論文の内容の要旨

Inequality in Water Access and Consumers' Coping Strategies under Intermittent Water Supply in the Kathmandu Valley, Nepal
(ネパール国カトマンズ盆地における間歇給水による水アクセスの不平等性と利用者の対応策)

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Globally at least 300 million people receive piped water for less than 24 hours a day, known as intermittent water supply (IWS). This study investigates the inequality in water access and the strategies consumers' use to cope with one of such IWS system in the Kathmandu Valley (KV), Nepal.

At first, the current situation of the IWS and consumers' coping strategies were investigated by a randomized household survey (n=369) and on-site water quality tests. The situation of the IWS was explained in terms of mode of intermittency: i.e. the supply frequency, supply duration (hour/supply) and supply volume. Half of the households received piped water for 6 or fewer hours per week. To augment or cope with the inadequate supply, 28% of the households used highly contaminated and expensive tanker-delivered water. Half of the piped water samples (n = 13) were contaminated with *Escherichia coli*. Free chlorine concentration in all piped water samples was below the national standards (0.1–0.2 mg/L). Household water treatment using point-of-use devices could increase access to safe water in the KV from 42% to 80%. The use of Lorenz curves and Gini coefficients revealed inequality of piped supply hours both between and within service areas in the KV, due mainly to a small percentage of households who received longer supply hours. Consumers who received fewer hours of piped supply were found to be more dependent on tanker-delivered water, expended more on water and cleaned their storage tanks at longer intervals than those who received longer hours of piped supply. To cope with reduced supply hours, home owners pay more to get water from alternative sources, while tenants compromise their water consumption. Consumers had a higher expectation for improvements in water quality and regularity and also had potential "substantial" willingness to pay for increased tariff if water quality and supply frequency were improved.

To assess the quality of water consumers in the IWS have access to, water samples were collected from various points in the distribution system and analyzed. Water quality in the distribution network was

found to be degraded in terms of TDS, Fe, Mn, NH_4-N, free and total chlorine, and microbial concentrations compared to the treated water from treatment plants. There were no gradual but high spatial and temporal variations in free chlorine, NH_4-N, *E. coli* and total coliform concentrations even in the same network potentially caused by irregular supplies, water apportioning, and irregular/uneven dosing of disinfection chemicals. Water quality degraded during in-house storage than in distribution network which indicates contamination during storage. There was no significant difference between water quality of the rooftop and basement tank; however, the rooftop tanks had higher median concentrations of TDS, Mn, and *E. coli*.

To estimate the daily water consumption of the consumers living under IWS, a novel approach of monitoring water level in the rooftop tanks using water level data loggers was applied and verified. By deploying the loggers in 28 homes, and converting the recorded water levels to the volume of water used, water consumptions at each hour and in a day were estimated. Concurrently, a questionnaire survey (n=28) was conducted to collect information on demographic, house, piped water supply, and water appliances. The average per-capita water consumption was 56 LPCD (liters per capita per day), and 40% of the households consumed less than 50 LPCD, the minimum volume of water consumption recommended by WHO. No household consumed the supply volume of 135 LPCD as planned in Nepal. Water consumption was higher (66 LPCD) on weekend and minimal during mid-week. Hourly consumption profiles were plotted which were able to reflect the real lifestyle of the KV residents. Micro-component of domestic water use was estimated by combining loggers' data and household self- reporting record of water use. Total daily water consumption constituted 31% for toilet flushing, 27% for kitchen, 16% for laundry and 13% each for shower and other miscellaneous activities. Demographic and house characteristics were found to be highly correlated with household water consumption. Regression models developed using Generalized Linear Model (GLM) showed that information about the number of females, number of vehicles, and number of faucets could best predict household water consumption in the KV.

Although it may take a long time to secure sufficient volumes of water by developing water resources, the results of this study implicated that:

1. Water utilities practicing IWS could improve their service levels and consumers' perception by: 1) improving water quality, and 2) maintaining equality in supply hours and supply frequency in their service areas.
2. Given a varied water consumption in the KV, authorities and policy makers should identify and target the vulnerable households who consume lower than minimum required water from viewpoint of health benefits. As KV awaits major supplements, and consumers' water usage pattern will likely change, it is more important than ever to determine specific factors that affect household water consumption.