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OUTSTANDING ARTICLES ORIGINATING FROM THE EAM-I CONFERENCE IN BRAZIL

To What Degree Can Potable Water Foster International Economic Development and Sustainability? What Role Does Health Play?

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Governments, international organizations, and practitioners have long proclaimed that investments in potable water supply and sanitation and improvements in public health lead to economic development in the developing world. Unfortunately, scholars have not been able to quantify these relationships for a plethora of reasons. This study found significant, positive relationships between investments in integrated projects of potable water supply combined with sanitation and public health and economic development. The study also moderately supported the hypothesis that the relationship between investments in such projects and economic development is stronger in the presence of better health.

The article concludes with hopes that the strength of the findings could encourage greater international investment to promote rural sustainability. In particular, the findings buoy calls for supporting indigenous organizations based in rural areas with integrated methodologies that encourage consciousness-level raising in addition to addressing the pressing needs of potable water and basic sanitation. ***Organization Management Journal*****, 9: 83–89, 2012. doi: 10.1080/15416518.2012.687988**

Keywords public health; rural water supply; economic development and investments

Sustainability as defined by the Brundtland Commission "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, p. 1). A more recent definition for sustainable development is "interventions that increase the capability of people, and the organizations instigating the interventions, to respond to community needs in a particularly agile and adaptive way that addresses current needs of the poor and does not endanger future capacity" (Brower, 2011). Both definitions highlight the importance of addressing the needs of the poor without causing problems for future generations. The second definition also addresses that the response should be "agile and adaptive," while the first definition is more generic. Important sustainability goals include economic development and improving public health in the developing world. The World Bank estimates that governments have invested hundreds of billions of dollars designing and constructing potable water supply and sanitation projects with the intent to produce economic development and improve public health (World Bank, 2008). In 1980, the UN General Assembly, at its 35th session, formally launched the International Drinking Water Supply and Sanitation Decade. The United Nations has established goals to "alleviate extreme poverty" by 2015" (United Nations, 2011). One of these goals is to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation (United Nations, 2010). Member countries committed to provide potable water and sanitation for *all* by 1990 (World Health Organization [WHO], 1981). Individual countries have

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set similar goals; for example, Argentina has committed to provide "deprived" neighborhoods with universal access to drinking water and sewage (Gardetii, 2007). Scholars and practitioners highlighted the lack of water supply worldwide seven years into the decade, estimating 78% of the rural population of the 75 developing countries did not have access to potable water and 85% did not have access to sanitation (Mullick, 1987). The world never met the goal.

Twenty years later, in September 2000, the United Nations General Assembly adopted a number of Millennium Development Goals (MDG) that challenged the global community to reduce poverty and increase the health and well-being of all peoples (Marques, 2007). In September 2002, the World Summit on Sustainable Development in Johannesburg reaffirmed these goals and added a specific target: to halve, by 2015, the proportion of people without access to basic sanitation and water.

Eight years after the MDG goals were established, more than 1 billion people globally were without access to improved water supply (which amounts to 1 human being out of 6); 2.6 billion people are without access to improved sanitation (half the developing world) (WHO, 2008). According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), 2.3 billion people suffer from water-related disease worldwide (Azizullah, Khattak, Richter, & Häder, 2011). There are also 4 billion cases of diarrhea that occur annually, and 2.2 million cases are fatal (Massoud, Al-Abady, Jurdi, & Nuwayhid, 2010). Indeed, instead of solving the problem, the problem seems to be growing (Allen, 2007; Bryant, 2008).

Significant research has demonstrated the importance of reaching these goals. Kandachar and Halme (2005, p. 5) emphasized the need for a "large scale effort on multiple fronts . . . by local and international policy makers." While not definitive, research indicates that water and sanitation improvements can be cost-beneficial (Hutton and Haller, 2004; Joyashree, 2008). Scholars and practitioners have linked deficits in health, education, housing, and even food security to the inadequate provision of potable water (Solanes & Jouravlev, 2006). In addition, some argue that water is a basic human need, and that right is denied to many people around the world (Biswas, 2007, Gleick, 1999).

In light of the importance and the magnitude of the problem, it is remarkable that a comprehensive search of the literature did not produce one peer-reviewed article quantifying the relationship between water, economic development, and health. Arguably, the best-funded and most comprehensive meta-study that reviewed 28 cross-sectional and time-series studies determined that it was not possible to show correlations between water supply and lower disease rates (Saunders and Warford, 1976). The dearth of information on water, economic development, and health in the developing world is similar to the problems of collecting data to address several other research questions (Muhwezi, 2007, 2008). Authors have identified the difficulties in measuring these relationships not just in the developing world (Hutton, 2001) but also in the developed world (Giegerich, 2008). Gardetti (2007, p. 51) offers, "It is the educational system itself that fails to encourage research" in this field.

Our story is, however, one of hope and not cynicism. We use data from *Agua del Pueblo*, (AdP), literally "The People's Water," a nonprofit organization that has been facilitating the transfer of potable water systems to communities in Guatemala for more than 35 years. Marter-Kenyon (2005) described the importance of the nonprofit sector in addressing the base-of-the-pyramid issues. *Agua del Pueblo* helps communities design, develop, finance, build, and maintain their own water systems (Clemens, Karp, & Papadakis, 2002). *Agua del Pueblo* has completed more than 900 projects and providing tens of thousands of miles of water lines. *Agua del Pueblo* has helped more than 100,000 residents, constructed more than 21,000 latrines, and trained more than 700 public health workers. Two of *Agua del Pueblo*'s three offices are located in the Petén and Alta Verapaz, two of the poorest areas of Guatemala (World Bank, 2009). This was done in order to decentralize from the capital city and to make sure that the offices were located near the areas where people need potable water systems. *Agua del Pueblo* follows an integrated methodology that includes the provision of water supply and sanitation services. According to the director of *Agua del Pueblo* (AdP), Pablo Quijivix, AdP's goal is not merely water supply or sanitation. Water supply and sanitation are rather means to the ultimate end of addressing poverty and underdevelopment (P. Quijivix, personal communication, May 25, 2011).

This study contributes to the literature in three ways. First, this is the first academic study that investigates investments in rural water supply, health, and economics. Second, the article is one of the first studies to investigate these phenomena longitudinally, focusing on improvements in economic development over time. Finally this is one of the first studies to utilize a rich and unique database of projects in the developing world.

WATER AND ECONOMIC DEVELOPMENT

Karnani (2005) emphasized the need for all international development research to focus on economic development. While definitive peer-reviewed literature is not available, significant research supports a potential relationship between water supply and economic development. Lall, Heikkila, Brown, and Siegfried (2008) identified three distinct water crises: access to safe drinking water, pollution, and water scarcity. The authors argued that each could have a significant impact on economic development. Somlyody and Varis (2006) emphasized the connection between water and economic development, especially in developing countries that rely on agriculture for a major part of their economy. Hutton and Haller (2004) attempted to perform a cost–benefit analysis to investigate the relationship between water supply and economic development.

They found that under certain conditions, the potential economic benefits for the introduction of water supply were more than the costs. These benefits were based on the observation that clean water allowed employees to miss fewer workdays, which lowered the cost of treatment for employers and increased productivity of employees. It is noteworthy to mention that the majority of these studies focus on the relationship between the general water supply and economic development. The general water supply typically was related to agriculture because agriculture accounts for 70% of water use in developing countries (Lall et al., 2008). The difference is our focus is on potable water in rural developing countries.

In a study of rural communities in Guatemala, AdP found that the typical rural woman lived more than one mile from the nearest water source and spent more than three hours per day to collect the water and bring it back to the home (Clemens, Karp, & Papadakis, 2002). One of the potential benefits of improved water supply is to free up time and allow women to perform other economic tasks (Saadatmand & Toma, 2007). The water-carrying responsibilities largely fall on women. Easier access to water provides women more opportunities. The additional time can change lives, allowing women to focus on other economic earning activities with their free time (agriculture, handicrafts, tailoring) and even more sustainable activities such as family development.

Larson, Minten, and Razafindralambor (2006) studied rural communities in Madagascar. They found that households without private water connections in their homes collected on average 14 liters of water per person per day, while those with private connections used an estimated 89 liters per person per day. The WHO recommended minimum is 20 liters per capita daily. When water is scarce, the poor cut back on hygiene. Those with private connections are benefited by the increase in hygiene allowed due to the provision of adequate water supply (Larson et al., 2006).

Infectious diarrhea (including cholera, salmonellas, shigellosis, amebiasis, and other bacterial, protozoal, and viral intestinal diseases) is the leading water related cause of morbidity and mortality in the developing countries (Hutton, Haller, & Bartram, 2007). Prevalence of the infection is a good indicator of quality of water supply and sanitation. In 2002, 138,410 cases of diarrhea were reported in Costa Rica, costing their government US$31 million (Ballesteros & Reyes, 2006). In Mexico the monetary burden caused by diarrhea in 2005 was 2.689 billion pesos, 69.1% of which fell on households (Marañón-Pimentel, 2009)

Children have proven to be especially susceptible to diarrheal diseases. Repetitive bouts lead to "undernourishment, failure to progress, scholastic underperformance and severe susceptibility to other infections and diseases" (Ballestero & Reyes, 2006, p. 193). The economic consequences of contracting a diarrheal disease include direct costs (transportation, doctors, and medicine) and indirect ones, primarily the opportunity cost of productive time lost.

Intestinal parasites are another significant problem in the developing world and Latin America especially. Parasites are less deadly, but when not treated contribute to malnourishment and underperformance. In a study of 107 rural and semiurban households in El Salvador it was found that 53% of the population harbored a parasite, and that 42.7% harbored two or more. The study also found that children aged 6 to 12 years were 11.5 times more likely to harbor certain types of intestinal roundworms (Corrales et al., 2006, p. 1824). This leads us to our first hypothesis.

Hypothesis 1: A direct and positive relationship exists between investments in integrated programs of potable water and sanitation and the change in economic development.

HEALTH, WATER, AND ECONOMIC DEVELOPMENT

In some indigenous communities researchers have found rates of intestinal parasitic worms as high as 90%. One of the reasons was scarcity of clean water in the community. Parasitic infections lead to mortality and morbidity (Holveck et al., 2007). The World Health Organization estimated that 1.6 million deaths per year were attributable to unsafe water supply and sanitation, including lack of hygiene (WHO, 2003). The public health implications of parasitic infections, morbidity, and mortality directly impact economic development, leading to our second hypothesis:

TABLE 1
Descriptive statistics and correlations

	Mean	Std. deviation	1	2	3
1. Economic development	18	5.2			
2. Year project completed	2003	2.6	.17		
3. Investments in water supply	240,000	180,000	.47**	.37*	
4. Public health	.02	.04	.54***	.17	.04

Note. Pearson's correlation coefficients are used.
*Correlation is significant at the .05 level (two-tailed).
**Correlation is significant at the .01 level (two-tailed).
***Correlation is significant at the .001 level (two-tailed).

TABLE 2
Results of the hierarchical regressions—Centered variables

	Standardized beta coefficients	
	Model 1	Model 2
Control:		
Year the project was completed	.17	.09
Direct effects:		
Investments in water supply	.39*	.28†
Public health	.55***	.67***
Indirect effects:		
Water supply × Public health		.46†
Change in R^2		.02†
R^2	.45***	.47***

Note. Dependent variable: economic development; one-tailed tests, $N = 35$.
†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Hypothesis 2: A direct and positive relationship exists between public health and the change in economic development.

For more than 60 years, scholars have recognized that poverty and disease form a vicious cycle. Men and women are sick because they are poor. They become poorer because they are sick and sicker because they are poorer (Winslow, 1951). There are many and diverse potential reasons for the relationship between improved water and sanitation and economic development, ranging from the easily identifiable and quantifiable to the intangible and difficult to measure (Hutton, 2001). Over recent decades, compelling evidence has been gathered that significant and beneficial health impacts are also associated with the economic development associated with improving water and sanitation facilities (Esrey, 1996; Hutton & Haller, 2004).

Gleick and Cain (2005) address the global water crisis in developing countries and state that one significant effect is the way in which poor health hinders economic growth. Pillay (2006) emphasizes the importance of clean water and water sanitation on health and how it relates to the economic growth of developing countries. Both of these studies are based on observations from data related to illnesses from unclean water and absences from work. Torpy (2007) discusses the connection between poverty and health. She shows the relationships between health and economic development. She also discusses the need for sanitized water to maintain health that can lead to economic development. Kirkpatrick, Parker, and Zhang (2006) argue that privatization of water services has the potential to solve the problem in the rural areas of developing countries if the proper support is obtained. This supports our use of data from the *Agua del Pueblo* organization, and the preceding arguments above lead to the following hypothesis and the theoretical model (Figures 1 and 2).

Hypothesis 3: Improved public health will positively moderate the relationship between investments in integrated programs of potable water and sanitation and the change in economic development. That is, in healthier communities, the relationship between investments in integrated programs of potable water and sanitation and the results of such programs in terms of economic development is stronger.

METHODS

As discussed, it is extremely difficult to obtain reliable data on potable water supply in the developing world. Scholars have demonstrated the importance of the philanthropic nonprofit sector, and for this reason the researchers collected the data from *Agua del Pueblo* (The People's Water; Abraham, 2007; Ozcelik, 2008). *Agua del Pueblo* (AdP) is a private, nonprofit technical assistance organization founded in 1972 to promote community development in Latin America. *Agua del Pueblo* has completed over 900 rural environmental sanitation projects. Its operation is based on community participation. Its beneficiaries have dug more than 6,000 miles of trenches, enough to reach almost

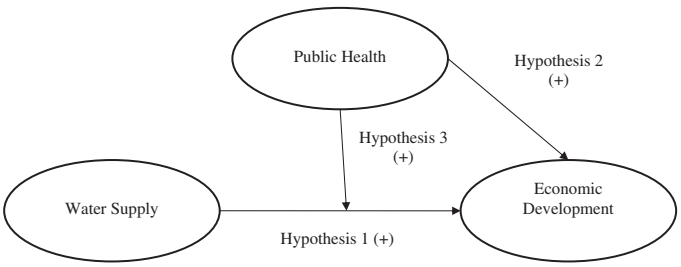

FIG. 1. Theoretical constructs and hypotheses.

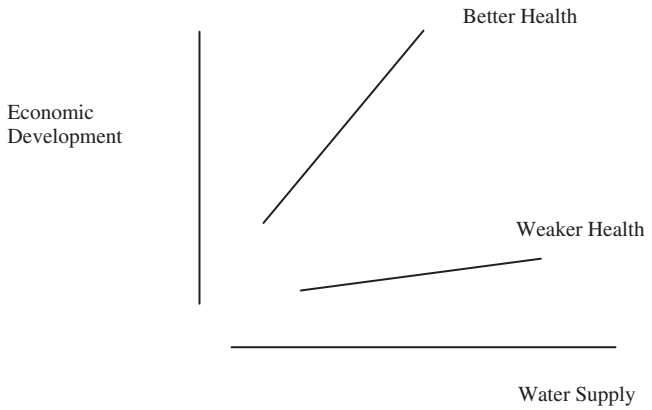

FIG. 2. Hypothesis 3: moderating and strengthening relationship between economic development on the relationship between water supply and public health.

one quarter way around the world. AdP efforts have helped Guatemalans enjoy one of the best coverage of rural water supply—as high as 92% in some states. By comparison, only 58% of the rural population in Brazil has access to water. The comparable estimate for Chile is 59%, Mexico 72%, Peru 66%, and Venezuela 70% (Solanes & Jouravlev, 2006).

The researchers randomly selected 73 water projects from the list of 900. The researchers also collected archival data on public health from the most recent Guatemalan National Survey of Maternal Heath (Ministerio de Salud Pública y Asistencia Social, 2002) and data on economic development from the Guatemalan survey of Basic Needs (Instituto Nacional de Estadisticas, 2002). Only 35 of the 73 projects had complete information (finances for the water project, improvements in economic development and public health) for this study.

The dependent variable was improvements in economic development. The study measured this variable by computing the changes in school attendance by children from the ages of 7 to 12 years between 1994 and 2002. The Guatemalan survey of Basic Needs provided measures of economic development in 1994 and 2002 (Instituto Nacional de Estadisticas [INE], 2002). These measurements were provided in percentages of people who did not have their basic needs met. These needs included housing type, overcrowding, water and sanitation disposal, school attendance, and coping capacities. School attendance was chosen because education can have powerful effects on individual earnings, distribution of income, and economic growth (Hanushek & Woessman, 2007). Children who live in areas of poor economic development are more likely to become sick as a result of an unclean water supply and miss more school days. The first independent variable was the investment in integrated projects of potable water supply and sanitation. The study estimated this independent variable as the average of the total cost of the project and the foreign investment for each project. The study measured maternal health in 2002 as a surrogate for public health. Maternal health has historically been used as a proxy for public health and serves as a useful "barometer" for public health and the effectiveness of a nation's health system (Graham, Fitzmaurice, Bell, Cairns, 2004). The study also controlled for the year in which the project was completed.

FINDINGS

The data were normally distributed and multicollinearity did not raise any concerns. We used hierarchical regression to examine the relationships between improvements in economic development and the explanatory variables of public health, investment in potable water supply, and their interaction. Hierarchical regression is often used in organizational studies to parse out the effects of the independent variables, especially when testing an interaction. For instance, Flynn, Chatman, and Spataro "used Hierarchical Regression to examine the effects of relational demography, personality, their interactions" on the dependent variable in their study (2001, p. 427). Douglas and Judge (2001) used hierarchical regression to review the change in R^2 due to the addition of a first-order interaction term based on their independent variables.

The results of the regression supported Hypothesis 1. That is, there is a direct and positive relationship between investments in integrated projects in potable water supply and improved sanitation and economic development ($p < .05$). This relationship was marginally strengthened in the test of the moderating effect of public health, with the coefficient of the interaction term and the change in R^2 being moderately significant ($p < .10$). Thus, Hypothesis 3 is moderately supported. Finally, the relationship between public health and economic development, Hypothesis 2, is also supported ($p < .001$).

LIMITATIONS

Causality. This study should not be used as a definitive demonstration of the causality between investments, economic development, and health (Kenny, 1979). First, in order to demonstrate causality, a researcher must demonstrate a significant correlation between the dependent and independent variable. Second, the researcher must demonstrate the time order—the independent variable must precede the dependent variable. Third, the researcher must demonstrate that no other independent variables actually caused the independent variable. That is, no mediating variable existed between the independent and dependent variables. Fourth, researchers must demonstrate that no other independent variable actually caused the dependent variable to vary. This study took the first step to investigate causality, but did not address the last three. In order to test the hypotheses, the study used a repeated cross section design (Menard, 2002). Although researchers have used repeated cross section designs effectively (Gold & Reimer, 1975; Williams & Gold, 1972), the design raised concerns regarding its inability to resolve issues within cohorts (Menard, 2002).

Generalizability. The context of this study is novel, which lends interest, but it is also a bit restrictive. The potential for generalizability depends to a large extent upon how one views idiosyncrasies associated with this particular context. The data were obtained from a single country. While the rural poor may be in similar circumstances in many developing countries around the world, their context may be different depending on many factors such as climate, geological region, and so on (Nurmi & Uksvarav, 1996; Ward et al., 1999). While a number of different regions in Guatemala are represented in this study, additional work should be conducted globally to confirm these findings. In addition, the study also focused on one organization—*Agua del Pueblo*. Morales and Clark (1996) and Ulhoi (1993) researched the importance of organizational design. *Agua del Pueblo*'s organizational design and methodology are somewhat unique based on its success. That is, the authors know of no other developing world–based private organization with similar organizational design, methodology, history, and large number of beneficiaries.

DISCUSSION AND CONCLUSION

The goal of this article is to provide the first longitudinal study of the effect of potable water on economic development in developing countries. The analysis supported Hypothesis 1, that a direct and positive relationship exists between investments in potable water and sanitation and economic development. This finding adds to the literature by providing evidence of the economic value of ensuring a supply of potable water in rural areas. The vast majority of studies published to date have only addressed water supply from an agricultural viewpoint.

The analysis also supported the second hypothesis by finding a direct and positive relationship between public health and sanitation and economic development. The analysis marginally supported the third hypothesis by finding that improved public health positively moderates the relationship between water supply and economic development. Arguably, public health could mediate (rather than moderate) the relationship between investments in water supply and economic development. Analyses demonstrated that public health was not a mediator (Baron & Kenny, 1986) in this data set.

Regrettably, it would be extremely difficult to solve the world problem of water supply and sanitation. Since the 1970s, nongovernmental organizations, nations, and the United Nations recognized the problem and pledged to solve it. To date, we are woefully short of the goals set by the United Nations in 1980 and again in 2000. The World Commission on Water estimated that it would require $600 to $800 billion to solve the potable water problem worldwide between 2000 and 2010 (Lin & Berg, 2008).

It is hoped that this article and subsequent research will highlight the problem and take steps to understand it in a more scholarly manner. Based on these results, international development aid agencies should consider encouraging and supporting nongovernmental organizations like *Agua del Pueblo* to focus on water supply and sanitation. If the goal is economic development, NGO resources would be more effectively spent in those communities with the greater degree of public health. It may be that the world's governments will begin to provide more resources to solve this problem if additional research can support these findings.

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