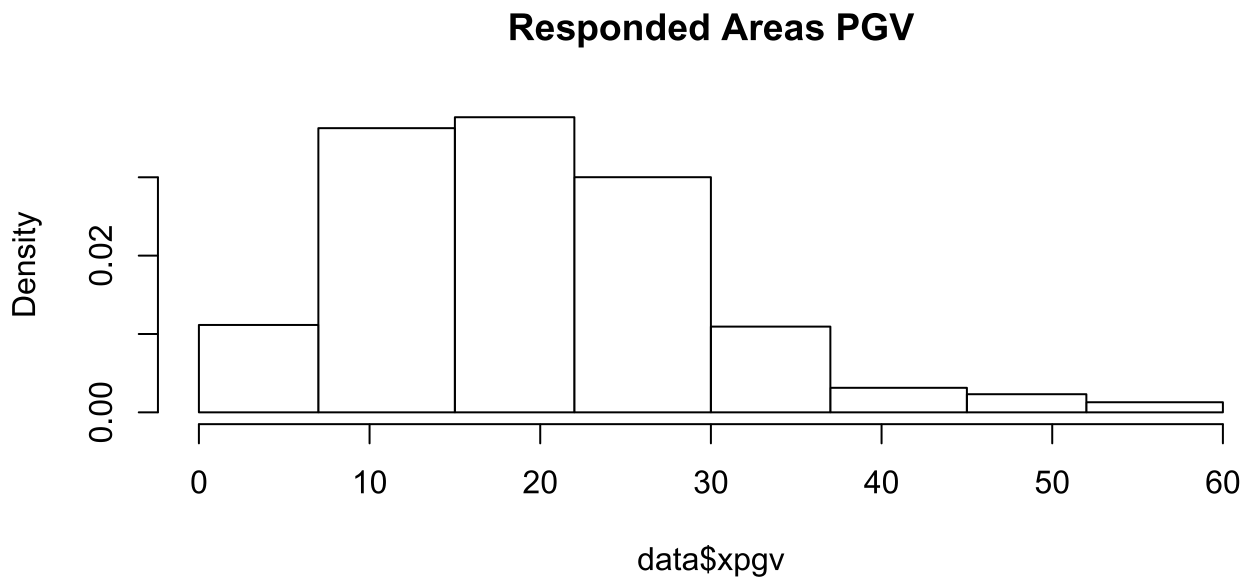
Responded Areas PSA (1 second interval)
Frequency
0
100
300
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
data$xpsa10

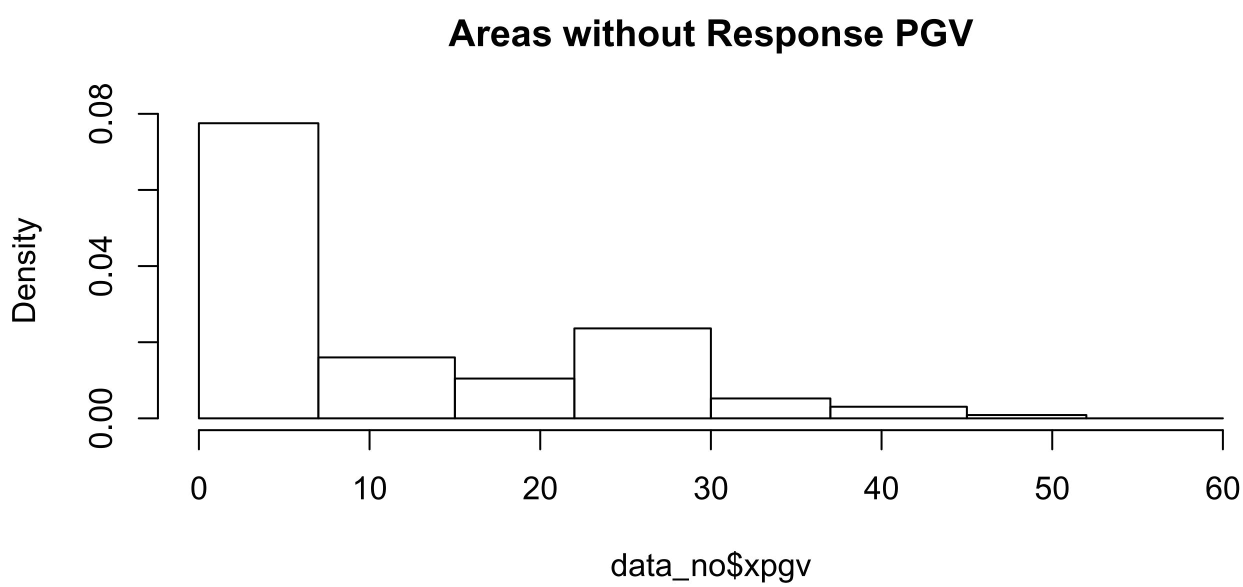


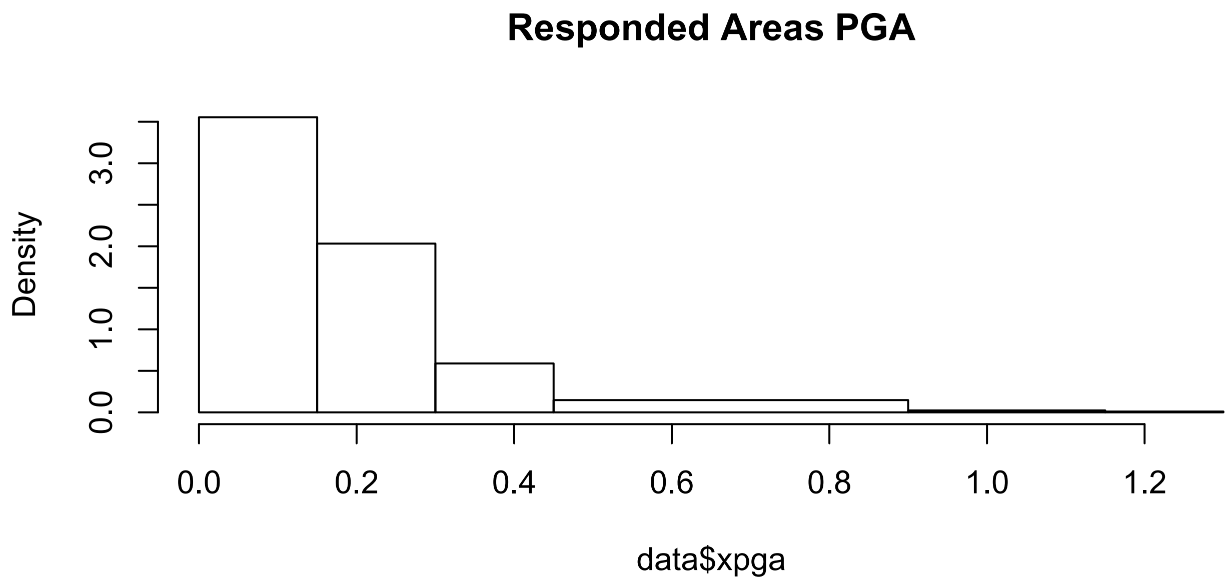
Areas without Response PSA (1 second interval)
Frequency
0
20
60
100
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
data_no$xpsa10

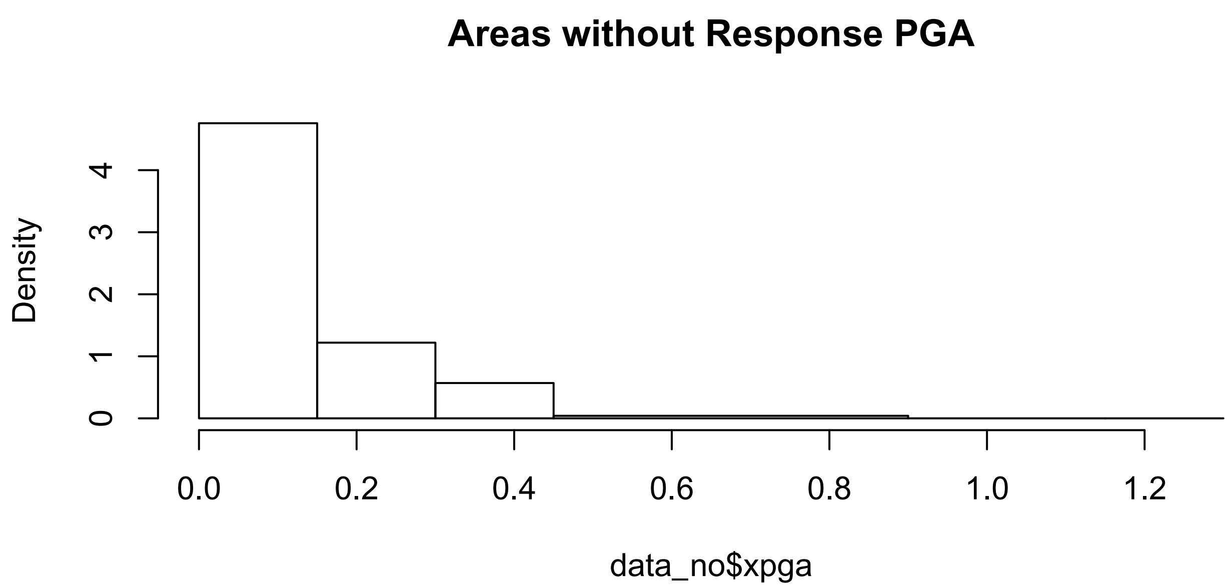

Responded Areas PSA (3 second interval)
Density
0
2
4
6
8
10
0.00
0.05
0.10
0.15
0.20
0.25
0.30
data$xpsa30

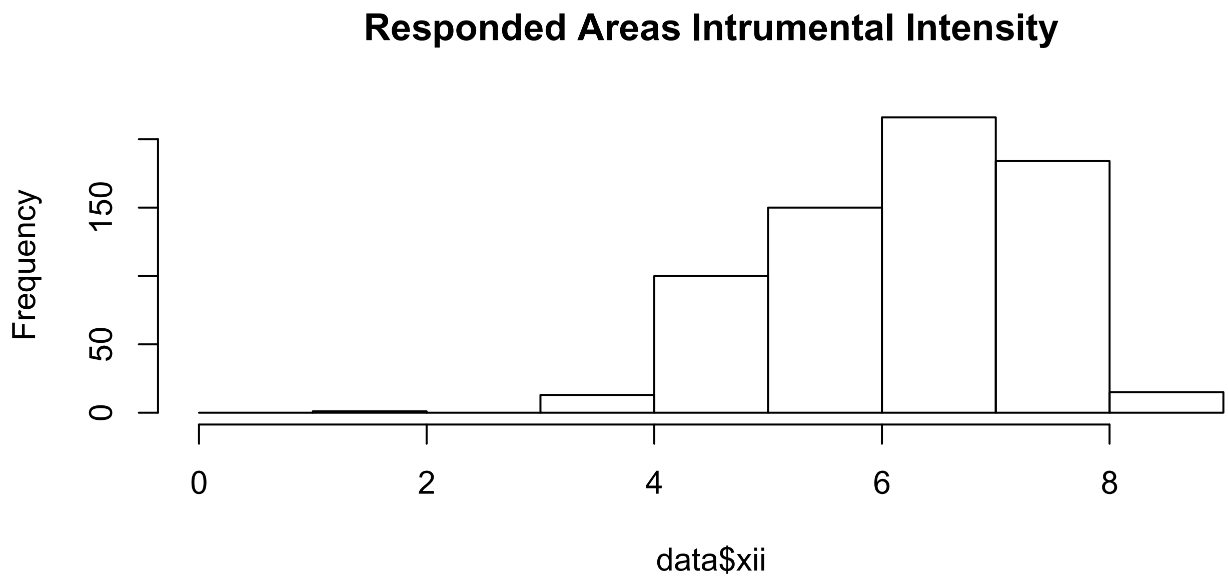

Areas without Response PSA (3 second interval)
Density
0
4
8
12
0.00
0.05
0.10
0.15
0.20
0.25
0.30
data_no$xpsa30

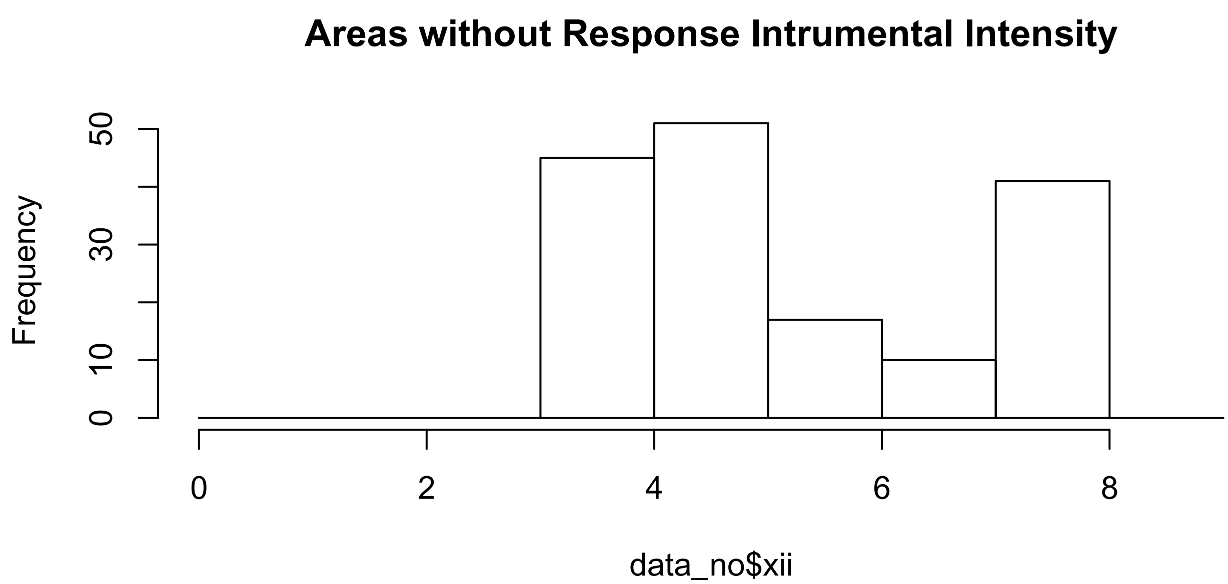

Responded Areas PGV
Density
0.00
0.02
0
10
20
30
40
50
60
data$xpgv

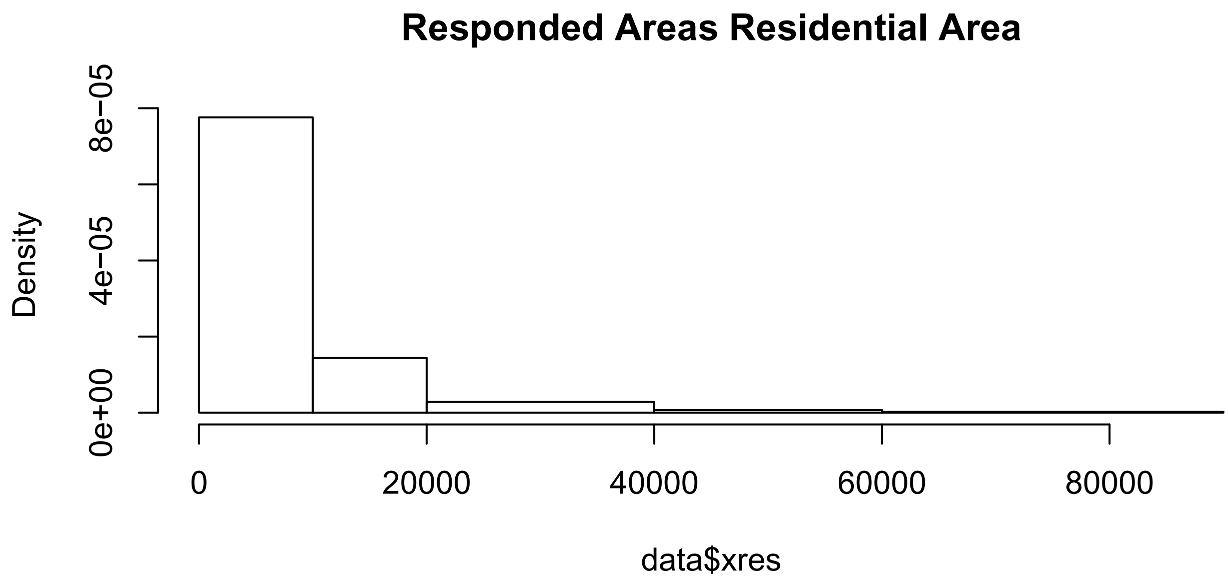

Areas without Response PGV
Density
0.00
0.04
0.08
0
10
20
30
40
50
60
data_no$xpgv

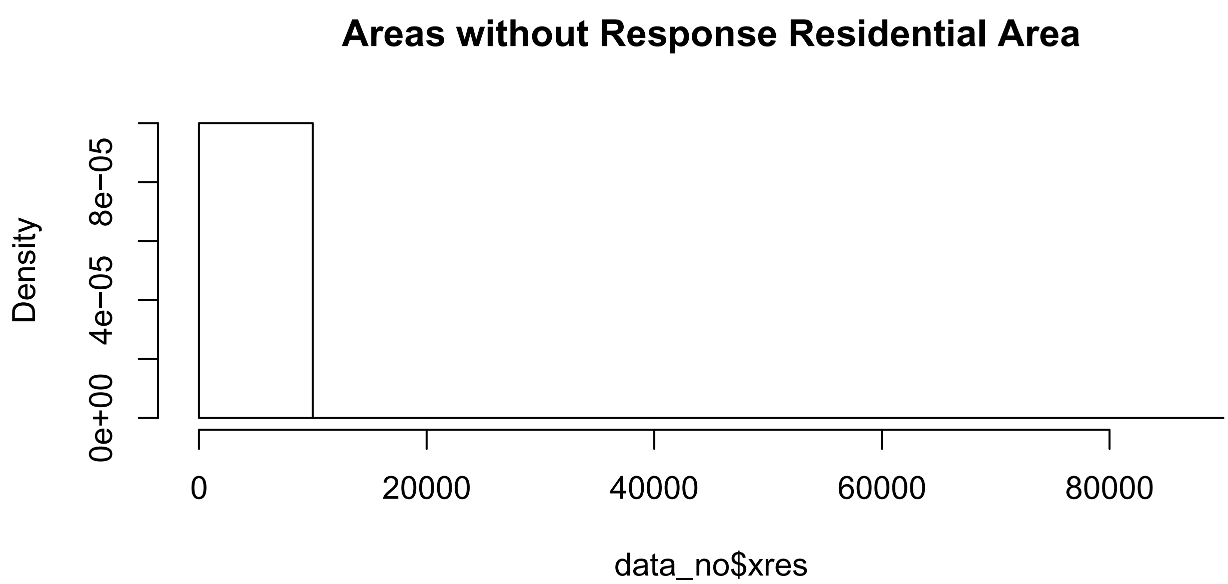

Responded Areas PGA
Density
0.0
1.0
2.0
3.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
data$xpga

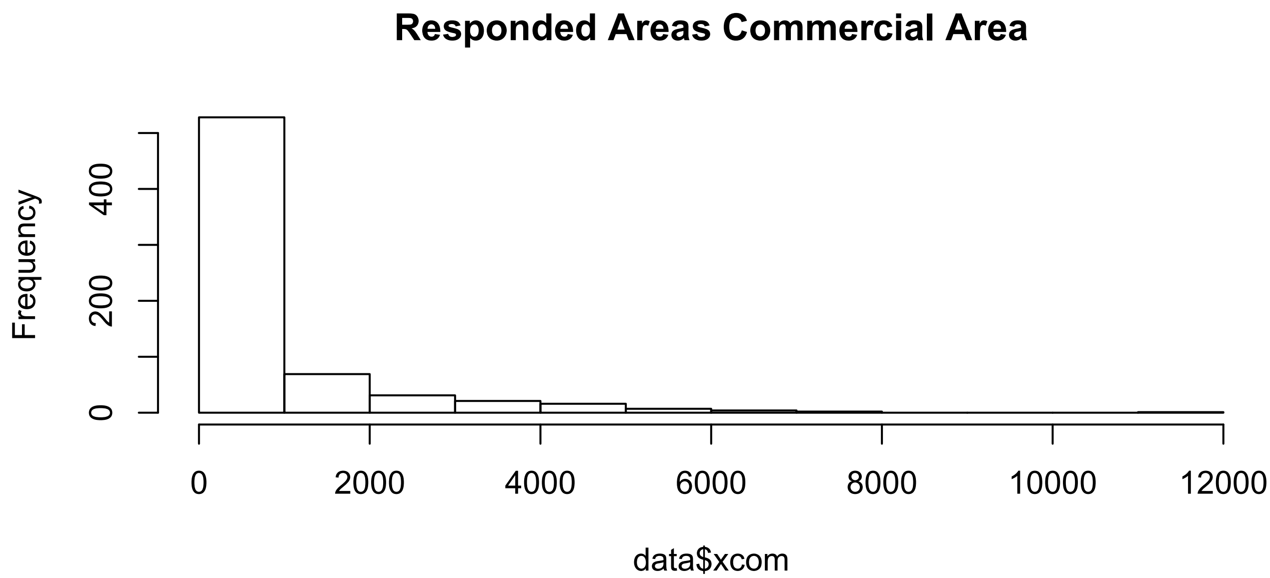

Areas without Response PGA
Density
0
1
2
3
4
0.0
0.2
0.4
0.6
0.8
1.0
1.2
data_no$xpga

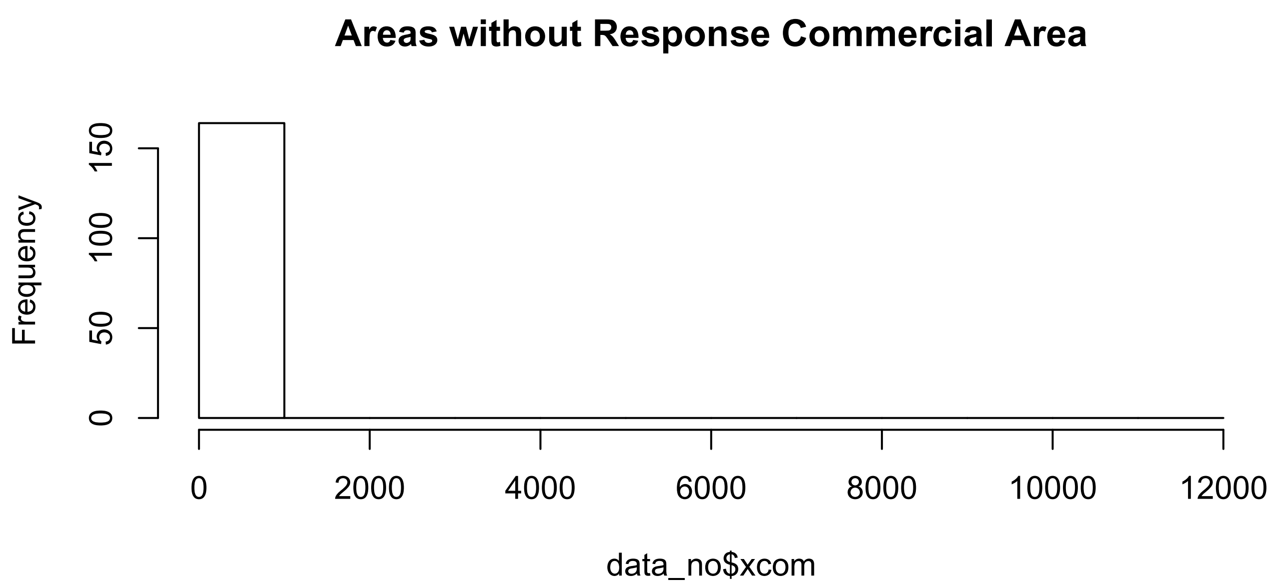

Responded Areas Intrumental Intensity
Frequency
0
50
150
0
2
4
6
8
data$xii

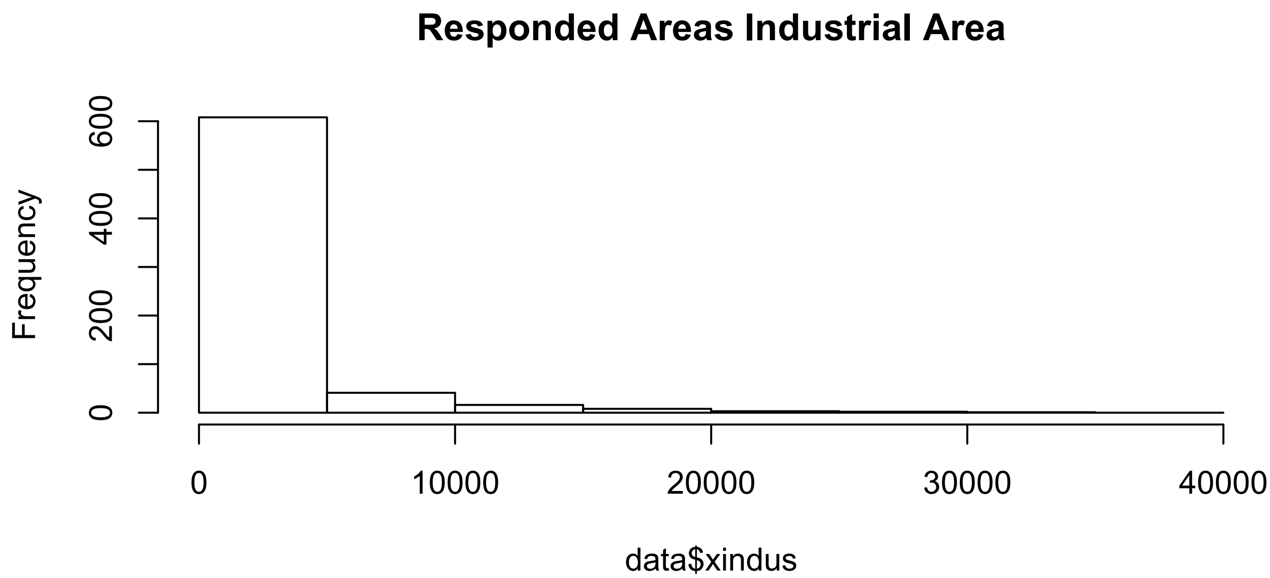

Areas without Response Intrumental Intensity
Frequency
0
10
30
50
0
2
4
6
8
data_no$xii

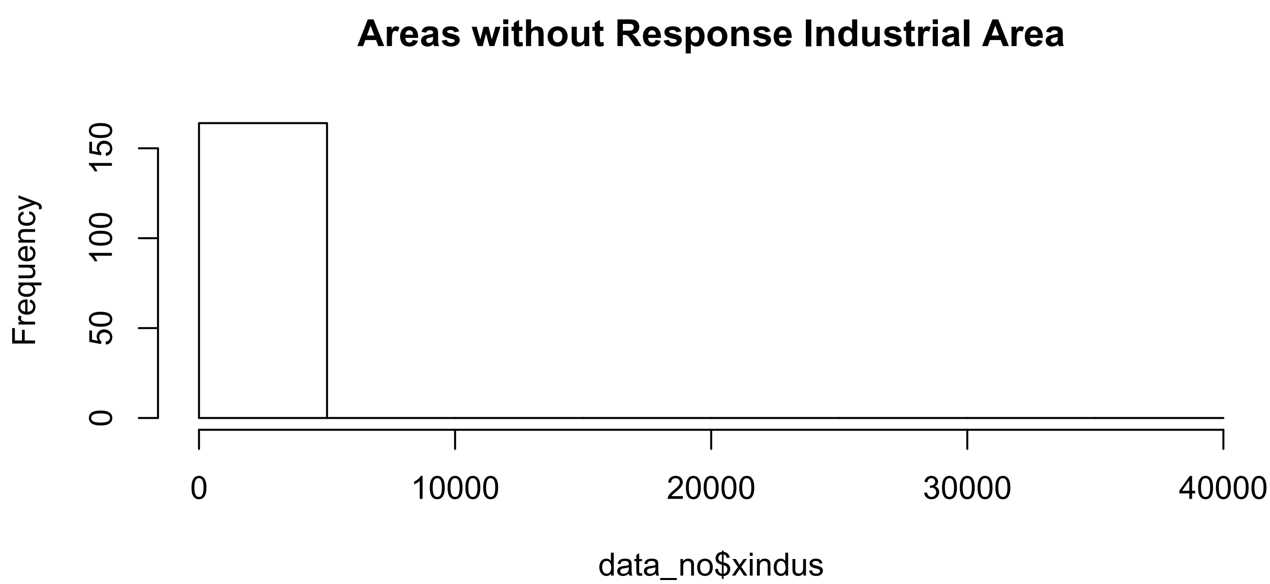

Responded Areas Residential Area
Density
0e+00
4e−05
8e−05
0
20000
40000
60000
80000
data$xres

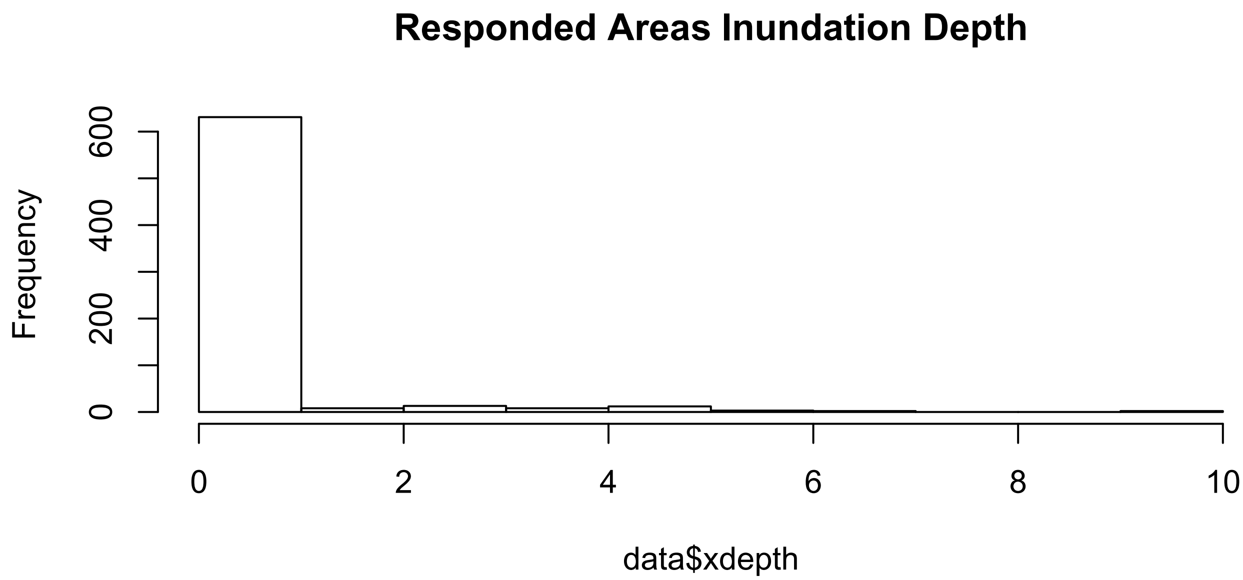

Areas without Response Residential Area
Density
0e+00
4e−05
8e−05
0
20000
40000
60000
80000
data_no$xres

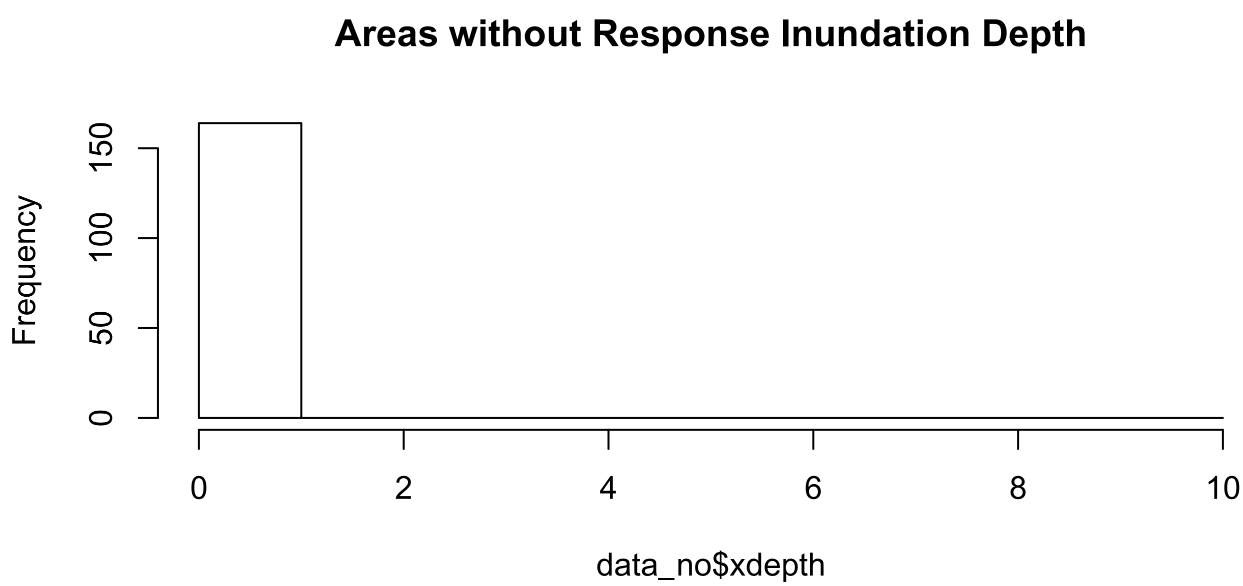

Responded Areas Commercial Area
Frequency
0
200
400
0
2000
4000
6000
8000
10000
12000
data$xcom

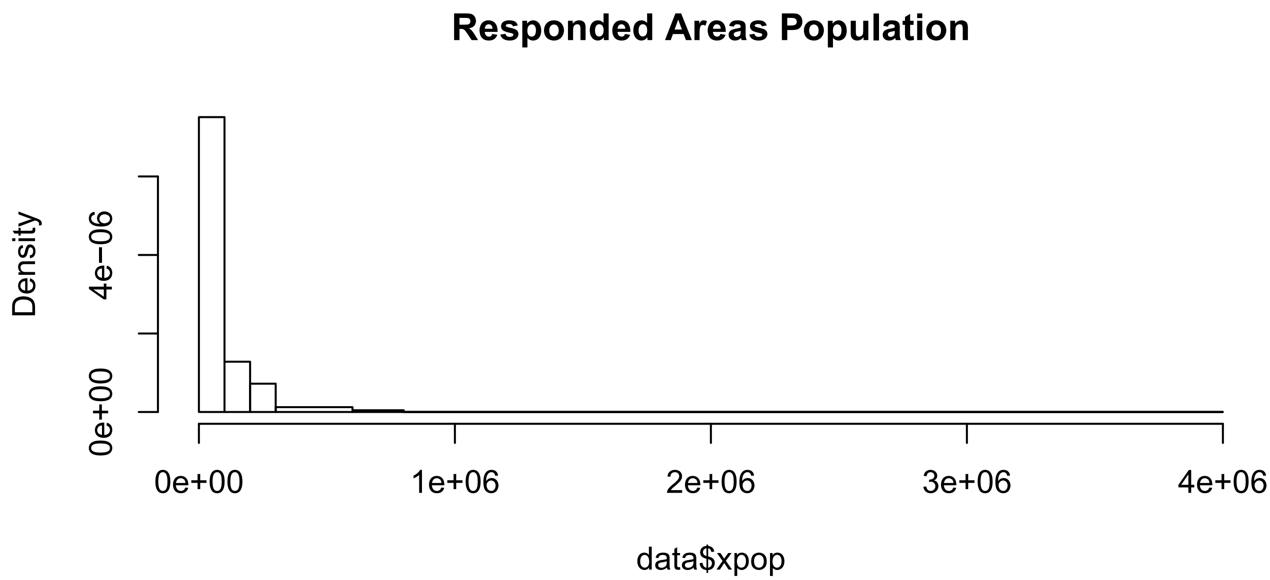

Areas without Response Commercial Area
Frequency
0
50
100
150
0
2000
4000
6000
8000
10000
12000
data_no$xcom

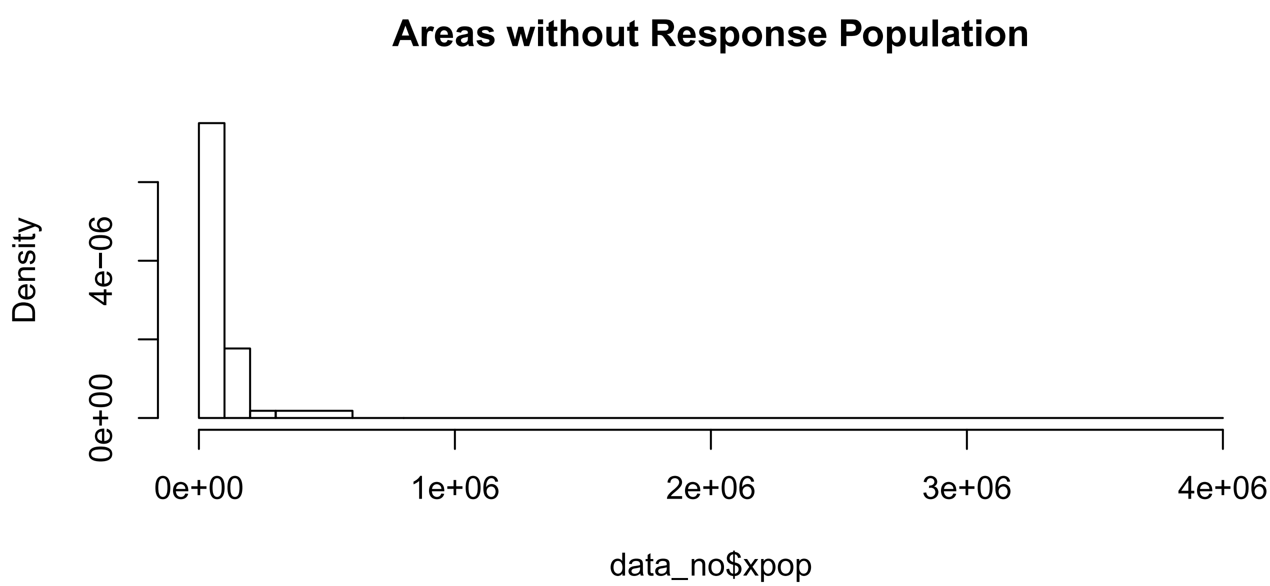

Responded Areas Industrial Area
Frequency
0
200
400
600
0
10000
20000
30000
40000
data$xindus

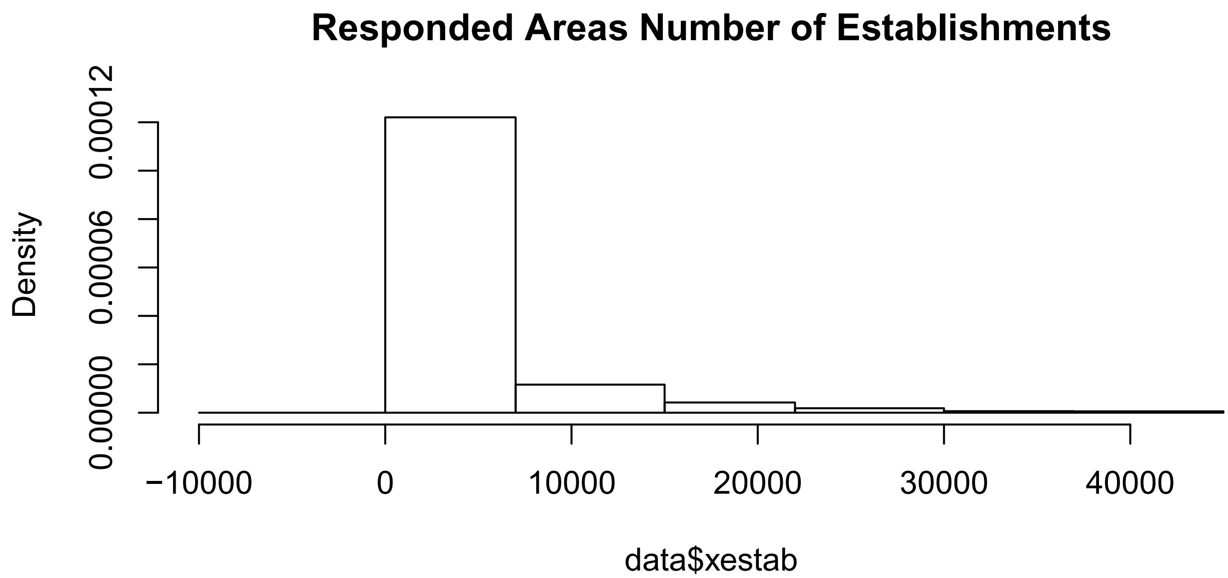

Areas without Response Industrial Area
Frequency
0
50
100
150
0
10000
20000
30000
40000
data_no$xindus

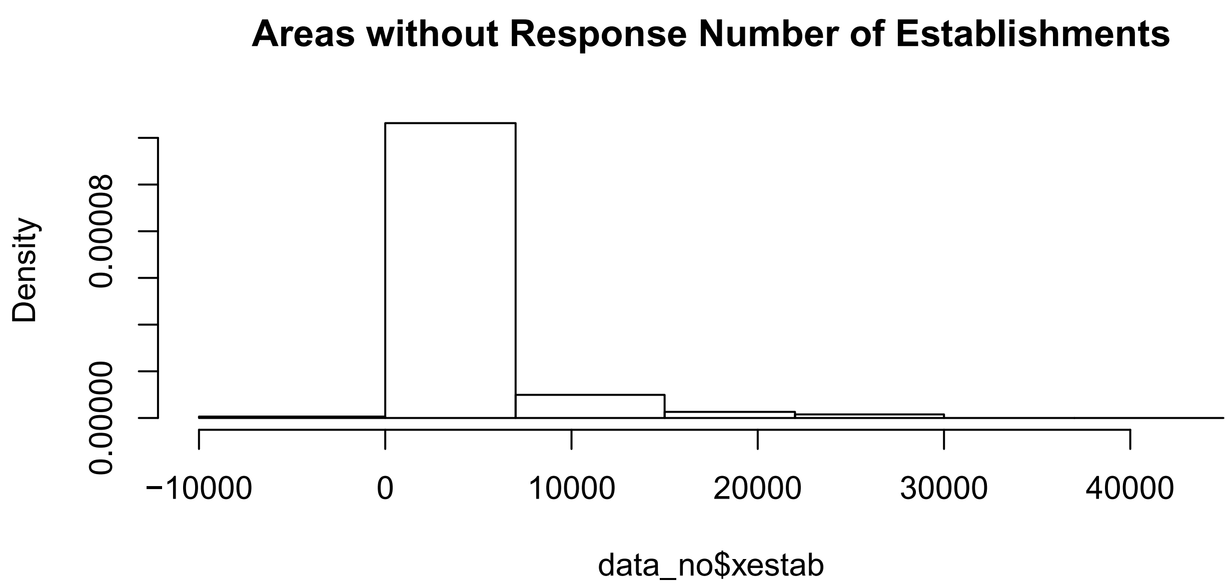

Responded Areas Inundation Depth
Frequency
0
200
400
600
0
2
4
6
8
10
data$xdepth

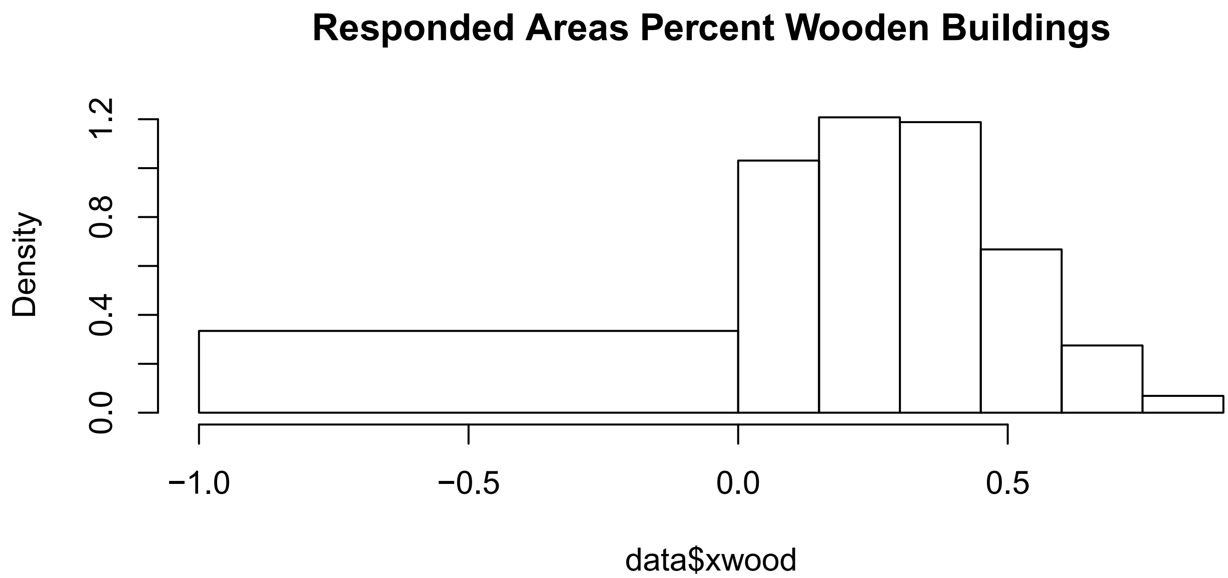

Areas without Response Inundation Depth
Frequency
0
50
100
150
0
2
4
6
8
10
data_no$xdepth

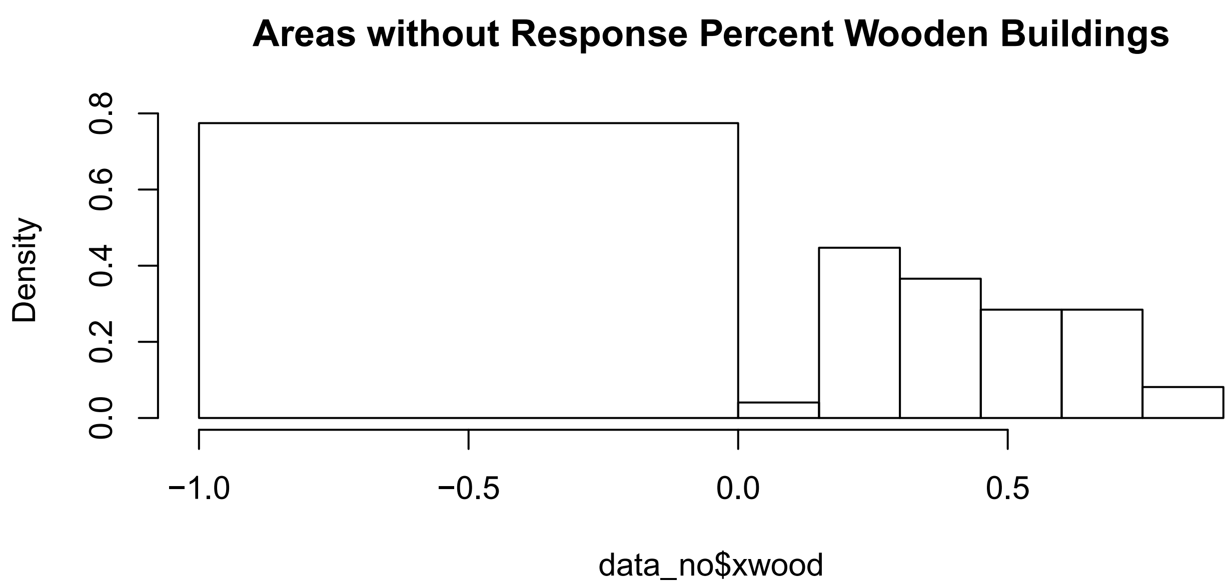

Responded Areas Population
Density
0e+00
4e−06
0e+00
1e+06
2e+06
3e+06
4e+06
data$xpop


Areas without Response Population
Density
0e+00
4e−06
0e+00
1e+06
2e+06
3e+06
4e+06
data_no$xpop

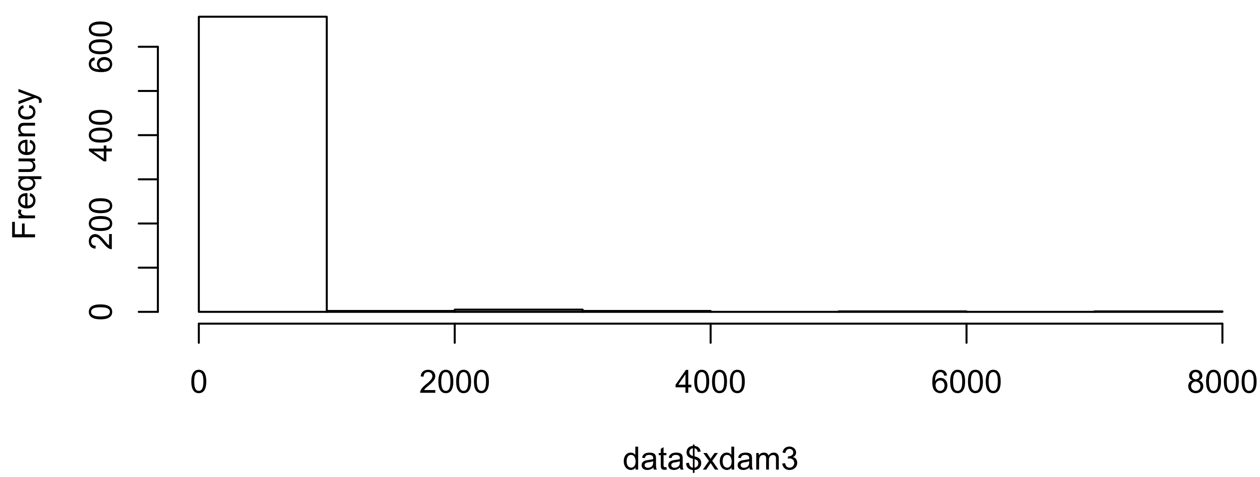

Responded Areas Number of Establishments
Density
0.00000
0.00006
0.00012
−10000
0
10000
20000
30000
40000
data$xestab


Areas without Response Number of Establishments
Density
0.00000
0.00008
−10000
0
10000
20000
30000
40000
data_no$xestab

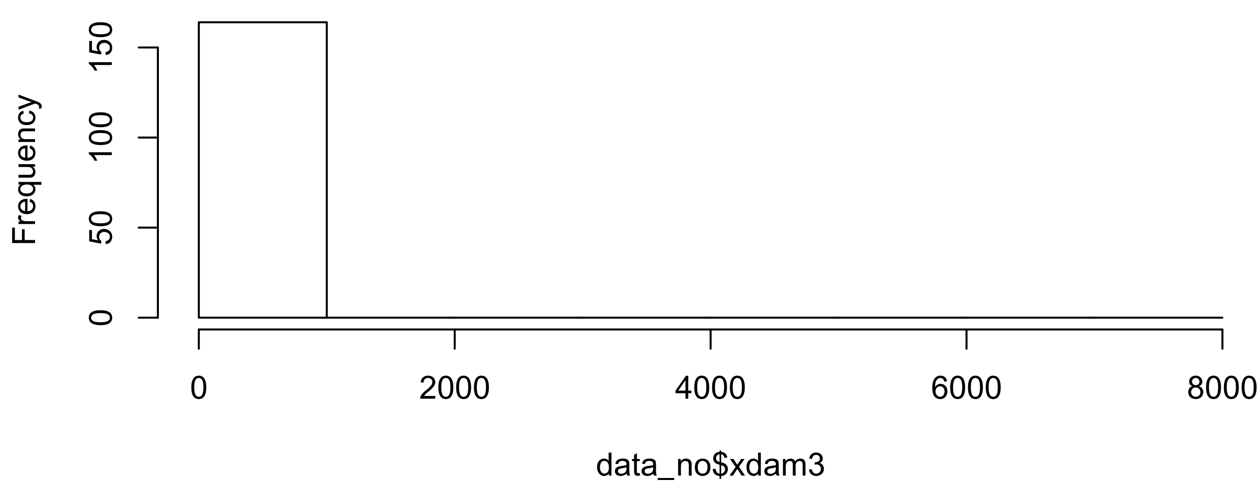

Responded Areas Percent Wooden Buildings
Density
0.0
0.4
0.8
1.2
−1.0
−0.5
0.0
0.5
data$xwood

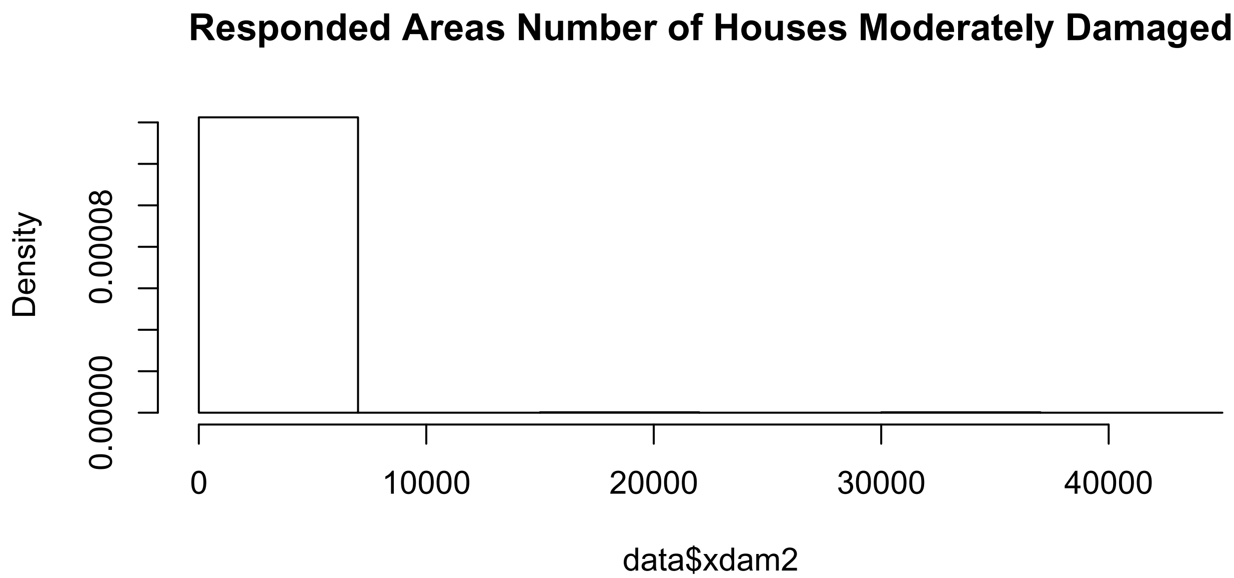

Areas without Response Percent Wooden Buildings
Density
0.0
0.2
0.4
0.6
0.8
−1.0
−0.5
0.0
0.5
data_no$xwood

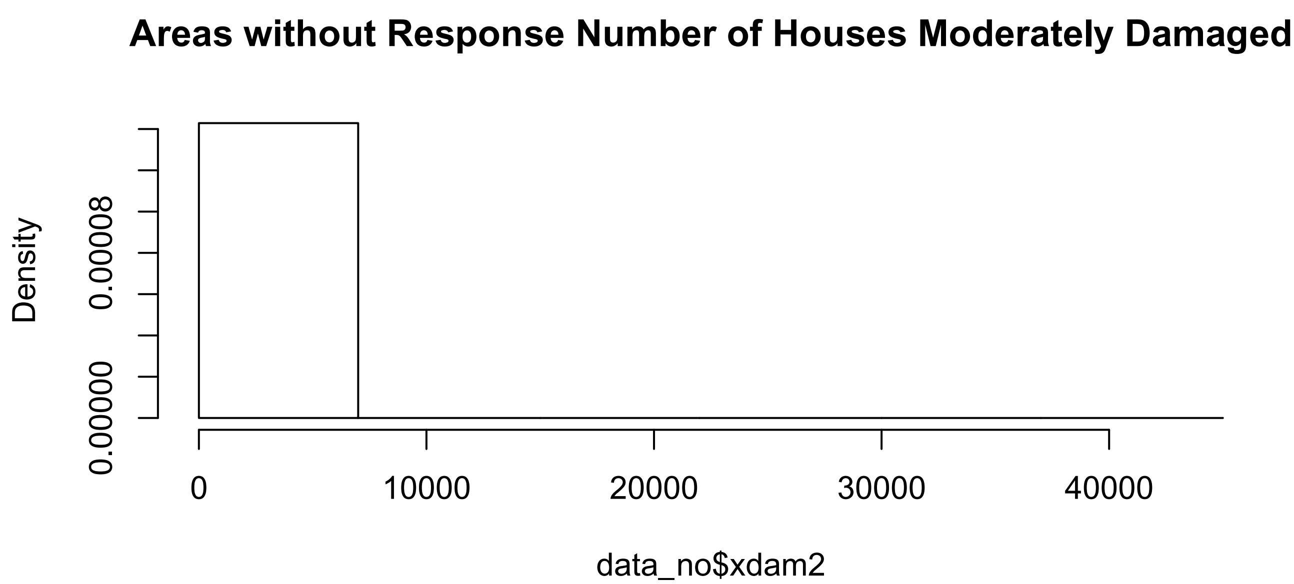
Responded Areas Number Houses Collapsed

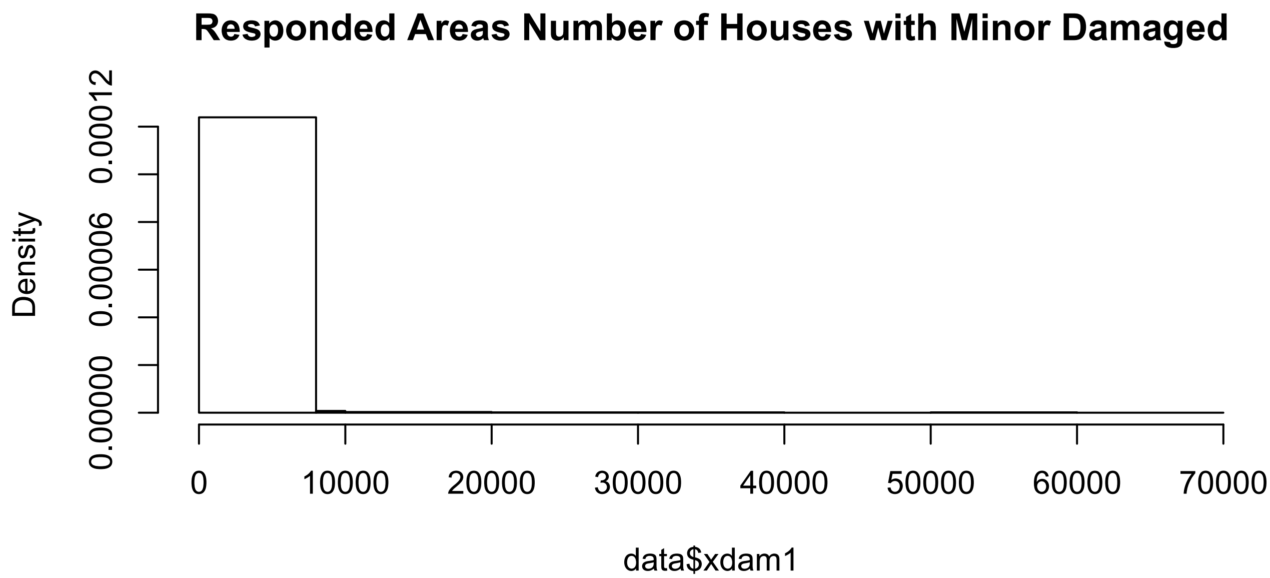


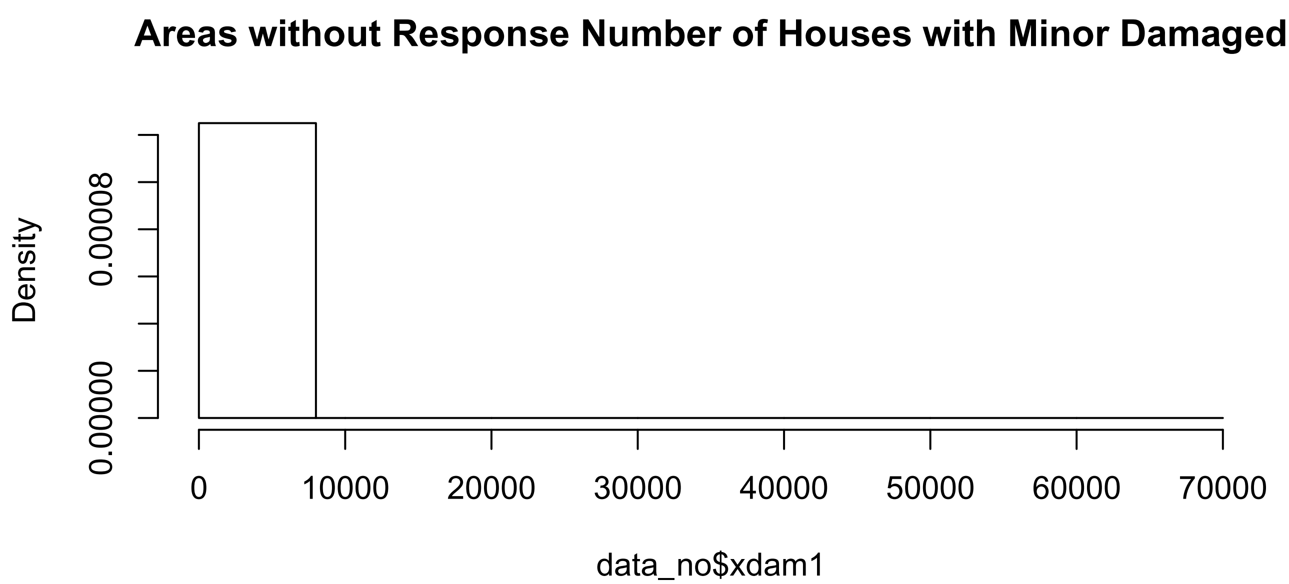
Areas without Response Number Houses Collapsed



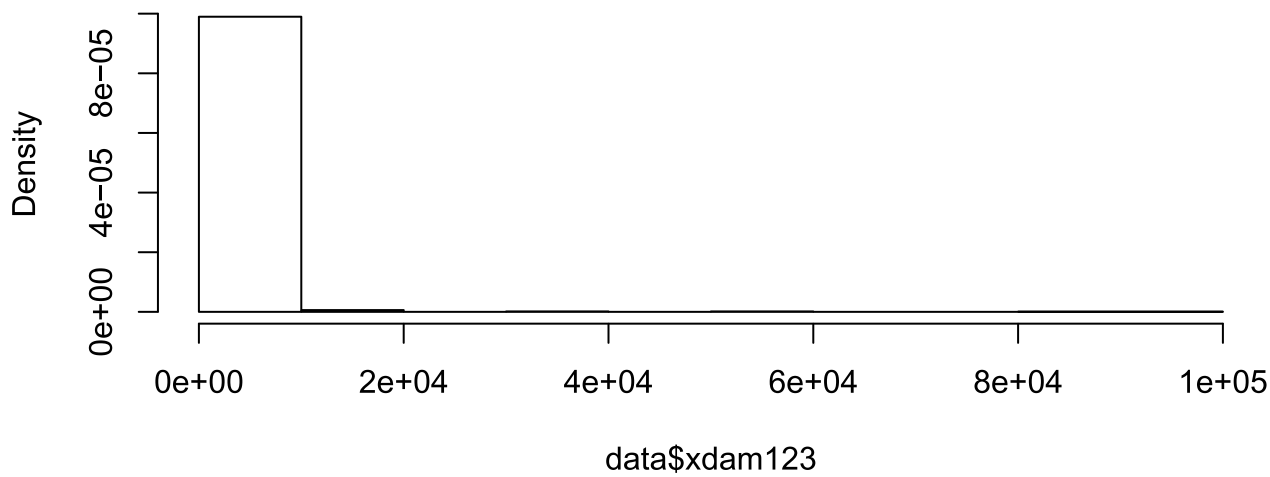

Responded Areas Number of Houses Moderately Damaged
Density
0.00000
0.00008
0
10000
20000
30000
40000
data$xdam2


Areas without Response Number of Houses Moderately Damaged
Density
0.00000
0.00008
0
10000
20000
30000
40000
data_no$xdam2

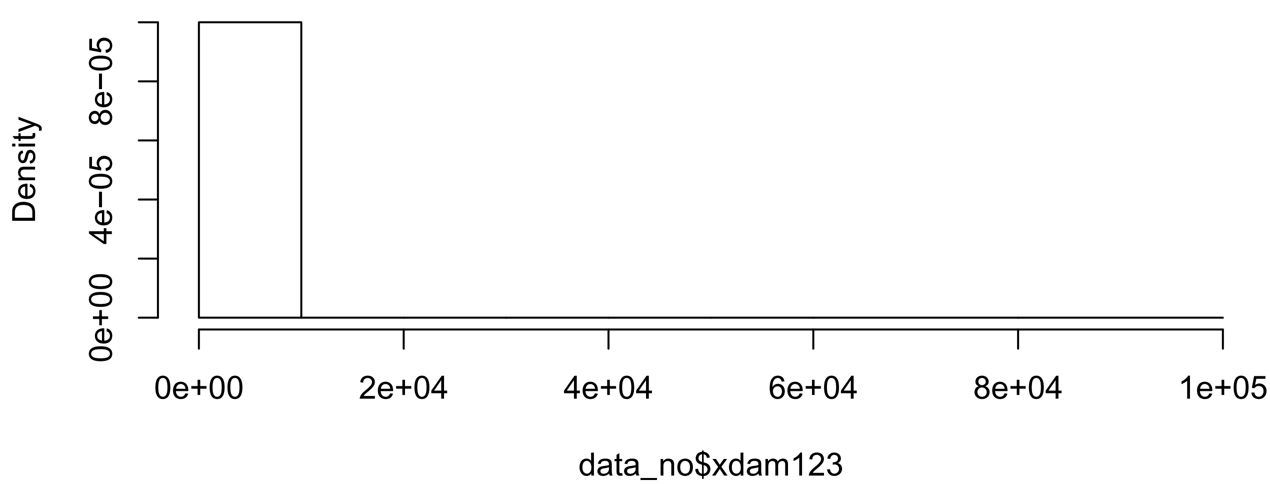

Responded Areas Number of Houses with Minor Damaged
Density
0.00000
0.00006
0.00012
0
10000
20000
30000
40000
50000
60000
70000
data$xdam1


Areas without Response Number of Houses with Minor Damaged
Density
0.00000
0.00008
0
10000
20000
30000
40000
50000
60000
70000
data_no$xdam1

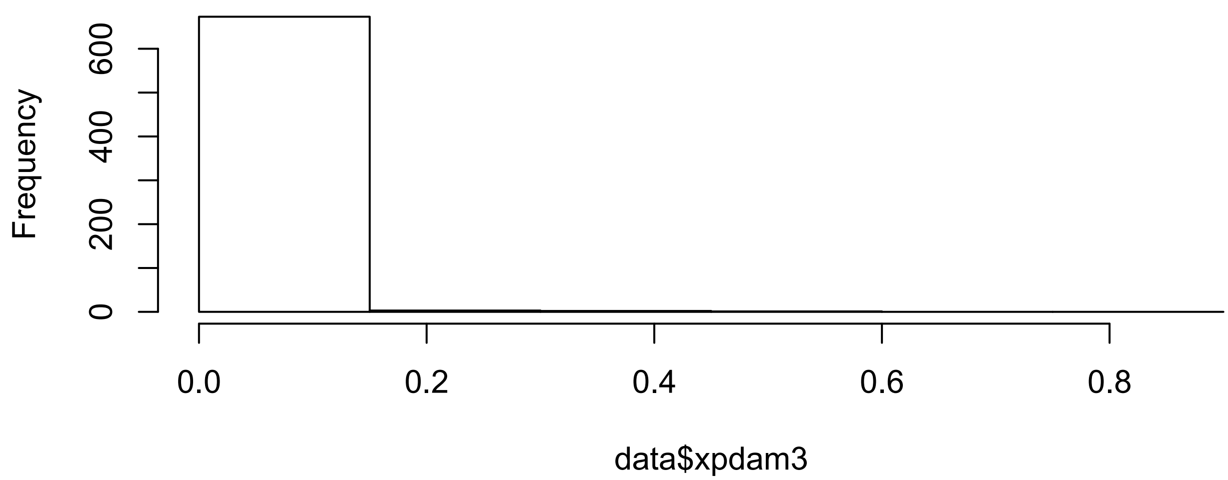
Responded Areas Number of Houses with at least Minor Damage



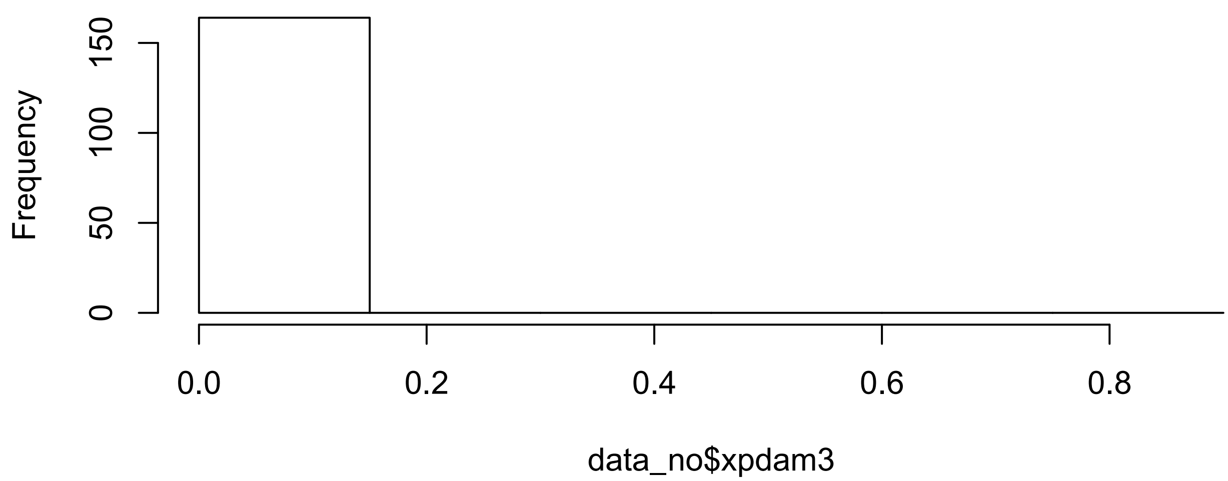
Areas without Response Number of Houses with at least Minor Damage

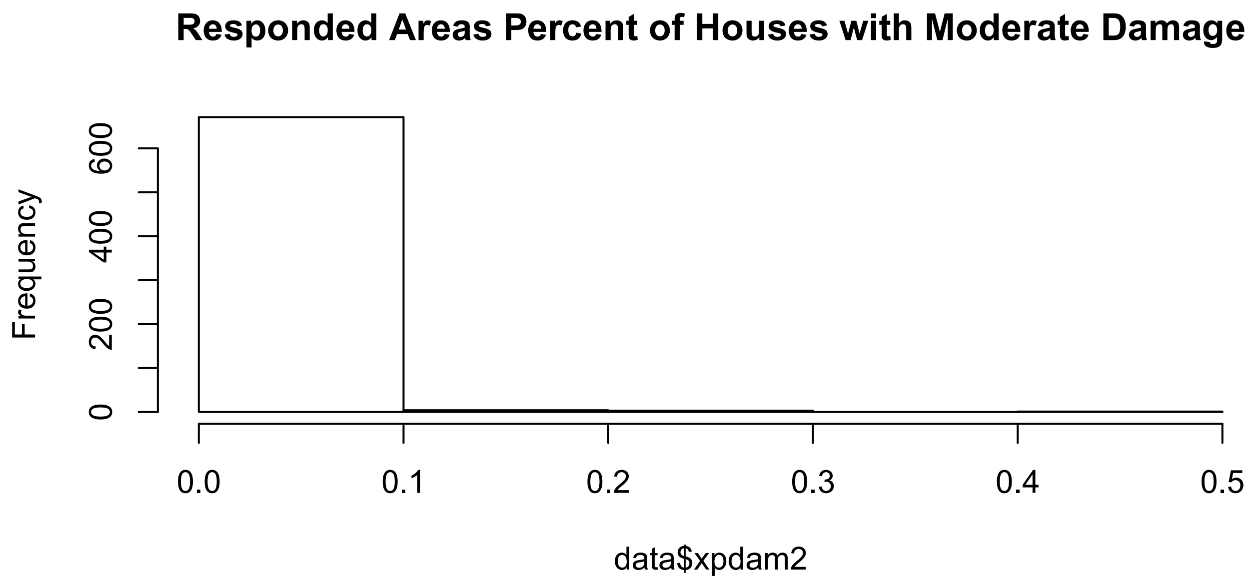


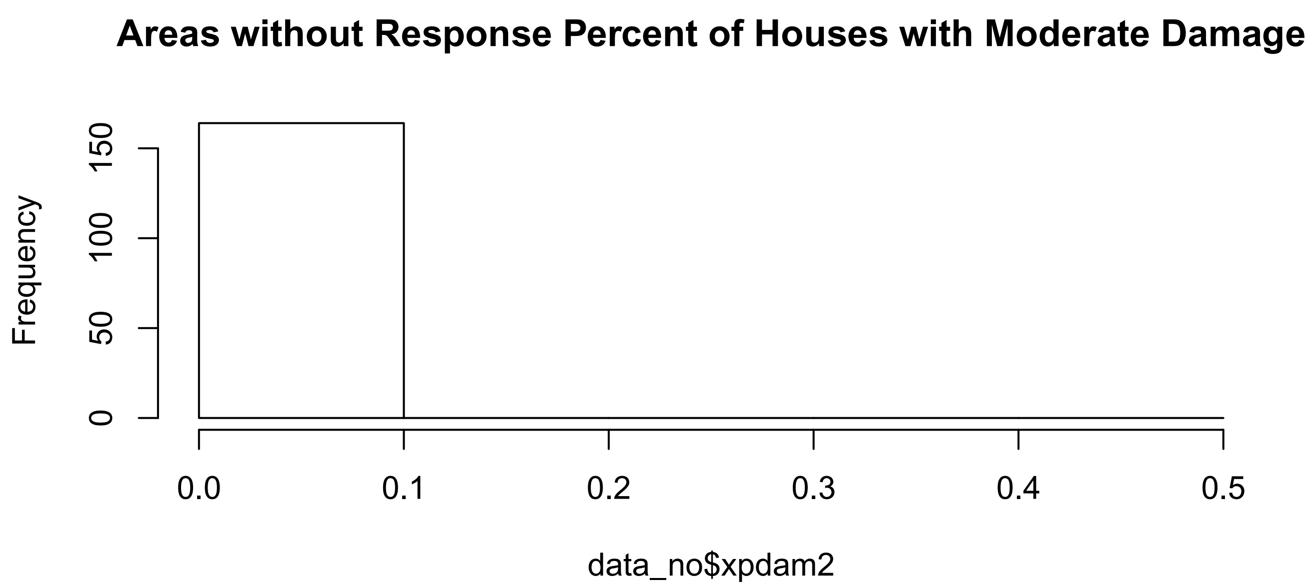
Responded Areas Percent of Collapsed Houses

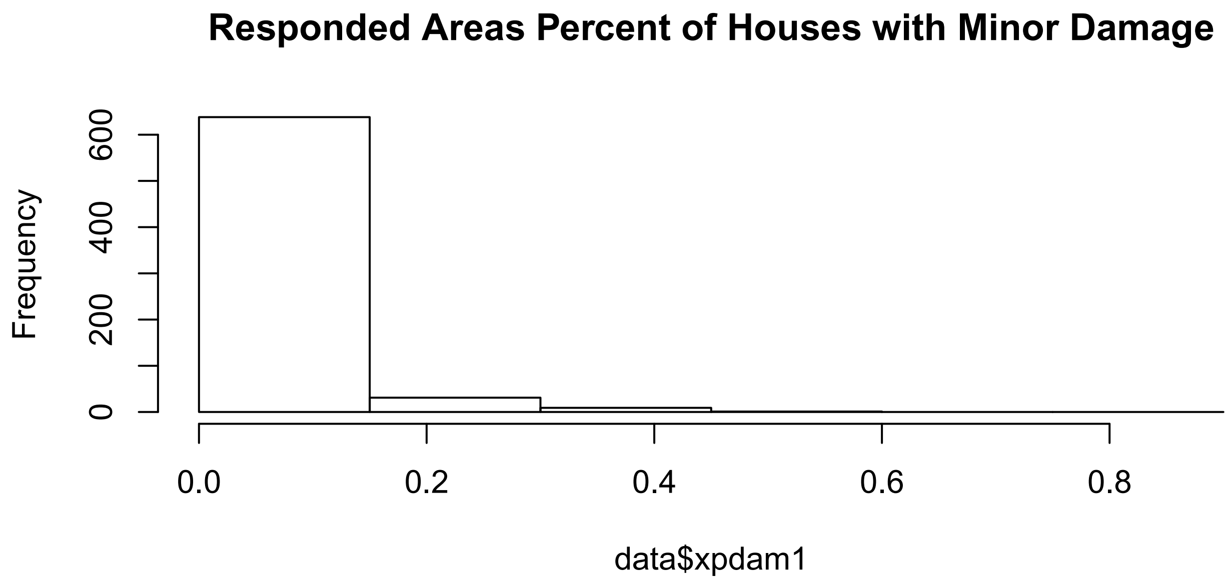


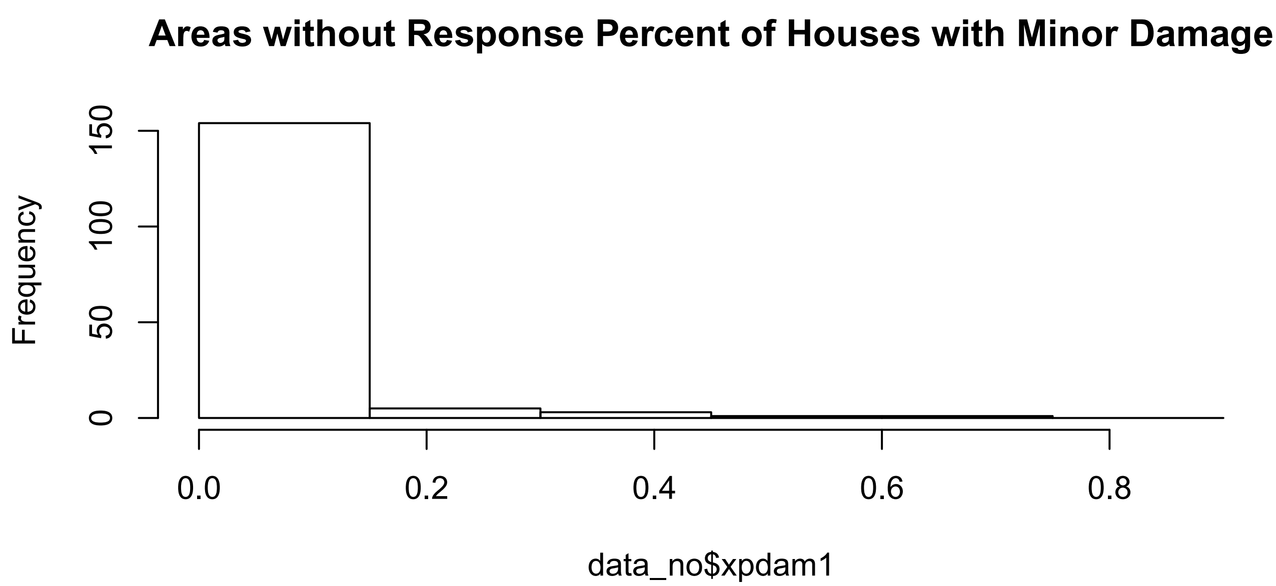
Areas without Response Percent of Collapsed Houses

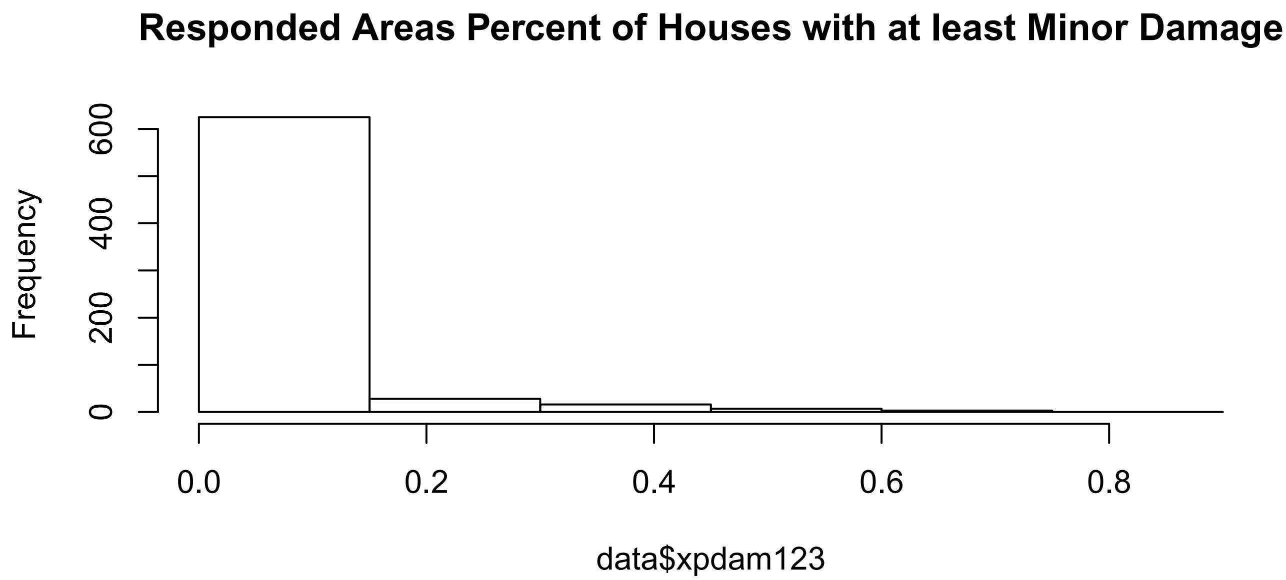


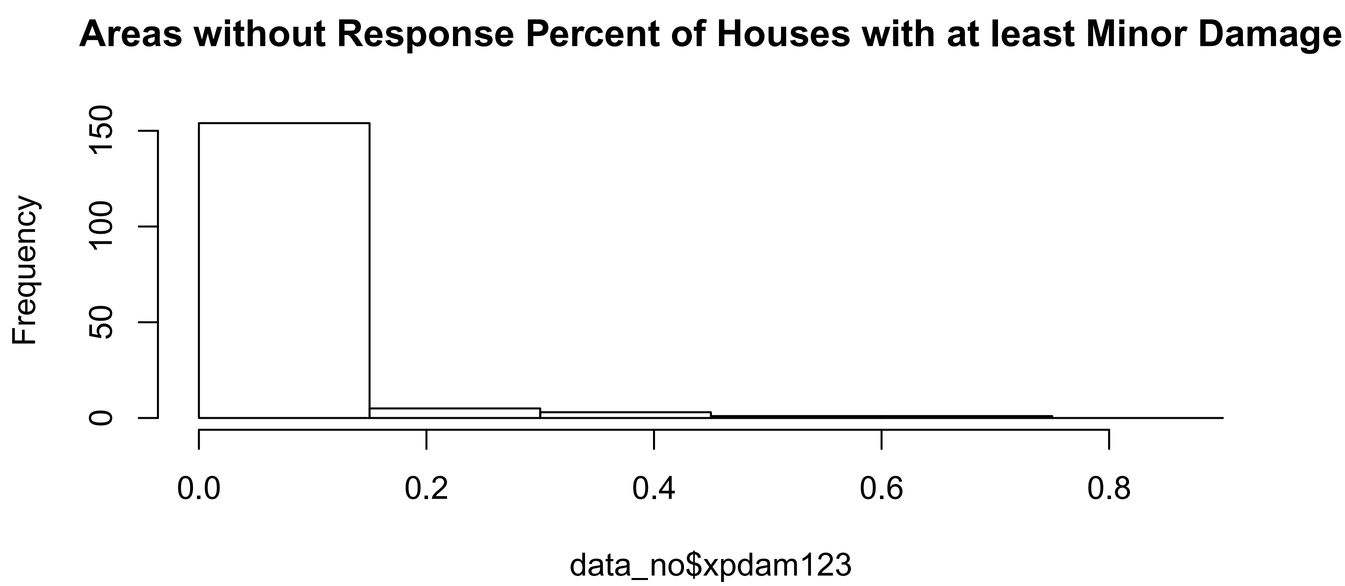

Responded Areas Percent of Houses with Moderate Damage
Frequency
0
200
400
600
0.0
0.1
0.2
0.3
0.4
0.5
data$xpdam2

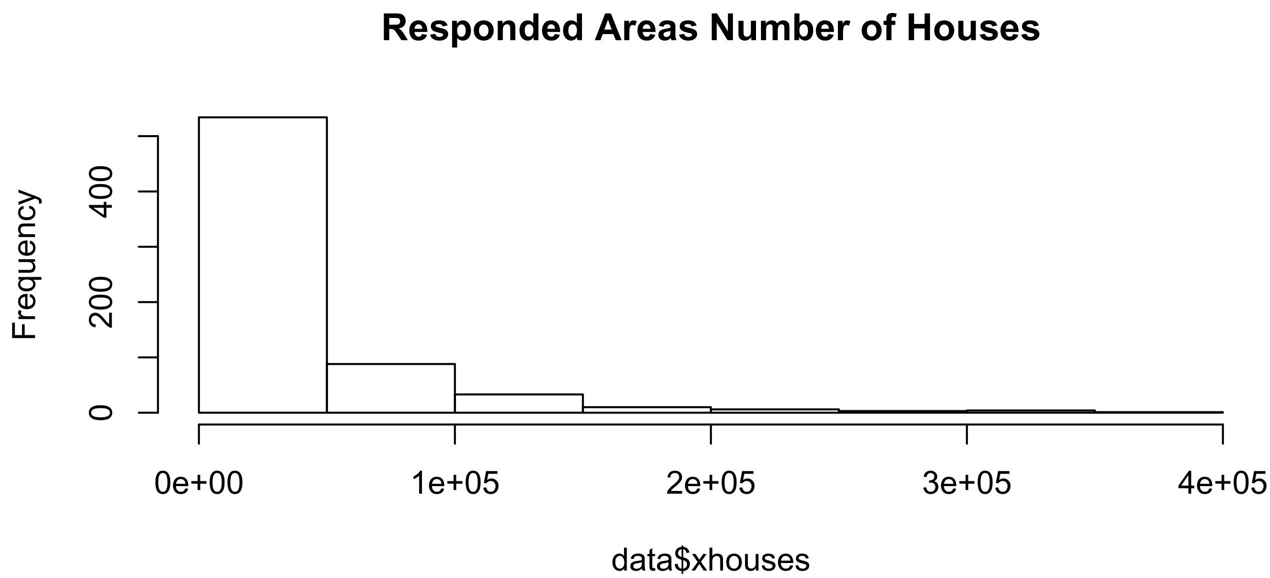

Areas without Response Percent of Houses with Moderate Damage
Frequency
0
50
100
150
0.0
0.1
0.2
0.3
0.4
0.5
data_no$xpdam2

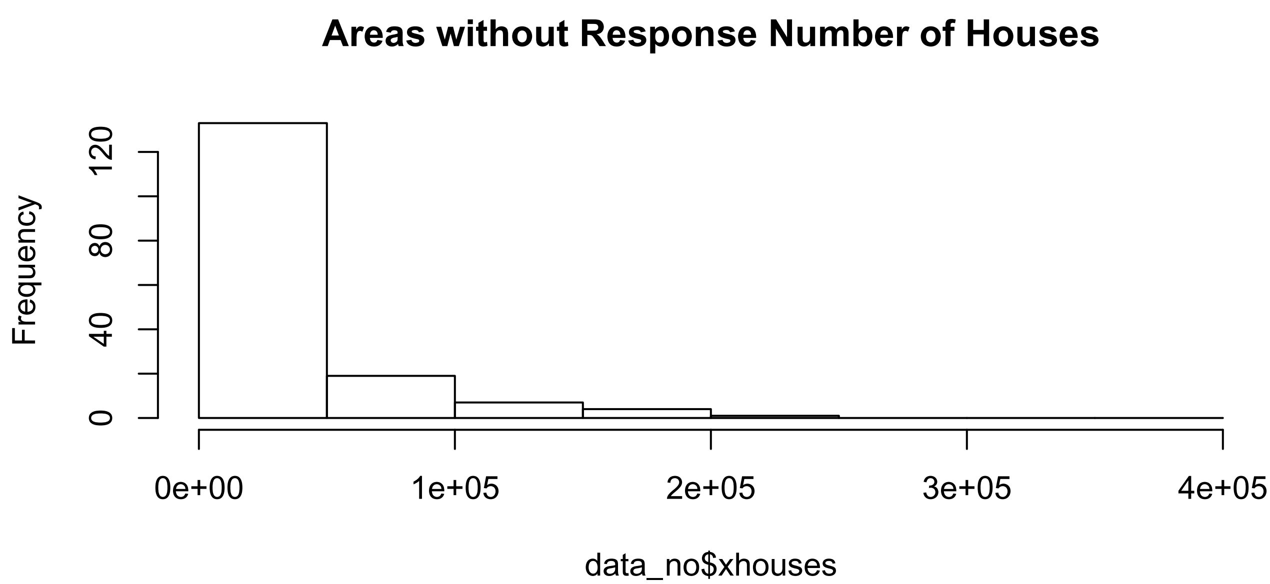

Responded Areas Percent of Houses with Minor Damage
Frequency
0
200
400
600
0.0
0.2
0.4
0.6
0.8
data$xpdam1


Areas without Response Percent of Houses with Minor Damage
Frequency
0
50
100
150
0.0
0.2
0.4
0.6
0.8
data_no$xpdam1


Responded Areas Percent of Houses with at least Minor Damage
Frequency
0
200
400
600
0.0
0.2
0.4
0.6
0.8
data$xpdam123


Areas without Response Percent of Houses with at least Minor Damage
Frequency
0
50
100
150
0.0
0.2
0.4
0.6
0.8
data_no$xpdam123


Responded Areas Number of Houses
Frequency
0
200
400
0e+00
1e+05
2e+05
3e+05
4e+05
data$xhouses


Areas without Response Number of Houses
Frequency
0
40
80
120
0e+00
1e+05
2e+05
3e+05
4e+05
data_no$xhouses