Water Security of Rural Water Supply Systems in Super Typhoon Haiyan Affected Areas

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Abstract
The rural water supply systems in the countryside necessitate sustainability and security assessment to ensure long-term and safe water supply to target beneficiaries. The study aimed to analyse the hidden threatening factors in water supply system along technical requirements. It also predicts the probability of incidents and security degree of the system. The rural water supply system in typhoon Haiyan affected areas was rehabilitated and constructed through national and international funds. It sampled about 5,921 rural water supply systems constructed and installed in 75 municipalities in Eastern Visayas. The water supply system sampled were: 13 Eastern Samar; 13 from Samar; 12 from Northern Samar; 13 from Leyte; 14 from Southern Leyte; and 1 from the Province of Biliran. The water security was assessed and analyzed according to the following indicators: demand and availability, natural factors affecting safety and quality, and policies and management mechanism. The water criteria was analysed using Analytic Hierarchy Process. The study found out that the natural factors such as floods, drought, eathquake have highest computed possibility values. The water security of the water supply systems in typhoon Haiyan affected areas has to implement control measures to minimize the degree of damange due to natural factors..

Keywords: water supply system water security, water security models, rural water supply systems

1. Introduction

Water security is a major issue in the water supply system programs and projects. Eastern Visayas region of the Philippines was extremely affected by 2013 super typhoon Haiyan that destroyed the water supply systems in rural areas. The water supply systems in these areas were reconstructed through national government and international funds implemented by the Department of Social Welfare and Development under the Kapit-Bisig Laban sa Kahirapan-Comprehensive and Integrated Delivery of Social Services (DSWD-KALAHI-CIDSS) program (DSWD, 2016). It constructed about 5,921 rural water supply systems (DSWD Report, 2016). These water supply systems have provided the domestic water needs of the people in Eastern Visayas that need to be assured of secured water supply system. The Millennium Development Goal 6 on clean water and sanitation stated that by 2030 the people must have clean water and sanitation (undp.org). Moreoever, the water security assessment and study was conducted to ensure that the rural water supply system in typhoon Haiyan affected areas will be resilient and can sustain extreme disasters such as typhoon and earthquakes through an established better and contextualized decision-making information for policy and management framework.

2. Methodology

2.1. Assessment Sample water supply systems

The 5,921 water supply systems were studied according to water security parameters requirements and classified to levels. About 713 water supply systems were assessed classified as: Level I -536; Level II – 158; and Level III-19. These were taken from 13 municipalities from Eastern Samar; 13 municipalities from Samar; 12 municipalities from Northern Samar; 13 Municipalities from Leyte; 13 Municipalities from Southern Leyte; and 2 Municipalities from Province of Biliran.

2.2. Water security conceptual framework

The study adopted the water security concept by Gunda, Hess, Hornberger, and Worland (2018) that water security centered on quantity and quality. Water security is water management, source protection, water conservation, and water reuse. Strategies must be prioritized and analyzed to ensure water security and sustainability of water supply systemThis concept was supplemented by integrated water resources management framework (Giopponi and Gain, 2017) and socio-hydrological assessment of water security (Siddiqi, Wescoat, Muhammad, 2018).

2.3 Water security analytical framework

The study utilized the Analytic Hierarchy Process (AHP) used to quantify factors influenced water security (Houng, Le, Duc, Long, 2017; Li, Li, Wenyan, Lu, 2011, Jin-long, 1992; Saaty, 1987). The goal was set along the three (3) criteria and priority weights were assigned according to degree of importance(Table 1).

Table 1. Criteria and indicators treat to water security

Criteria	Indicators
Demand and Availability	Water demand /water use (DA1)
	Surface water scarcity (DA2)
	Groundwater utilization (DA3)
Natural Factors affecting safety and quality (NF)	Floods, drought, earthquake,(NF1)
	Reducing vegetation (NF2)
	Topographical factors causing difficulties in water supply (NF3)
	Water scarcity (NF4)
	Domestic waste from households (NF5)
Policies & management mechanism	Water resource protection (PMM1)
	Boundary uniformity policies(PMM2)
	Water supply utilities personnel (PMM3)

The study adopted the analytic hierarchy process of Houng Le et al.(2017) and pairwise comparison was computed based one-factor relationship and the higher possibility value based on the higher the degree of importance (the higher the value the higher the degree of importance). The assignment of weights on the factors were determined by Five(5) water supply experts in Eastern Visayas. These weights were used to describe the potential factors on water security of the 713 water supply systems.

3. Results and Discussion

Table 2 shows the one-factor relationship the computed possibility values of the main criteria. The natural factors affecting the safety and quality has the highest computed possibility value of 0.627 which mean that this natural factors have higher chances on the water security. This implies that the water security of rural water supply system is greatly affected by natural factors, as an example floods brought about by typhoon Haiyan as experienced in Eastern Visayas.

Table 2. The possibility values of one-factor relationship of main criteria

Criteria/Factors	Computed possibility values
Demand & availability (DA)	0.284
Natural factors affecting safety and quality (NF)	0.627
Policies and management Mechanism (PMM)	0.426

Further analysis using the specific indicators of the major criteria was conducted as s shown in Table 3.

Table 3. The possibility values of one-factor relationship on specific indicators of criteria

Indicator	Computed possibility values
DA1	0.233
DA2	0.111
DA3	0.123
NF1	0.456
NF2	0.311
NF3	0.321
NF4	0.221
NF5	0.433
PMM1	0.343
PMM2	0.333
PMM3	0.231

Table 2. illustrates the computed possibility values for the specific indicators that the NF1 has the highest computed possibility value of 0.424 over the other factors indicators. This implies that the floods, drought, earthquake are of highest degree of importance on water security of water supply systems design consideration.

4. Conclusion, Significance and/or Future Works

The natural factors affecting safety and quality are crucial in water security for rural water supply. Hence, water supply system design must be resilient to ensure long-term and sustainable operation. Future works on AHP may include third level indicators.

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