Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 3 Issue 12, December - 2016

Testing the Significance in Waste Reduction at County and State Level

Rolando Pena-Sanchez
Division of International Business and Technology Studies
Texas A&M International University
rsanchez@tamiu.edu

Abstract— This study reviews and tests the Significance in Waste Reduction at Guilford County, and as well as at the State of North Carolina; where this State has designated the fiscal year 1991-92 as the baseline for comparison of solid waste disposal rates and waste reduction (tons per year); and under this baseline the Guilford County published their efforts and planned actions on waste reductions during the period 2001-2011; efforts and actions that represent a significant waste reduction, which has been proven via linear regression fitting and through a graphical description of a Box-Plot.

Keywords— Waste reduction, statistical significance, linear regression, box-plot

I. INTRODUCTION

Talking about waste classification, the Guilford County's report includes: Construction and Demolition Waste (C&D Waste), which is solid waste resulting solely from construction, remodeling, repair or demolition operations on pavement, buildings or other structures, except inert debris, land clearing debris and yard waste. Yard Waste: Vegetative debris generated from lawn maintenance and landscaping, including brush, grass, tree limbs and other similar vegetative materials. Land Clearing and Inert Debris (LCID Waste), including only concrete, brick, concrete block, uncontaminated soil, rock, gravel, untreated wood, limbs, leaves and stumps. Municipal Solid Waste (MSW Waste): any solid waste generated from the residential, commercial and industrial sectors other than hazardous waste, sludge, regulated industrial waste or solid waste resulting from an agricultural or mining operation. Electronics (E-Waste): Old computers and obsolete computer equipment, televisions, cell phones, electronic games and toys, DVD and VHS players, stereo equipment, small appliances and microwaves. Household Trash: Waste products generated in households, including garbage, furniture and other household materials. Household *Hazardous* Waste (HH-Waste) [5]: Household items and products which contain *hazardous* materials [5], including automotive fluids, gasoline and oil, glues and epoxies, solvents and cleaners, paints, stains and varnishes, all types of batteries, fluorescent tubes and bulbs, mercury thermometers/thermostats, pesticides, insecticides, pool chemicals, polishes, drain cleaners, hair remover, nail polish.

Environmental education is part of the environmental services and under this prerogative Guilford County provides informative programs and exhibits tailored to suit a variety of applications, including community events, civic organizations and clubs, schools, scout groups and children's organization.

Environmental education is the departure to prevent environmental crimes [6]: Don't mess with Texas is a famous slogan used around the state of the lonely star to stop *littering*, which is considered as an environmental crime. An environmental crime is a felony against environmental legislation that is liable for prosecution [8]. Examples are**:** pollutant emissions to air, water and soil; trade in endangered species; improper disposal of wastes [2], etc. According to the Environmental Protection Agency (EPA), a Criminal Enforcement Program focuses investigative resources on cases that involve negligent, knowing or willful violations of federal environmental law [11]. Environmental crimes are the most difficult crimes to investigate because they require high levels of education in various topics [10], such as biology, chemistry, physics and the environment [9]. Ever since the Environmental Protection Agency's Office of Criminal Enforcement was founded in 1982, there has been a steady increase in prosecuted environmental crimes.

Usually the violations are those that are deliberate and not the product of accidents or mistakes [7]. Not knowing the specific statutes, or the set of laws that prohibit the unlawful conduct is not a justification. When an offender is aware that the wrongful conduct is prohibited by law, the violation is said to be *willful*. If this does not describe what a person is reporting, it may be a case for a civil enforcement action. Frequently, the investigations of environmental crimes will uncover other crimes, such as lying to the government, fraud and/or conspiracy.

II. OBJECTIVE

The research objective of this article is to test the significance in Waste Reduction during the selected period (2001-2011) for each one of the two locations: County and State.

III. DATA AND METHODOLOGY

This study was carried out with a secondary type data set conformed from an annual report (Solid Waste (SW) Management Planning Info) located at an official website of environmental services coordinated by the Office of Guilford County Solid Waste {telephone: (336) 641-3792, P. O. Box 3427, Greensboro, NC}**:**

http://www.myguilford.com/planning-and-development/environmental-services/sw-management-planning-info/

FIGURE 1 contains the data to support this study, where the upper curve represents the information about the Guildford County, while the lower curve covers the data for the State of North Carolina. At FIGURE 1: 2001 represents the fiscal year (FY) 2000-2001, 2002 represents the FY 2001-2002, and so on till 2011, which represents the FY 2010-2011.

BASELINE: The State of North Carolina has designated fiscal year 1991-92 as the baseline for comparison of solid waste disposal rates and waste reduction. *Negative* quantities (FIGURE 1) relating to waste reduction indicate an *increase* in the amount of waste disposed when compared to the baseline rate; meanwhile, *positive* amounts relating to waste reduction indicate an actual *reduction* in the amount of waste disposed when compared to the baseline rate.

According to the research objective, the dependent Variable is Waste Reduction (Tons per Year) for the selected period 2001-2011; and the appropriate hypotheses are:

Research Hypothesis (H_A): The linear trend of waste reduction is significant for the selected period of time

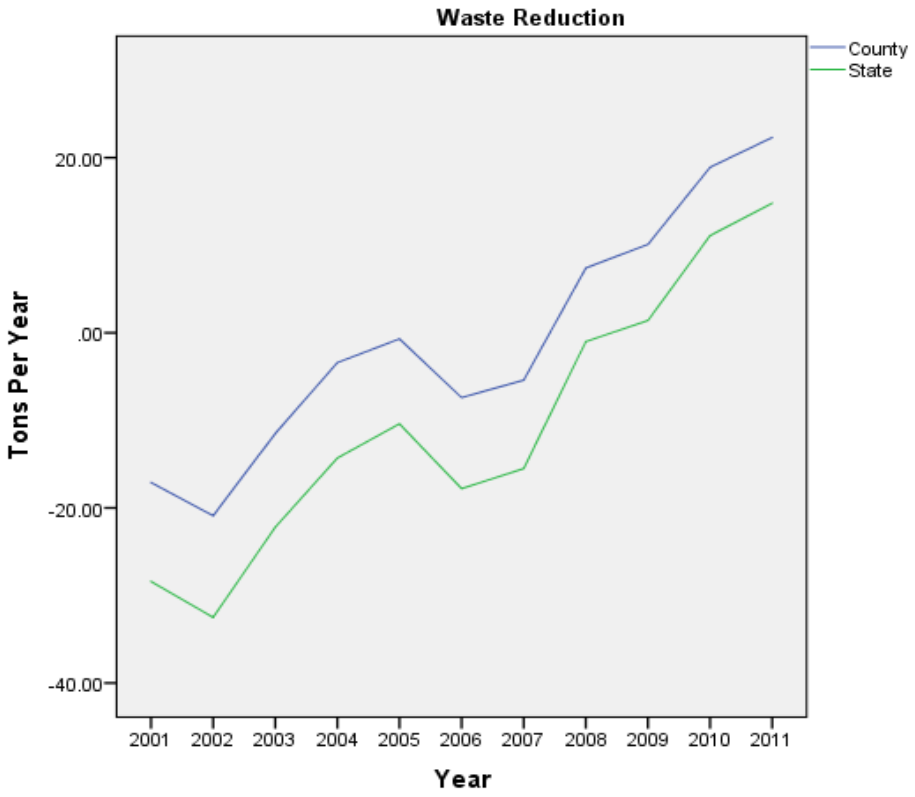
Null Hypothesis (H_0): The linear trend of waste reduction is not significant for the selected period of time

Thus, the corresponding statistical notations for the previous hypotheses are:

$$H_0: \beta = 0 \text{ versus } H_A: \beta \neq 0$$

Where β represents the slope for the linear tend of waste reduction at each one of the two locations: County and State.

FIGURE 1 – WASTE REDUCTION (TONS PER YEAR) 2001- 2011



Source: http://www.myguilford.com/planning-and-development/environmental-services/sw-management-planning-info/

IV. STATISTICAL ANALYSIS

Linear regression technique represents fitting a least squares parametric model or curve to data, so we can make predictions (interpolations) on points not covered by the data. If bivariate data sets are known then a model can be estimated, but we want to estimate the model parameters that make the model fit best (highest R^2_{adj}) to the data according to some numerical observations; or to find another more appropriate model.

The linear regression trend takes the form $\hat{Y} = b_0 + b_1 t$, where $\hat{Y}$ represents the waste reduction (Tons) estimate per time units; t is the independent variable measured in years. Thus, b_0 and b_1 are the least squares estimates of the population linear regression coefficients β_0 and β_1 respectively.

FIGURE 2 contains a sequence of circles (County's waste reductions) and perfect square rectangles (State's waste reductions) where the geometric center of each circle and rectangle represents the corresponding observation.

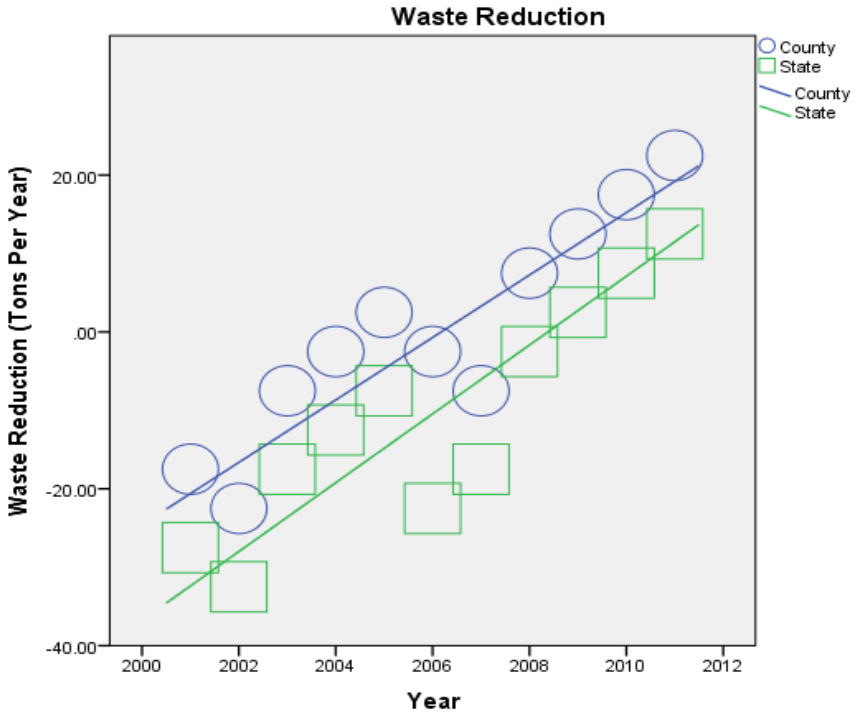


FIGURE 2 – LINEAR REGRESSION FITTING FOR WASTE REDUCTION (TONS PER YEAR) 2001- 2011

TABLE 1 – COEFFICIENT ESTIMATES FOR THE LINEAR REGRESSION FITTING OF WASTE REDUCTION ON TIME SHOWN IN FIGURE 2

Location	R^2	R^2_{adj}	Linear Regression Fitting Standardized Coefficient (β)	**p-value**	Decision at α=0.01
County	0.888	0.875	0.942	0.001	Reject H_0
State	0.893	0.881	0.945	0.001	Reject H_0

V. CONCLUSIONS AND FINAL REMARKS

TABLE 1 and as well as FIGURE 2 confirm that the research objective has been reached. Thus, we can conclude that the waste reduction during the period 2001-2011 was significant (p-value<0.01) for both locations: County and State.

Moreover, TABLE 1 provides a measure of the goodness of fit of the linear trend via the determination coefficients R^2 and $R^2_{adjusted}$, which for both locations exceed 87%.

Do not confuse *statistical* significance with *practical* significance; because, a small effect can be highly significant if the sample size is sufficient large.

Statistical significance means only that the null hypothesis of exactly no effect is rejected; it does not mean that the effect is important, which is what

"significant" typically means. When an effect is significant, we have confidence that the effect is not exactly zero. Finding that an effect is significant does not tell us about how large or important the effect is.

Therefore, finding that an effect is statistically significant signifies that the effect is real and not due to chance; like the planned environmental actions at Guilford County, where such planned activities had been generating a significant (p-value < 0.01) waste reduction (TABLE 1).

FIGURE 3 represents a Box-Plot, which is a nonparametric graphical [4] verification of a significant discrepancy among the medians [3] for yearly waste reductions at both locations (County & State), this FIGURE 3 contains two rectangles, and for each rectangle the median is represented by its horizontal line segment dividing the corresponding rectangle. Comparing both distributions, our conclusion is that the distribution of County data shows the largest median waste reduction. In other words, among County and State: the distribution of Guilford County data shows the highest median waste reduction during the period 2001-2011.

A standard Box-Plot contains five statistics [1]: the lower observation, the first quartile, the second quartile (or median), the third quartile and the largest observation.

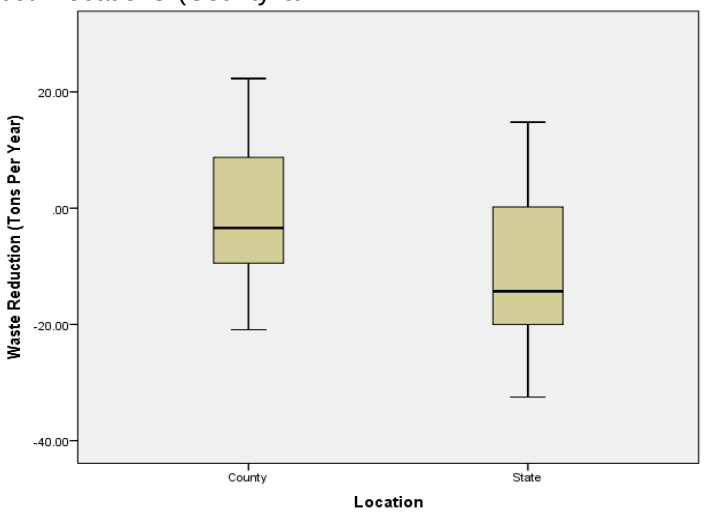


FIGURE 3 – BOX-PLOT FOR THE DATA FROM FIGURE 1

The ideas presented in this report could encourage the planning process on actual and future waste reduction programs at *City, County and State* level.

REFERENCES

[1] BERENSON, M. L., LEVINE, D. M., KREHBIEL, T. C. (2009). *Basic Business Statistics: Concepts and Applications*. 11th Edition. PEARSON-Prentice-Hall.

[2] CRAWFORD-BROWN, DOUGLAS J. (1999). *Risk-Based Environmental Decisions: Methods and Culture*; KLUWER Academic Publishers.

[3] COOPER, D.R. and SCHINDLER, P. S. (2008). *Business Research Methods,* 10th Ed. *McGraw-Hill*.

[4] DUTOIT, S.H.C., STEYN, A.G.W., and STUMPF, R.H. (1986). *Graphical Exploratory Data Analysis*. *Springer-Verlag*, Berlin.

[5] EPA (2016)**.** Environmental Protection Agency. Learn the Basics of Hazardous Waste.

Source **:** https://www.epa.gov/hw/learn-basics-hazardous-waste

[6] INMAN, E. K. (2001). Environmental crimes; *The American Criminal Law Review*.

Source : http://www.allbusiness.com/government/environmental-regulations/1119978-1.html

[7] PENA-SANCHEZ, R. (2009). Employee Perceptions of the Environmental Risk: Maquila Industries on the Mexico-U.S. Border. *Intl. Business and Economics Research Journal*. Vol. 8, Number 1, pp 51-58.

[8] ROBERTS, S. (2009). Experts predict uptick in pollution prosecutions. *Business Insurance*, 43(20),

[9] SASSEVILLE, D. R., WILSON, W. G. and. LAWSON R. W (1997). *ISO 14000 Answer Book: Environmental Management for the World Market*. John WILEY & Sons, Inc.

[10] VOORHEES, J. and WOELLNER, R.A (1997). *International Environmental Risk Management: ISO 14000 and the Systems Approach*; LEWIS Publishers.

[11] WATSON, R. P., KIEL, D. C., and ROBAR, S. F. (2004). *Managing Environmental Policy: A Casebook*; KRIEGER Publishing Co.