Asian Cities Climate Resilience

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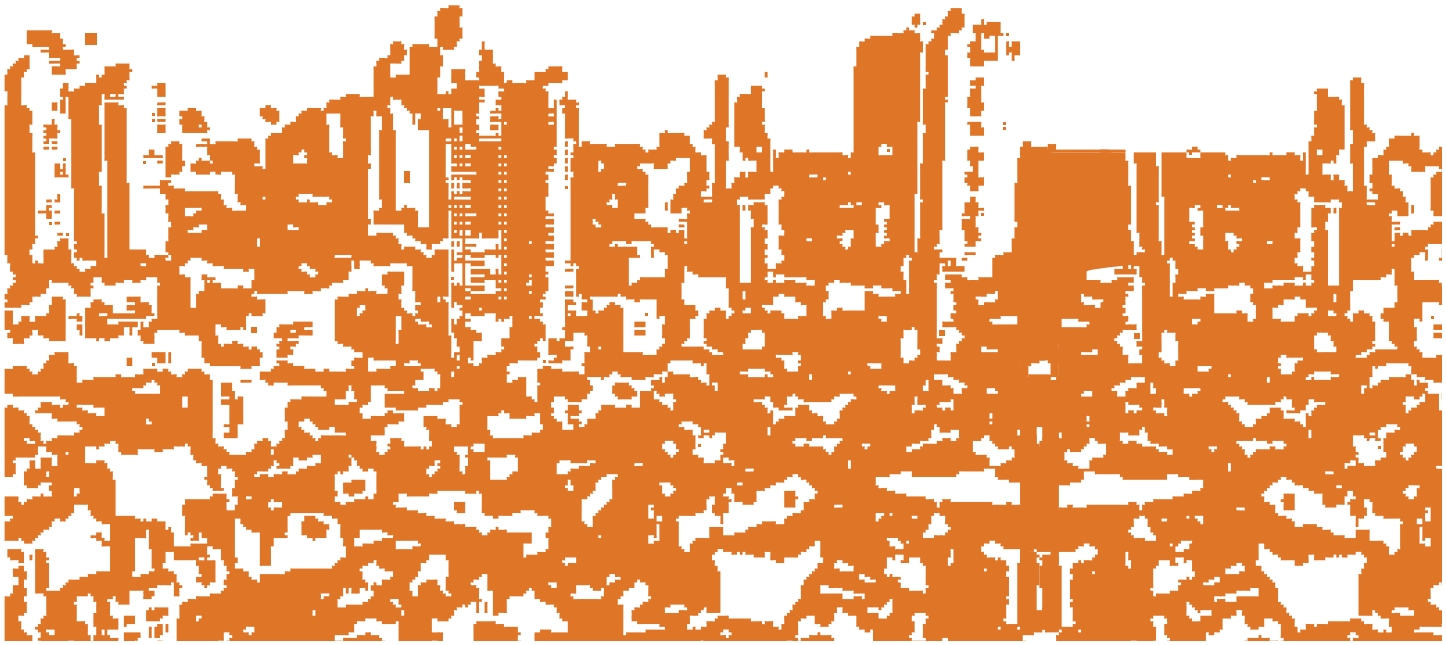
Towards establishing water security and urban resilience in the city of Baguio

BY ALEJANDRO N. CIENCIA, JR., LORELEI CRISOLOGO MENDOZA, GLADYS A. CRUZ, NIMREH CALDE, MICHAEL CABALFIN AND MAILEENITA PEÑALBA



About the authors

Alejandro N. Ciencia Jr. is an associate professor of political science at the University of the Philippines Baguio. He is currently chair of the Department of Economics and Political Science (DEPS), College of Social Sciences, University of the Philippines Baguio. Alejandro was director of the Cordillera Studies Center (CSC), UP Baguio's research arm, when this project began. Email: anciencia@up.edu.ph and ali.ciencia@gmail.com.

Co-authors and project co-researchers, also at UP Baguio, are Lorelei Crisologo Mendoza, professor of economics; Gladys A. Cruz, associate professor of economics; Nimreh Calde, assistant professor of political science; Michael Cabalfin, assistant professor of economics with a PhD in economics from the Australian National University; and Maileenita Peñalba, assistant professor of political science.

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Glossary

Access to drinking water	'Access to drinking water means that the source is less than 1 kilometer away from its place of use and that it is possible to reliably obtain at least 20 liters per member of a household per day' (WHO, undated).
Climate change resilience (or climate resilience)	'[T]he ability to plan for, survive, recover from and even thrive in changing climatic conditions' (Rockefeller Foundation, 2009).
Safe drinking water	'[W]ater with microbial, chemical and physical characteristics that meet WHO guidelines or national standards on drinking water quality' (WHO, undated).
Resilience	'[T]he ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation and the capacity to adapt to stress and change' (ICLEI, 2012).
Water security	'[T]he capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters and for preserving ecosystems in a climate of peace and political stability' (UNWATER, 2014).

Acronyms

ACCCRN	Asian Cities Climate Change Resilience Network
BWD	Baguio Water District
CEPMO	City Environment and Parks Management Office, Baguio City
DSWD	Department of Social Welfare and Development
FGD	Focus group discussion
HH	Household
KII	Key informant interview
LDWQMC	Local Drinking Water Quality Monitoring Committee
LPG	Liquid petroleum gas
NHTS-PR	National Household Targeting System for Poverty Reduction Unit, DSWD
NWRB	National Water Resources Board
NWRC	National Water Resources Council
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PNSDW	Philippine National Standards for Drinking Water
PRECIS	Providing REgional Climates for Impacts Studies (PRECIS regional climate modelling system)
STAR	STAtistical Regional climate model
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNICEF	United Nations Children's Fund
UNWATER	United Nations Inter-Agency Mechanism on All Freshwater Related Issues, Including Sanitation
WHO	World Health Organization

Abstract

A resilient city must have, among other things, the capacity to satisfy the water-related and sanitation needs of its residents in a manner that is sustainable, equitable and conducive to human development. This working paper presents the findings of a study on water security, water access, sanitation and urban resilience in Baguio City, Philippines.

The overarching question for the research undertaking is: what institutional arrangements, including policy recommendations, technology-based interventions and adaptive practices, need to be put in place and adopted by Baguio City residents to ensure water security and build climate resilience? The study produced rich data on water security in Baguio City. Data revealed that Baguio's supply of acceptable quality water – ie water that meets national drinking standards – is inadequate. Baguio residents have adopted adaptive behaviours to address the issue of water shortage in the city. These behaviours include rainwater harvesting and recycling and setting up community water systems.

Thus far, the Baguio Water District which is mandated 'to provide adequate and potable water at affordable rates to all consumers' has not excelled at carrying out this task. Adhering to a framework that sees resilience as 'bouncing forward' instead of 'bouncing back,' and underscores the mutually reinforcing significance of social or human resilience, ecological resilience and institutional resilience, the study finds that resilience efforts in the city are mostly aimed at building social or human resilience. Ecological resilience is mostly neglected. Data suggest that there is a threat of over-extraction of Baguio's water resources. The citywide adoption and implementation of rainwater harvesting and improved enforcement of environmental regulations, alongside a more integrated and coordinated regulatory framework, are being recommended to ensure institutional resilience.

1 Introduction

A resilient city must have, among other things, the capacity to satisfy the water-related and sanitation needs of its residents in a manner that is sustainable, equitable and conducive to human development. The desire at present to build and maintain resilient cities may be attributed to the growing global recognition that climate change threatens the capacity of societies to ensure human survival and well-being. Variability over time in the climate can have a significant impact on the economy, livelihoods and productivity of communities and households. It can put at risk the physical health and welfare of individuals. It can challenge the capacities of particular ecological systems to satisfy the physical and economic requirements of local populations that depend on them and threaten the sustainability of these systems as providers of much-needed natural resources. Consequently, a changing climate exerts considerable pressure on local institutions and organisations to resolve social conflicts often involving issues of scarcity or unequal access to some vital natural resource.

The general response to climate change has been to promote resilience. As defined by Local Governments for Sustainability (ICLEI) (2012), resilience involves 'the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation and the capacity to adapt to stress and change'. Note that apart from possessing the features of 'absorbing disturbances' and 'adapting to stress and change', resilience also involves 'retaining the same basic structure and ways of functioning'. This highlights the point that resilience has mostly been understood as signifying a 'bouncing back' – ie a return to normalcy after the intrusion of disrupting events.

This conception of resilience, however, is rather limited and, as a consequence, no longer tenable. Climate change as both a **global** phenomenon and a condition of unpredictable **variability** suggests that an expected return to a fixed original point or stable condition of normalcy may no longer be possible. Moreover, as argued by Dodman *et al*. (2009), 'bouncing back' does not seem to be a very attractive option considering that currently recognised 'normal' conditions are actually far from equitable, sustainable or supportive of greater human well-being. Dodman *et al.* (2009: 153) write:

> *Is it acceptable to return to the 'same basic structure' in which some 1 billion people live on less than $1 per day, in which there are 350–500 million cases of malaria each year and in which around half of the people living in African and Asian cities lack adequate water and sanitation facilities? ...[P]erhaps it is more appropriate to consider resilience as a process, a way of functioning, that enables not only coping with added shocks and stresses but also addressing the myriad challenges that constrain lives and livelihoods and facilitating more general improvements to the quality of human lives.*

Instead of 'bouncing back,' resilience ought to be understood as 'bouncing forward'. The phrase should suggest that resilience is marked by a forward-looking orientation, instead of a reactionary, 'business-as-usual' outlook. Indeed, resilience must be seen more as a process whose implementation follows a holistic approach. In the words of Dodman *et al.* (2009: 153–154): 'Resilience as a process therefore needs to take into account the economic, social, psychological, physical and environmental factors that are necessary for humans to survive and thrive'. Again, resilience is **not a stable condition** but **a process** whereby communities and societies will constantly – and precariously – navigate their way through the challenges that accompany change.

Consistent with this understanding of the concept, resilience must be regarded as involving the interaction of at least three disparate elements: the individual, the ecological and the institutional. Resilience entails the working together of the three elements in a 'mutually reinforcing manner to help individuals, households and communities cope with change, including climate change' (Dodman *et al.*, 2009: 154). Accordingly, one can speak of **ecological, social and institutional resilience**. Ecological resilience may be understood as the ability of the natural system to regularly return to a state of equilibrium, particularly after being subjected to human disturbance – eg activities aimed at extracting from nature some vital resource. Social resilience, meanwhile, refers to the capacity of individuals and groups to adapt in response to disruption and to thrive even in times of instability.

Understood as such, ecological and social resilience may at times be in conflict with each other. In areas that exhibit unmitigated population growth, the pressure to satisfy human wants can lead to the over-extraction of natural resources. This observation drives home the point that some balance between the two needs to be obtained. Instead of choosing one at the expense of the other, constantly finding the right balance between ecological and social resilience seems to be the wiser option. It is for this very reason that institutional arrangements need to be established to ensure that a balance between the two can be sustainably maintained at present and in the future. Institutional arrangements must see to it that the satisfaction of human needs does not result in the over-extraction of vital natural resources. Securing environmental integrity should not necessarily mean extinction of human life or the disregard of human well-being.

Resilience must therefore be taken to mean the ability to maintain human life and advance social and human well-being in response to disruptive events without sacrificing ecological integrity through the adoption of sustainable practices and the establishment of working institutional arrangements. Note that **'institutional arrangements'** is used here to refer to a broad set of practices that include governance structures, policies and rules, technology-based interventions, financial plans and so on. To ensure in the long run the sustainability of institutional arrangements and practices, their concrete outcomes ought to be seen by individuals and groups as also promoting equitability and overall human development, otherwise societal conflicts will ensue, thereby putting at risk the integrity of human communities. Note too that this understanding of resilience seems compatible with ACCCRN's definition of climate change resilience as 'the ability to plan for, survive, recover from and even thrive in changing climatic conditions' (Rockefeller Foundation, 2009).

This working paper presents the findings of a study on water security, water access, sanitation and urban resilience in Baguio City, Philippines, a small yet generally regarded as a highly urbanised city in the northern Philippines. Adopting the framework used by Dodman *et al.*, the study aims to draw attention to what the authors feel will be a very serious concern for the residents of Baguio – and other urbanising areas in the Philippines and Asia – in the coming years. The issue is ensuring water security and sanitation in an urban setting. This working paper seeks to address the general question: **what institutional arrangements, including practices and policies, may Baguio residents adopt at the city and *barangay* level[1] to enhance their access to safe water, promote sanitation and promote resilience vis-à-vis climate change?**

1.1 Baguio City: background information

This section presents an overview of Baguio City. Baguio is a small urban centre located approximately 250 kilometres north of Metro Manila and 1,500m above sea level (see Figure 1). Dubbed the 'summer capital' of the Philippines, it is a major tourist destination for foreign and local visitors due to its cool highland climate, especially in the months of March, April and May. With an average temperature ranging from 15 to 23 degrees Celsius, Baguio offers a unique experience to many Filipino lowlanders who have grown accustomed to the generally hot and humid Philippine climate. Baguio's climate is usually wet from May to October and dry the rest of the year (Nolasco-Javier *et al.*, 2015: 5). The city is an educational hub in northern Luzon, housing a number of universities and colleges. At present, it is the most urbanised area in the 'one city, five municipalities' cluster called BLISTT.[2] Baguio is the most urbanised city in the Cordillera region.

1 *Barangay is the Filipino term for 'community', 'village' or 'neighbourhood'. It is also the lowest level of the politico-administrative system of the Philippines.*

2 *BLISTT stands for Baguio City, La Trinidad, Itogon, Sablan, Tuba and Tublay. These are local government units located in the*

Developed in the early 1900s by American colonial administrators, Baguio was originally designed to serve as a rest and recreation area but it soon became the gateway to the mineral and natural resource-rich areas of the Cordillera. Inhabited in the 1900s by indigenous people (IP) referred to as 'Ibaloy,' Baguio is now home to a mix of lowland migrants, migrants from other parts of the Cordillera and descendants of original Baguio settlers. Cruz *et al.* (1993:16) noted, for instance, that '[m]igration into Baguio City has become so pronounced that at present, the population in Baguio is considered as 'highly migrant'.' In 1994, the National Economic and Development Authority (NEDA) also reported that '[s]ince the sixties Baguio's population growth has sustained an average of 4.4 per cent, more than 50 per cent of which is accounted for by migration' (cited in Cruz and Calugan, 1997:26). Furthermore, Population Commission Director, Dr. Rosa Fortaleza, said in a recent interview that some 5,000 people are added to Baguio City's population yearly (Sunstar, 2013). Director Fortaleza stated further that '[w]e have noted that there is a fast growth in population not because of the people's fertility but because of migration' (ibid).

In terms of land area, Baguio City, compared to Metro Manila, is miniscule[3] - with a land area of around 57.5 square kilometers - and less urbanised. Its development as an urban area, however, seems reflective of the general process of urbanisation that other Philippine towns are likely to experience in the future. The influx of migrants, the construction of buildings and infrastructure, exploitation and utilisation of resources found within its boundaries and neighbouring areas and mounting pressure on government to provide for city services like electricity and potable water supply, in addition to ensuring and maintaining peace and order, characterise Baguio City now and are likely to characterise other Philippine cities in the future.

Originally a settlement of 841 inhabitants in 1904, Baguio in 2010 had a daytime population of around 700,000 and a night-time population of 318,676 (Estoque and Murayama, 2012: 316). The disparity between the two figures can be explained by the fact that a large number of Baguio's daytime population consists of workers residing in Baguio's neighbouring areas. Baguio's night-time population is expected to 'reach 334,562 in 2015 and to double in thirty (30) years' (Opiña, 2014). These data support an assertion made by the World Wide Fund for Nature (WWF) (2013: 19) that 'that there is no doubt that Baguio City has expanded way beyond its carrying capacity,' putting in serious question the city's capacity to provide its rapidly growing population with basic services and the amenities associated with urban living, in addition to meeting globally recognised human development goals.

Studying specific aspects of life in Baguio seems much more manageable compared to Metro Manila. This suggests that Baguio City – being an urban area and a small and manageable research site – is a suitable location for studies that highlight the issues of urban resilience and water security. This also suggests that research findings would be reflective of (some of) the general features of urbanisation that will be experienced in other parts of the country.

Arguably, the challenges that Baguio City faces vis-à-vis climate change are, in general, also reflective of those confronting other urbanising areas in other Asian countries, particularly those that are geographically situated in disaster-prone areas, with less-developed economies, rapidly growing populations, significant levels of poverty, inadequate infrastructure and road systems, limited capabilities to provide for social services and inefficient bureaucracies.

province of Benguet, in the Cordillera Administrative Region.

3 *Consisting of 16 cities and one municipality (Manila, Quezon City, Caloocan, Las Piñas, Makati, Malabon, Mandaluyong, Marikina, Muntinlupa, Navotas, Parañaque, Pasay, Pasig, San Juan, Taguig, Valenzuela and the municipality of Pateros), Metro Manila has a total land area of 638.6km^2, more than 11 times the size of Baguio City. Metro Manila also dwarfs Baguio City in terms of population and population density. Metro Manila has an estimated total population of approximately 11.86 million (Philippine Statistics Authority, 2010), almost 40 times the population of Baguio; and a population density of almost 13,000/km^2 (Leyco, 2015) in 2010, more than twice the population density of Baguio City which is estimated to be above 5,500/km^2 in 2010 (Philippine Information Agency, 2015).*

Figure 1. Map showing the location of Baguio City

Source: map prepared by Jeffrey H. Javier using QGIS 1.8 (Open Source GIS mapping software). Data source for shapefiles obtained from the Philippine GIS Data Clearing House and the Department of Environment and Natural Resources-Cordillera Administrative Region (DENR-CAR).

In addition, Baguio – as a small city but not as highly urbanised as Metro Manila – also seems to possess a quality similar to other small cities – ie 'the greatest potential for climate resilience' (ACCCRN, 2013). Given its undeveloped or underdeveloped infrastructure and governance systems, Baguio is a suitable setting for a study that will involve consideration of technology-based interventions and policy recommendations aimed at fostering climate change resilience. Its small population size and land area – ie compared to Metro Manila – bode well for possible resilience-related initiatives, particularly those that may require mobilisation of communities and households. Mobilising Baguio's 300,000-plus residents should be easier compared to mobilising Metro Manila's 11 million. That infrastructure and governance

systems are undeveloped or underdeveloped suggests that there is the opportunity to consider instituting new or improving existing infrastructure or governance systems. Moreover, the observation in this paper that a significant number of Baguio residents still rely on 'natural' water sources (eg springs), indicates that possible adaptive strategies for Baguio residents are not limited to the adoption of highly technical innovations. Baguio residents can turn to 'natural' water sources in the event of a disruption in the water distribution services of the Baguio Water District (BWD), the primary agency tasked with providing residents with adequate quantities of potable water. With available 'natural' water that presumably is generally clean and safe – ie a type of resource no longer available to most Metro Manila dwellers – Baguio residents, in this particular sense, can be expected to be more resilient. Baguio City thus appears to be an apt site for a study on urban resilience. Smaller, urbanising areas of the Philippines may learn important lessons from Baguio City's experience vis-à-vis climate change resilience and water security.

1.2 Baguio as a vulnerable city

The Philippines, in general, is a mega-biodiversity area and a natural hazards hotspot. It has a large human population of around 100 million. It is highly vulnerable to disasters given its location vis-à-vis the path of typhoons and fault lines, etc.[4] In light of the large – and still growing – size of its population, disasters and the effects of climate change have a considerable bearing on the livelihoods, security, economic well-being and general quality of life of Filipinos. Disasters and climate change-related developments can hamper the country's economic performance. Calamities that hit the Philippines in the last quarter of 2013, particularly Typhoon Haiyan/Yolanda and the Bohol earthquake, were said to have curbed economic growth in the first quarter of 2014 (Rivera, 2014). The 'Philippine Economic Update' (World Bank, 2014: 6–7) reports that Typhoon Haiyan/Yolanda – which was estimated to have resulted in 8,000 dead or missing people, 4.1 million displaced people and more than half a million houses destroyed – exposed people in the severely affected areas to long-term economic risks, including a rise in poverty levels, unemployment and underemployment. Disasters tend to constrain the ability of the Philippine government to provide for social welfare, stimulate economic growth and pursue inclusive development, alongside other noteworthy goals. Citing the country's unenviable vulnerability to disasters and the budgetary problems that they create, Ebbinghausen (2013) reports, 'the Philippines has consistently experienced financing gaps owing to disasters since 2000... The country's 2013 national disaster budget, amounting to about 128 million euros ($171 million), was used up even before Super Typhoon Haiyan hit'.

Baguio City is a highly vulnerable city in a disaster-vulnerable country. The 2013 study by the World Wide Fund for Nature-Philippines (WWF) finds Baguio City to be the 'most vulnerable to climate change impacts' of 12 Philippine cities that include Cebu City, Davao City, Iloilo, Cagayan de Oro City, Dagupan City, Laoag City, Zamboanga City, Angeles City, Batangas City, Naga City and Tacloban City. Located along the country's typhoon belt, Baguio is highly vulnerable to tropical cyclones and occurrences of extreme rainfall. Having a distinct May–October wet season, Baguio holds the country's record for the highest annual rainfall (9006mm) which it experienced in 1910. Marked by steep slopes, Baguio experiences landslides especially when occurrences of extreme rainfall result in soil saturation.

Nolasco-Javier *et al*. (2014: 1) report that:

> *[A]mong the most landslide prone in the Philippines is the Baguio district... Rainfall-induced landslides (RILs) occur yearly and are triggered by rainfall due to southwest monsoon, tropical cyclones and their interactions; and orographic lifting by the Cordillera mountain range. Both natural and human factors contribute to the region's susceptibility to RIL. Fatalities can reach hundreds and economic damages may reach billions of dollars per event.*

Interestingly, despite its mountainous topography, Baguio also experiences the occurrence of flooding in certain parts of the city – eg City Camp Lagoon area. In addition, parts of the city apparently are also vulnerable to sinkholes. In 2015, 14 Baguio City *barangays* were reported to be located on top of sinkholes (Comanda, 2015).

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4 *According to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (2015:23), the Philippines is the third most exposed country to natural disasters; Vanuatu and Tonga are first and second, respectively (UNESCAP, 2015: 23). Annually, an average of 20 cyclones enter the Philippine Area of Responsibility (Nolasco-Javier et al., 2014).*

But Baguio is not only vulnerable to landslides, extreme rainfall, flooding and sinkholes. It sits near four major faults (Nolasco-Javier *et al.*, 2014: 6). It is not immune to earthquakes as demonstrated by the 16 July 1990 Luzon earthquake that hit the city, causing approximately 1,000 deaths and destroying a number of residential and commercial buildings. The earthquake produced landslides that effectively blocked travel on the major highways leading to the city. Baguio was practically isolated from its neighbours for a significant number of days.

Indeed, Baguio City has a history of being inaccessible to land travel mainly as a result of landslides and erosions blocking normal routes to the city, hampering the inflow of much-needed goods and human travel to and from the city. In October 2009, Baguio was again isolated from neighbouring areas by landslides caused by tropical depression Pepeng (International code name Parma).

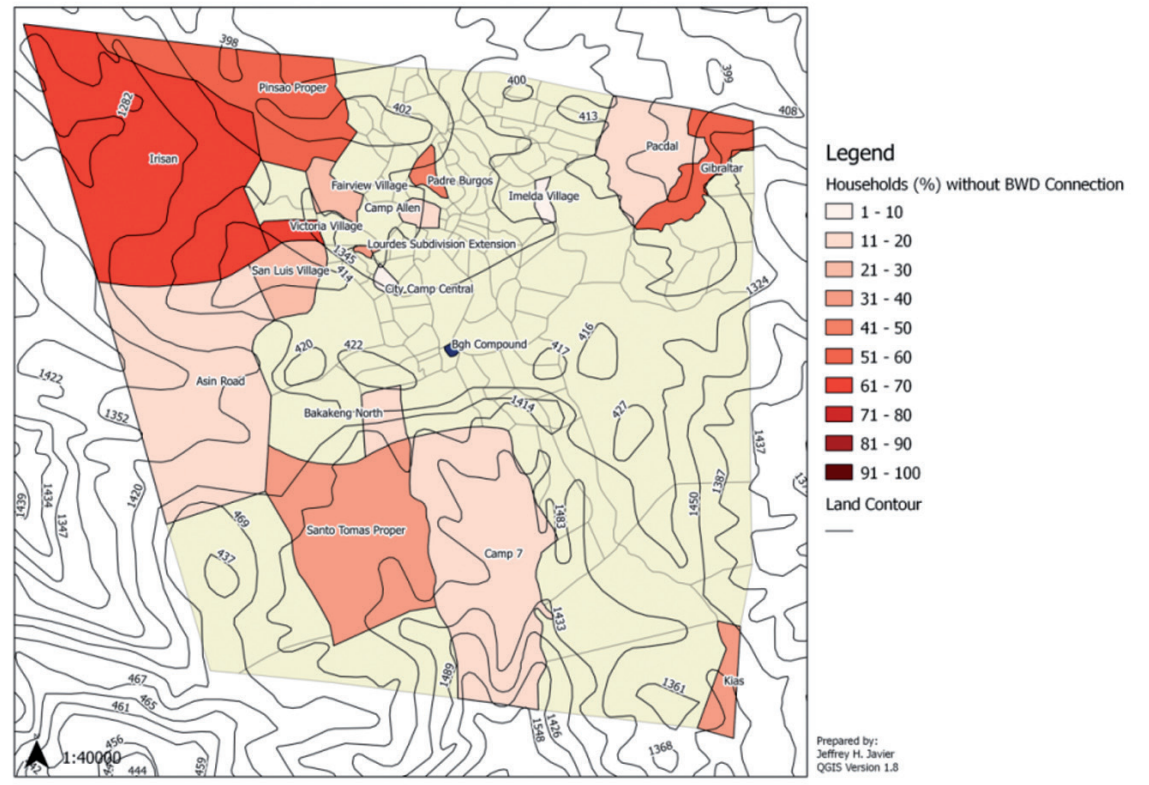
1.3 Water distribution as an urban service in Baguio

This working paper explores a specific type of urban service – ie provision of access to safe drinking water – which is expected to be affected by climate change and, as a consequence, affects climate change resilience. Among the challenges posed by the tremendous growth in Baguio's population is the need to ensure the adequate supply of water – preferably safe drinking water – to residents and visitors.

Currently, some households in the city are not directly connected to the pipeline system of the Baguio Water District (BWD) whose specific mandate is 'to provide **adequate** and **potable water** at **affordable** rates to **all** consumers' (BWD, undated; Commission on Audit, 2012). In fact, seven of the city's 129 *barangays* are not served by the BWD (Royeca 2015b; see also Appendix 1). Moreover, not all households in the other 122 *barangays* are connected to the BWD's pipe system. Figure 2 offers a graphic representation of the proportion of non-BWD households in the 19 randomly selected *barangays* surveyed for the study. It shows that in some *barangays*, like Irisan, Pinsao and Gilbraltar, more than 60 per cent of households are not connected to the BWD. Note that a direct BWD connection does not mean access to a regular/daily supply of water, let alone safe drinking water. The situation however is not exactly a new development in the history of Baguio. As reported by Gonzales (2007: 5), 'Baguio's residents have coped with water shortages, especially during summer, for years, as well as uneven access due to topographic differences and seasonal fluctuations in demand'.

The situation has now become a long-standing feature of life in Baguio City. While a regular or daily supply of water from the water district for all residents is hardly forthcoming, the city's population continues to grow. Construction of high-rise buildings in the city appears to have gained considerable momentum of late. Can the city ensure an adequate, if not ample, water supply for Baguio's growing population in the future? Moreover, it is no longer uncommon for residents to hear reports of water crises in Baguio City – eg 'Baguio facing water crisis' (Sunstar, 2013); 'Water crisis looms in Baguio' (Fontanilla, 2015); and 'Now at 17,000m^3 per day, water supply shortage at 27,000 cu.M by 2022' (Palangchao, 2015). As will be shown below when official BWD data (Royeca, 2015a) are presented, there appears to be some truth in these reports.

Figure 2. Map of households without BWD connection in surveyed barangays



Source: map prepared by Jeffrey H. Javier using QGIS 1.8 (Open Source GIS mapping software). Data source for shapefiles obtained from the Philippine GIS Data Clearing House and the Department of Environment and Natural Resources-Cordillera Administrative Region (DENR-CAR). Information shown on the map was based on the findings of the present study's March 2015 citywide survey.

Water shortages in Baguio – particularly in terms of water distributed by the Baguio Water District – are now an accepted fact of life in the city, and not the consequence of occasional disruptions in the water distribution service. Climate change, whether it results in more rain or less rain, can be expected to alleviate the 'bad' water distribution situation in the case of more rain, or aggravate it further in the case of less rain. However, climate change that results in 'wetter' rainy seasons can be expected to cause more landslides and soil erosions. Considering Baguio's history, is the city resilient enough to 'bounce forward' when a major disruptive event occurs?

In light of its mostly migration-induced population growth (see Cruz and Calugan, 1997; Manahan and Torres, 1989), it is unlikely that the poor and most vulnerable sections of the city's population have adequate access to water that would allow them to meet a decent standard of living and sanitation and health requirements. Considering that water plays a critical role in sanitation and in containing or hastening the spread of diseases, is the quality of water that is delivered or accessible to Baguio residents meeting sanitation standards or does it pose a threat to their health? Can Baguio City residents, especially the poor and vulnerable, not only survive but thrive in the coming years?

This raises a number of issues. BWD's difficulty in fulfilling its mandate of providing adequate and potable water to all residents, particularly in relation to the city's expanding population, tests the city's carrying capacity. There are also the occasional shocks that can lead to disruptions in the already-problematic water distribution services in the city. And special attention needs to be paid to the situation of the more vulnerable members of the population. It appears that Baguio City will need to find ways to be resilient and ensure that its water-related needs are met at present and in the coming years.

1.4 Climate change and water security in Baguio

Nolasco-Javier *et al.* (2014) analysed climate trends for the city of Baguio and over the last 35 years and reported on projected trends in the coming years. Without discussing in detail the technical aspects of the study, its analysis of climate trends for the period 1970–2010 reported the following:

> (1) *There is a cumulative increase of 0.23°C; (2)* ***No significant change in rainfall is evident****; (3) Hot days (defined as higher than the 99th percentile, ie more than 27.8°C) were more frequent in the 1980s and earlier; possibly the cooling effect of the 1990 Mount Pinatubo eruption lessened the number of hot days; (4)* ***The number of extreme rainfall (ie higher than 164mm) appears stable throughout the observation period****. For this observation period, there were 136 days with extreme temperature and 150 days with extreme rainfall (above 99th percentile or more than 164 mm). This corresponds to an average of 7 extreme weather days in a year (Nolasco-Javier et al., 2014:9. Emphasis supplied).*

As for projected trends in the next 35–50 years, Nolasco-Javier *et al*., quite interestingly, noted a divergence between two climate forecasting/simulation models – ie STAR and PRECIS[5] – on the issues of projected rainfall and temperature. The PRECIS model found a positive correlation between rainfall and temperature while STAR projected an inverse correlation. Nolasco-Javier *et al*. wrote:

> *The PRECIS model, which PAGASA[6] has adopted, used data for the period 1971–2000 as a baseline and projects for the period 2036–2065. Results project a 1.9°C increase for the period 2036-2065. Rainfall is projected to increase by 63 per cent in the June-July-August quarter; increase by 22 per cent for the September-October-November quarter and decrease by -6 per cent for the December-January-February quarter; and decrease by -27 per cent in the March-April-May quarter.*
>
> *PIK's STAR model determined an inverse correlation between temperature and rainfall (R=-0.47). Spies (2013) reported 3 scenarios with mean temperature change of +0.23°C (the average trend in the observation period), + 0.5°C and +0.8°C. Projected future climate for the period 2031–2050 were developed using baseline data for 1991–2010. The simulation for yearly rainfall shows a decrease of -485 mm, -927 mm and -1425 mm for Scenario 1, 2 and 3, respectively.* ***While PAGASA projects wetter wet seasons and drier dry seasons, the STAR results show a general reduced rainfall in the rainy season and a slight decrease or no change in dry season rainfall*** *(Nolasco-Javier et al., 2014: 9. Emphasis supplied).*

Despite the obvious disagreement between the forecasting models, both agree that **there will be a change** in the amount of rainfall that Baguio will experience in the future – with one predicting more rainfall and the other expecting less during the rainy season. Nolasco-Javier *et al*. (2014: 11) thus argue that '(T)hese divergent results between STAR and PRECIS call for more serious preparations for climate change and its impact.'

Climate change is expected to produce fluctuations in water supply. It may result in periods marked by extreme amounts of rainfall, flooding and landslides. It may also result in periods of drought and extremely hot weather. Water can be a threat or a benefit to human life, a weapon against disease or its purveyor.

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5 *STAR (STAtistical Regional climate model) and PRECIS (Providing REgional Climates for Impacts Studies (PRECIS regional climate modelling system).*

6 *The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is the Philippine weather bureau.*

2 Research question and objectives

This working paper presents the findings of a study on water security, water access, sanitation and urban resilience in Baguio City, Philippines and asks: **what institutional arrangements, including practices and policies, may Baguio residents adopt at the city and *barangay* level to enhance their access to safe water, promote sanitation and promote resilience vis-à-vis climate change?** This question demands credible, evidence-based answers, on the basis of which appropriate policy-based and other institutional responses may be identified and formulated.

This study may be viewed as having three components. The first component is primarily concerned with obtaining baseline data on Baguio City's general water supply requirements. The second component seeks an in-depth understanding of the requirements and capacities of specific poor and vulnerable *barangays* in Baguio City. The third component is interested in identifying and recommending possible institutional arrangements that Baguio residents may adopt to improve water security and climate change resilience in the city.

The term 'institutional arrangements' can include 'technology-based interventions' – ie initiatives involving the application of scientific knowledge, often manifested in the adoption of technology-based instruments or devices, to address issues concerning water security and climate change resilience. Examples of these are water filtration or purification devices. While technology-based interventions are often expensive, the present study is interested in the adoption of low-cost instruments or devices[7], consistent with the idea that such interventions ought to benefit the most number of communities and individuals.

To answer the main/overarching question, the study had the following specific objectives:

- To obtain baseline data on Baguio City's water supply – specifically in terms of quantity and quality; the water-related demands**8** of its residents and visitors; and **actual access** to water in the city, particularly for poor and vulnerable inhabitants.

7 *For the project team, the production of a draft design for such devices already counts as a technology-based intervention, especially when it is disseminated to city officials and residents. The assembly of an actual device might require additional time, resources and funding.*

8 *Baguio City is presently drafting an environmental code. In it are provisions pertaining to water use: 'the minimum water supply requirement for a household connection is 150 litres per capita per day'. If this provision is approved, it will provide residents with a* **legal** *definition of the term 'minimum water supply requirement'. But how do residents themselves, especially the poor and vulnerable, define their minimum supply requirements? Arguably, their appraisal of their general well-being is shaped more by their own definition of their needs than by one prescribed by a local code. Moreover, it would be interesting to know how legally prescribed standards actually compare with residents' expectations.*

- To assess the city's capacity to satisfy general water-related sanitation and health standards9 and 'access to drinking water' norms10 and to ensure survivability, primarily in terms of the satisfaction of the water requirements of its inhabitants, in the event of its isolation from neighbouring areas (whether as the result of natural or human-induced calamities or emergency situations).
- To identify and recommend possible policies, practices and other institutional arrangements to address primarily water security requirements, sanitation and access to drinking water standards.

The working paper begins with a brief description of the methods employed and the data that were obtained and used in writing this paper. This is followed by the presentation of the paper's findings. The paper ends with a summary and discussion of its general findings.

9 The Philippine National Standards for Drinking Water (PNSDW) sets the criteria for drinking water in the country.

10 Like those set by the WHO and UNICEF Joint Monitoring Programme (WHO/UNICEF JMF).

3 Methods and data sources

To address our research questions and objectives, a mix of data gathering methods were used. This enabled **triangulation** as a means of ensuring the credibility and validity of results. To answer the overarching research question, data was needed on the **quantity** and **quality** of Baguio City's water to formulate recommendations and interventions.

Data gathering methods for the study included (a) a survey, (b) secondary data analysis, (c) focus group discussions (FGDs), (d) key informant interviews (KIIs) and (e) the water diary method. A citywide survey involving 500 respondents was conducted by the authors to provide updated quantitative data on water insecurity as currently experienced in the city. Data gathering for the survey was conducted between 28th February and 21st March 2015. The citywide survey will be referred to in this paper as the March 2015 citywide survey. It bears noting that Mason's 2013 study involved a survey but it covered only one *barangay* in Baguio City.

A survey provides data that can be used to make generalisations about a population. In relation to water access and water insecurity, surveys can elicit valuable data on the number and proportion of city residents who rely on different types of water sources, have access to potable water and have experienced water-related health and sanitation problems in previous years. Surveys can also capture the actual distribution of city inhabitants' knowledge, opinions, attitudes and behaviours on the topic of water use.

Secondary data analysis was also conducted by the research team. Relevant and relatively recent studies, including scholarly journal articles and dissertations, available official government reports and documents and news reports have provided the research team with very useful data on the quantity and quality of Baguio's water. Key documents include:

- Official data (Royeca, 2015a) forwarded by BWD General Manager Salvador Royeca to the lead author in February 2015 which contained information on (a) consumption in cubic metres from 2010–2014 (b) total number of water facilities (c) total yearly production from 2010–2014 and (d) the agency's water-demand forecast up to 2021; and
- The June 2015 Baguio City Water Supply Situationer (Royeca, 2015b) which was prepared also by General Manager Royeca. The Situationer contained data on data on (a) *barangays* served by the BWD (b) *barangays* not served by the BWD (c) water facilities of the BWD (d) total active connections (e) BWD water service connections as of May 2015 (f) annual water production (g) the BWD's challenges (h) projected water supply and demand (i) non-revenue water (j) deep wells in the city (k) deep well map locations (l) the Busol Forest Reserve and (m) BWD initiatives to address challenges.

Considering that these data have been collected and processed by experts of the BWD, they may be regarded as the most authoritative data available information on the subject matter.

The study also entailed key informant interviews (KIIs), mostly with heads and experts of relevant governmental agencies and non-government organisations. Information provided by knowledgeable informants was used to complement data obtained through other methods. The KIIs gave the research team the opportunity to clarify certain matters with the informants. The KIIs proved most useful in eliciting pertinent recommendations from key informants.

Focus group discussions (FGDs) were also used as a complementary data-gathering tool. FGDs were conducted to provide the research team with data on the opinions, attitudes and behaviours of selected residents of Baguio on the topic of water use, access and insecurity. Unlike the survey, however, the conduct of FGDs enabled members of the research team to elicit and probe information from respondents within the context of a group in a relaxed, open-ended and interactive setting. The conduct of the FGDs gave the researchers the opportunity to extract from participants shared experiences, ideas and views. The FGDs also proved useful in extracting group recommendations for addressing the issue of water insecurity.

The water diary method, meanwhile, was adopted to give the research team data on actual water consumption. Endorsed by some scholars (eg Wutich, 2009) as a reliable technique for estimating actual water consumption in households without water meters, the water diary method was used to give the research team some idea of the daily water consumption of selected non-BWD-connected participants. This information about actual consumption can be compared to the proposed daily per capita minimum water supply requirement for Baguio City, which is 150 litres. The water diary method provided the researchers with plausible data on actual water consumption in such households. It did not produce, however, generalisable data given the non-random selection of participants.

The research team thus relied on a mix of research methods to obtain useful and credible data and to produce a holistic picture of water insecurity as experienced in present-day Baguio City. The mix of quantitative and qualitative methods highlights the research team's belief that the issue of water insecurity has both objective and subjective dimensions. Water insecurity has an objective and physical dimension considering that water is a physical resource yet it also has a subjective and social dimension given that people's consumption of water is shaped not only by biological considerations but also by factors like societal norms, cultural practices and idiosyncratic personal preferences and expectations.

4 Main findings

This section presents the findings of the study. The first part deals with data pertaining to water access and sanitation in Baguio City. The second part discusses the legal and policy dimensions of the issue of water security in the city. It offers recommendations for improving Baguio's laws and policies that pertain to water use. It also draws attention to a possible technology-based intervention that may be pursued to address the problem of water insecurity in Baguio.

4.1 Background information: Baguio's water

Baguio's water supply comes from four sources: wells, springs, surface diversions and a rain basin (Estoque and Murayama, 2013: 248). The city's water supply system is administered by the Baguio Water District, a quasi-government agency. The BWD was established in 1975 through Baguio City Council Resolution No. 63-75. Prior to its creation, water utility was provided by the Baguio Waterworks System which was owned by the City Government under the supervision of the National Waterworks and Sewerage Authority (NAWASA). Today, BWD operation is managed by a board of directors composed of five members and a total personnel complement of 249 staff (see Commission on Audit Report, 2012).

The BWD manages a relatively extensive system of water production and distribution that consists of 42 tanks/sump tanks, 57 deep wells, 10 springs/dams, 177 hydrants, 484 valves and 78 water pressure-reducing valves (PRVs) (Royeca, 2015a). In 2011, the BWD was producing an estimated 50,000 cubic metres of water daily (Mason, 2013: 19). Its capacity to distribute water to city residents has however been hampered by the lack of water storage facilities and the city's mountainous topography that has made water distribution technically challenging and costly for the water district (Baguio City Council, undated).

The BWD relies on the city's watershed reserves for the water that it distributes with 85 per cent of its piped water supply being drawn from groundwater (Gonzales, 2007: 5). In 2002, the watershed and forest reserves of the city accounted for 9.07 per cent of the city's total land area (Estoque and Murayama, 2013: 246). Existing watershed and forest reserves are found in Busol, Buyog, Camp 8, Santo Tomas, Pucsusan, Lucnab, John Hay and Crystal Cave. According to reports, some parts of these watersheds have already been compromised (Sunstar, 2013).

The following section discusses data obtained from three main sources: (a) official BWD data (Royeca, 2015a), including the 2015 Baguio City Water Supply Situationer prepared by the agency's general manager (Royeca, 2015b) (b) the March 2015 citywide survey and (c) data from other government agencies, specifically as they relate to issues of sanitation, water quality and meeting the water-related and sanitation needs of poor households. The data in this section focus on the general issues of quantity and quality of Baguio's water. The first sub-section focuses on the BWD's capacity to produce the water demanded by Baguio inhabitants. The second sub-section presents and interprets the results of the citywide survey. Unlike the first sub-section, it offers data on a range of water-related issues from the perspective of water users, including those not connected to the BWD's piped-water system. Note that relevant findings of the water diary method are mentioned in this sub-section when the consumption of meter-less households is discussed. This is followed by a sub-section on data obtained from other government agencies. It focuses on the issues of sanitation and water quality in relation to poor households in Baguio City.

4.2 Official data from Baguio Water District (BWD)

This sub-section discusses water demand and supply in Baguio in terms of population and the proportion served and potential consumption and actual production. It also analyses water distribution including system loss. It then analyses water consumption by type of concession utilising data provided by the Baguio Water District. Note that members of the research team processed the data provided by the BWD.

4.2.1 Water supply and demand

Scrutiny of official 2015 BWD data (Royeca, 2015a) reveals that water demand in Baguio is increasing but supply is lagging behind. From almost 288,000 in 2006, the total population of Baguio – the BWD's target clientele – is expected to increase to over 368,000 by 2021, increasing by an average of 1.7 per cent annually. BWD claims that it has been serving 94 per cent of the population between 2006 and 2019 and will be able to serve 100 per cent by 2020 (Royeca, 2015a). Water demand has increased from almost 51,000 cubic metres per day in 2006 to over 63,000 cubic metres per day in 2014, rising by an average of 2.8 per cent annually. Water demand is expected to increase by an average of 3.6 per cent per year between 2015 and 2021. Between 2006 and 2014, water supply was only 62 per cent of demand. Water supply is forecasted to decrease to 57 per cent of demand between 2015 and 2021 (research team's calculation based on Royeca, 2015a).

Water production has decreased over time but leakages have also decreased. BWD distributed a monthly average of 1.28 million cubic metres in 2010 and distributed a monthly average of 1.03 million cubic metres in 2014, decreasing by an average of 0.7 per cent monthly and by 6.7 per cent annually over the past five years. In 2010, an average of 47.5 per cent of the water supply was unaccounted for. Leakages have decreased over the last three years and stood at 30 per cent in 2014. The amount of water distributed has not significantly changed between 2010 and 2011. However, water distribution decreased by 12 per cent in 2012 and further by 10 per cent in 2013. In 2014, water distribution slightly decreased by 0.2 per cent (calculation based on Royeca, 2015a).

It must be noted that BWD's claim that 100 per cent of the city's population will be served by the BWD by 2020, in addition to the suggestion that leakages will be significantly reduced in the coming years, can lead to the incorrect impression that in five years water demand in the city will be met by the BWD's water supply. Very recent and updated information emanating from BWD's general manager Salvador Royeca (2015b) indicates that by 2020, even when 100 per cent of Baguio residents are expected to be served by the BWD, there will still be a considerable – and growing – discrepancy between actual water supply and the amount of water demanded by residents (see Table 1). Total 100 per cent BWD coverage will **not** indicate a situation where water supply meets water demand.

Table 1. Projected water supply and demand in Baguio City, 2013–2021

Year	Total population	Served population	Unserved population	Water demand (cu.m./day)	Water supply (cu.m./day)	Shortfall (cu.m./day)
2013	326,790	307,183	19,607	56,688	40,414	–16,274
2014	332,137	312,209	–19,607	58,367	41,504	–16,863
2015	337,435	317,189	–19,928	60,047	42,594	–17,453
2016	342,683	322,122	–20,246	61,727	43,684	–18,043
2017	347,885	327,012	–20,561	64,329	44,774	–19,555
2018	353,040	331,858	–20,873	66,931	45,864	–21,067
2019	358,151	336,622	–21,182	69,533	46,954	–22,579
2020	363,220	363,220	–21,529	72,135	48,044	–24,091
2021	368,246	368,246	0	74,737	49,134	–25,603

Source: Royeca (2015b). Figures on unserved population and shortfall computed using Royeca's data.

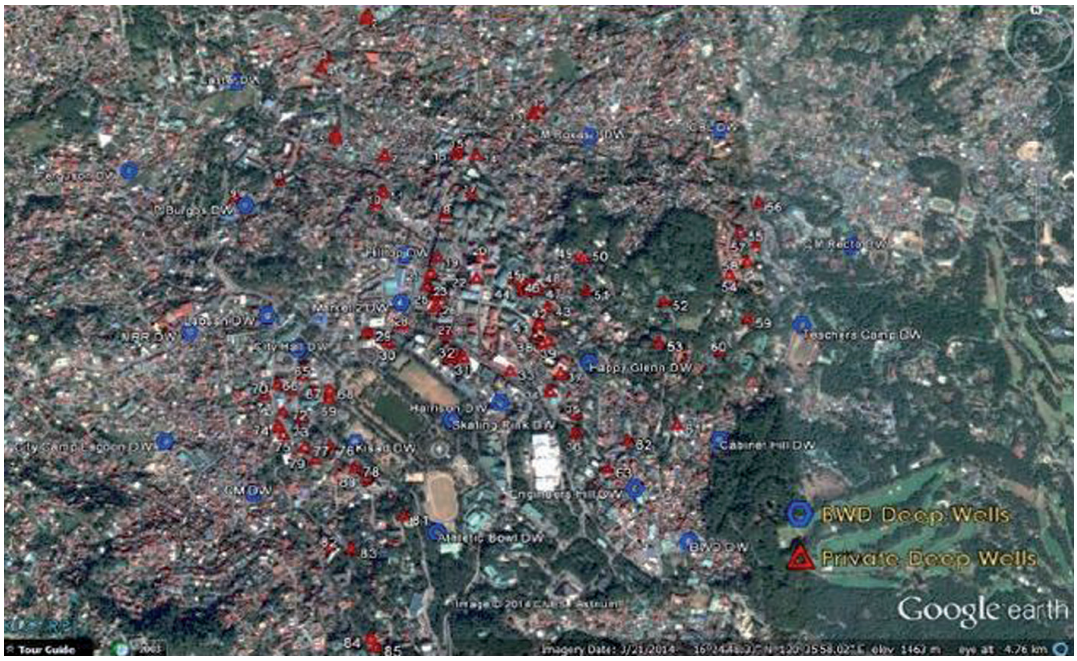
4.2.2 Water shortages

Quite significantly, the data on the BWD's shortfall appears to confirm the claim that Baguio City has been experiencing a water shortage problem for some time now. The BWD identifies a number of factors as the causes of Baguio's water shortage problems, including: (a) population growth (b) the influx of transients (c) leakages (or non-revenue water) (d) climate change, and (e) declining pumping water levels as the result of depleting recharge areas of water sources, which in turn can be blamed on the proliferation of private deep wells and urban development (Royeca, 2015b).

While the BWD has 57 deep wells, there are estimated to be over 1,000 private deep wells in the city (Royeca, 2015b). Citing data on commercial establishments inspected between April and July 2014, Royeca says 152 out of 225 (or almost 70 per cent) of these have their own private deep wells (see Figure 3).

As to the impact of urban development on pumping water levels, Royeca states that 'almost 70 per cent of the city's land area is already developed and only 30 per cent have grown old pine trees, production pine stands and brush lands' (Royeca, 2015b: 13). The city's remaining watersheds are also threatened by human encroachments (see Figure 4).

Figure 3. Map showing locations of BWD deep wells and private deep wells



Source: Royeca, 2015b: 15.

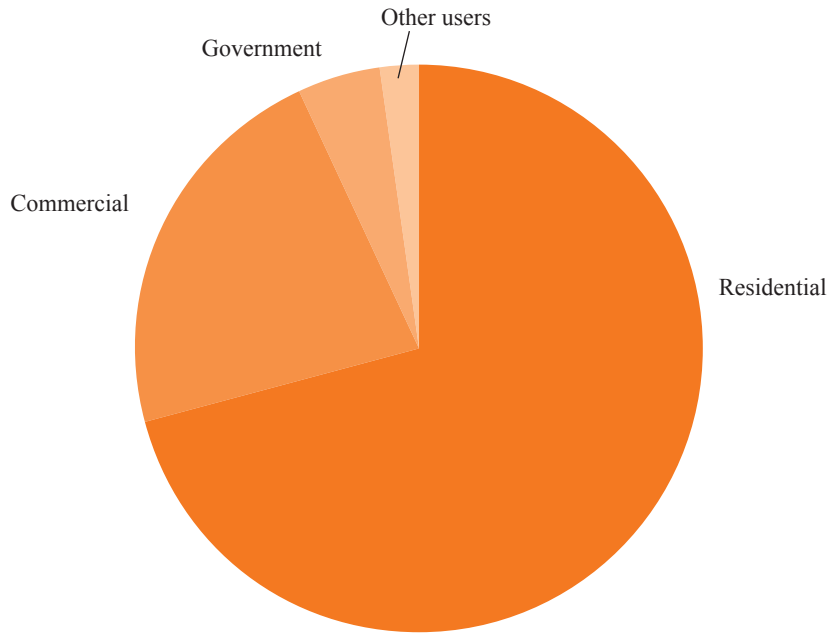
Figure 4. Map of Busol watershed threatened by encroachments

Source: Royeca, 2015b: 16.

4.2.3 Water concessionaires

Official 2015 BWD data (Royeca, 2015a) show water consumption according to types of concessionaire. Most of the water district supply is consumed by residential concessionaires, followed by commercial users and government. Over the past five years (see Figure 5), 71 per cent of BWD water has been consumed by residential users, 22 per cent by commercial users and 4.6 per cent by the government. Another 2.3 per cent is used by other users.

Figure 5. Water consumption by type of concessionaire, 2010–2014



Source: researchers' estimates based on Royeca (2015a).

Residential consumers are classified into three types: Residential A (one-family concessions), Residential B (concessions of two or more families) and Residential C (one-family concessions in subdivisions). Water pricing is different across concessions. Almost 75 per cent of the residential consumption accrues to type A, while almost 25 per cent is used by type B; almost 2 per cent is used by type C.

Over 75 per cent of commercial consumption accrues to type Commercial B (medium-sized business establishments), while over 20 per cent is used by type Commercial A (small business establishments); over 1 per cent is used by Commercial C (medium-sized business establishments located in subdivisions). Most of the water consumption by the government (73 per cent) accrues to the national government while over 27 per cent is used by the city government. The largest share (31.2 per cent) of other water consumption involves water derived by consumers from the BWD's metered deep wells for which the BWD collects payment. Twenty per cent is consumed by the Philippine Export Zone Authority (PEZA) and 17 per cent is used for 'recovery', the BWD's term for water stored or the process which involves storing water in elevated reservoirs.[11] Sixteen per cent is used by Pinesville – a sub-division on the outskirts of the city – and 15 per cent goes to water deliveries that BWD operates (calculations based on Royeca, 2015a).

11 *When released and made to flow through turbines, the stored water from elevated reservoirs generates electricity that is used to power the BWD's water pumps. The BWD carries out the process to ensure its capacity to distribute water to consumers.*

4.2.4 Seasonality

As to patterns in monthly water distribution and consumption in 2010–2014, the BWD data (Royeca, 2015a) shows unsurprisingly that seasonality, particularly the shift from a wet to a dry climate and vice-versa, impacts on the amount of water distributed and consumed in the city (see also Appendices 1 and 2). Importantly, the amount of water distributed by the BWD and consumed by Baguio residents fluctuates from month to month, mostly depending on climatic or seasonal factors. Stated differently, seasonality affects the supply of water available to Baguio residents. Water distribution can be expected to be more difficult and irregular, especially during the summer months of March, April and May.

At least two issues deserve comment at this point. The first concerns the observation that official BWD data (Royeca, 2015a) is essentially macro data. The problem is that macro data cannot show, among other things, actual distribution of water per resident. One can imagine a situation where on a macro scale actual water supply meets water demand. This however would not demonstrate that each resident of the city is actually able to satisfy his or her water-related needs. Reliance on macro data, in the absence of micro data, can lead to initiatives aimed at increasing the total supply of water but such undertakings would not meet the requirements of equitability if actual distribution per resident is not considered. The second point concerns the observation that BWD data on water supply cover the quantity, not quality, of Baguio's water. Recall that the mandate of the BWD is to distribute adequate potable (and affordable) water. The authors believe water distribution as an urban service refers not only to the distribution of water per se but to potable and safe water as well.

4.3 Results of the citywide survey

This section describes Baguio's water demand using data obtained from the March 2015 citywide household survey.

4.3.1 Sources of water

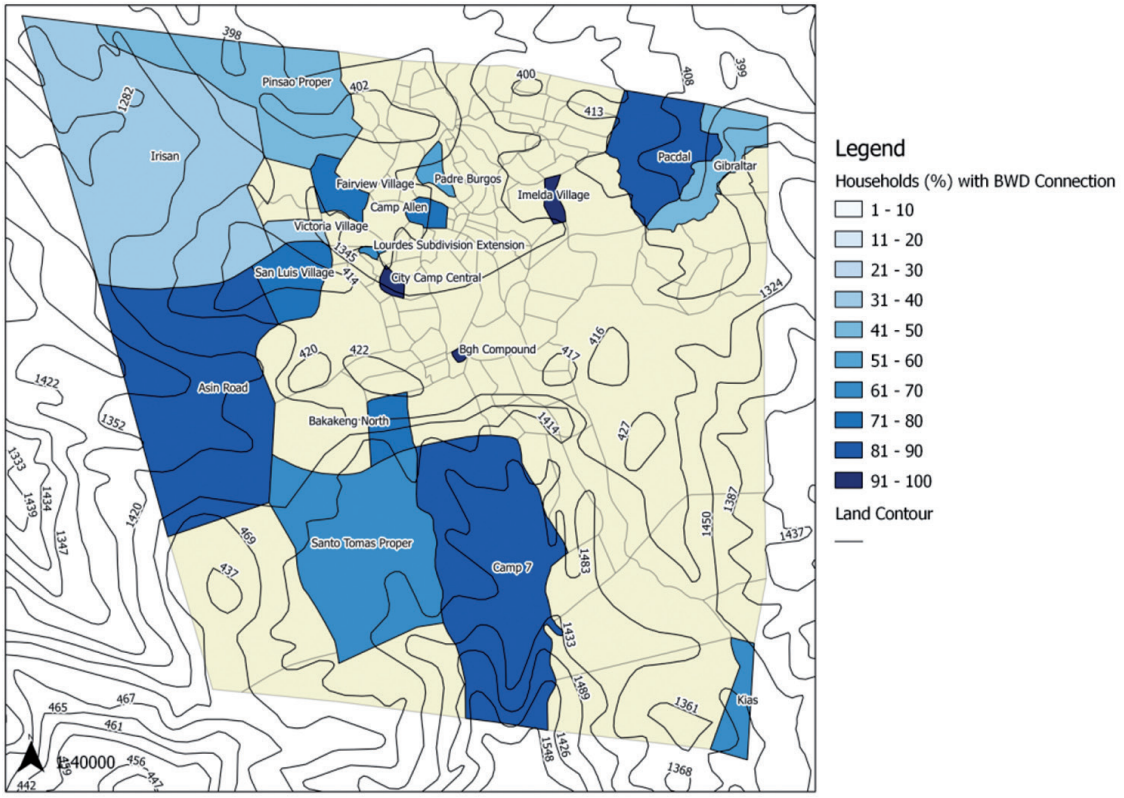
Households in Baguio City derive their water for domestic use from several sources, the primary one of which is the Baguio Water District. Survey data shows that only 68.6 per cent of households in the city have a private connection to the BWD. This means that around 30 per cent of households residing in the different *barangays* in the city derive their water from sources other than the BWD. Figure 6 shows which households in Baguio City rely on BWD as their main water source (for a map of non-BWD households, please see Figure 2).

Indicating that BWD water is generally insufficient to meet the all-year-round needs of its customers, households augment what they are able to get from BWD with water derived from water delivery services (22.2 per cent), springs (6.4 per cent), community water sources (4.4 per cent) and private deep wells (2.6 per cent) (see Table 2). Drinking water is separately accessed from water-refilling stations (91 per cent). Rainwater harvesting is also a common practice with 44.3 per cent of BWD subscribers using rainwater whenever it is available. Note that these water-related activities may be regarded as examples of adaptive strategies aimed at improving Baguio households' access to water.

The water needs of households without a BWD connection are mainly provided by establishments that deliver water via water tankers. Almost half of those not served by BWD get water from this source. This proportion is more than twice that of BWD customers who also rely on water delivery whenever BWD supply dwindles or dries up especially during the summer. Water from springs, private deep wells and community water systems fills the gap that BWD is unable to supply. Note the much higher proportion of households without a BWD connection with access to these water sources suggesting that they might not have a need for a BWD line. Over one-third use spring water while one-fifth have access to water from private deep wells. Not everyone in the latter category, however, own a deep well since six out of 34 households are served

by two private water-distribution firms which supply piped water to households in the neighbourhood from a private deep well. The price households are charged is competitive given the current alternatives. Some survey respondents report that the water from these aforementioned sources is clean and abundant – something that not all BWD consumers report.

Figure 6. Baguio City households whose main source of water is BWD



Map indicating the percentage of households per barangay whose main source of water is BWD.

Source: map prepared by Jeffrey H. Javier using QGIS 1.8 (Open Source GIS mapping software). Data source for shapefiles obtained from the Philippine GIS Data Clearing House and the Department of Environment and Natural Resources-Cordillera Administrative Region (DENR-CAR). Information shown on the map was based on the findings of the present study's March 2015 citywide survey.

Table 2. Types of water sources used by households in Baguio City

Source of water	HH with BWD supply*	HH without BWD supply*	N*
BWD line shared with other HHs	104 (30.3)	12 (7.6)	116 (23.2)
Water delivery service	76 (22.2)	77 (49.0)	153 (30.6)
Springs	22 (6.4)	55 (35.0)	77 (15.4)
Private deep well	9 (2.6)	31 (19.7)	40 (8.0)
Community water system	15 (4.4)	14 (8.9)	29 (5.8)
Rainwater	152 (44.3)	95 (60.5)	247 (43.6)
Purified water from water-refilling station	312 (91.0)	134 (85.4)	446 (89.2)
N	343	157	500

*Multiple responses included

Community water systems also supply the needs of around 6 per cent of households. The more organised of these water systems are those found in three *barangays*. The Irisan Water Cooperative, the Water Consumers Association of Kias, the John Hay Water Distribution System and the water system developed by a religious organisation were cited as the main water source of 8.9 per cent of households without a BWD line.[12]

It is interesting to note that a substantial proportion (56.6 per cent) of households not currently served by BWD is not interested in getting a BWD connection. The advantages of their non-BWD water sources often cited include that spring water is perceived as unlimited and of better quality than BWD water. Water from their deep wells is often preferred because the BWD supply is often unpredictable and not reliable. A major drawback that is also cited is the expensive fees charged by BWD for new connections. Participants also consider water delivery to be cheaper because one only pays for what one orders unlike BWD that charges customers even when their monthly consumption is zero or charges a minimum rate for consumption of 10 cubic metres or less per month. There are of course technical difficulties such as homes being inaccessible that makes a BWD connection an unviable option. Rules preventing informal settlers from connecting to water and electricity utilities were also cited as reasons preventing households from applying for a BWD connection.

The actual proportion of households not covered by BWD appears to be lower than the 30 per cent figure cited above. This is because various arrangements exist among households who share a private BWD connection. In fact, 3 out of 10 of those with a BWD line share this with at least one other household. This is in addition to the 7.6 per cent of households without a BWD connection who buy BWD water by the drum from a neighbour. For example, there was one single connection found to be serving the water needs of 15 households composed of 42 people. Arrangements vary with respect to water use and rates. The survey results suggest that in most cases in Baguio City, considering the availability of non-BWD water sources – especially water-refilling stations, on top of BWD's water distribution system – anybody who needs water can get what he needs when he needs it. In some cases, landlords allow their tenants to fill their containers first before they do. Arrangements also consider how strong the water pressure is, giving households living in hard-to-reach places some advantage. Although conflicts cannot be avoided, cooperation rather than competition among households sharing the same water source has been found to be effective in addressing their water needs. Regarding the water bill, the households devise ways of fairly sharing in the cost. The bill is either divided by the number of households who share

12 *For further discussion on community water systems, private water systems and water-refilling stations and how Baguio residents have devised ways to address lack of access to water, see Appendix 3.*

(30.4 per cent of the survey sample) or this is done per head (17.4 per cent of the survey sample). Where multiple tenants in a boarding house or apartment block share one BWD line, bills are determined either through the installation of sub-meters (7 per cent), the charging of some fixed amount per month (4.3 per cent) or including water costs in their monthly rent (7.8 per cent). Fourteen per cent pay from ₱20–30[13] (approximately US$0.44–0.66) per drum of water.

4.3.2 Water distribution system

The Baguio Water District allocates water to its customers following a schedule of water distribution (see Table 4). A constant water supply from BWD is a rare occurrence and is reported by only 10 per cent of households with a BWD connection. Less than 40 per cent of BWD users have water everyday but it does not last the whole day. A two-to-three times a week water schedule seems to be the norm, with 21.3 per cent and 35.3 per cent reporting such, respectively.

Table 3. Baguio Water District water schedule

BWD water schedule	Frequency	Percentage
Constant	36	10.5
Everyday	63	18.4
4–6 times a week	48	14.0
Three times a week	121	35.3
Twice a week	73	21.3
Once a week	2	0.5
Total	**343**	**100 per cent**

Such a situation thus demands that households have the means for collecting and storing water since a constant water supply is not a luxury most Baguio residents enjoy. In the citywide survey, two-thirds of households reported owning water tanks and/or drums which are filled either directly from the pipes or with the use of a watering hose. A negligible proportion of households do not store water because there is water in the taps throughout the day anyway.

Table 4. Water storage facilities used by households

Water storage facility	Frequency*	Percentage
Water tank	229	66.8
Drum	226	65.9
None	11	3.2
N	**343**	

*Multiple responses included

13 One Philippine peso is equivalent to US$0.022.

For many households, knowing the days and the time that water will be released is important as many tasks are scheduled around it. In many places, BWD releases water late at night or during the early hours in the morning causing residents some inconvenience. Neither does the water supply last the whole day even in areas that only get water once or twice a week from BWD. In fact, residents reportedly had water from the BWD for an average of 44 hours only over the last week prior to the household survey. This is approximately just one-quarter of any given week that BWD-connected households have water in their taps. Water storage containers are thus used by residents to cope with the lack of flowing water most of the time. This practice ensures that residents enjoy some level of water security.

But BWD's **reliability** in keeping to its water schedule is often questioned. Consumers do not always get water from BWD when they are supposed to do so. This is a major cause of water insecurity for many BWD consumers. The problem becomes even more acute during the dry season when the BWD supply drastically decreases and the water pressure becomes non-existent making it extremely difficult for households living in steep or high places to access water from BWD.

4.3.3 Water demand

Water from the Baguio Water District is used for a variety of purposes. Almost all BWD subscribers reported using this water for cooking, washing dishes, bathing, laundry and flushing the toilet. Watering of plants using water from BWD was reported by two-thirds of the respondents. Cleaning the house (inside and outside), washing the car or bathing pets are also done using BWD water.

Table 5. Household water uses among BWD customers*

Purpose	Percentage
Cooking	95.0
Washing dishes	99.7
Bathing	99.7
Laundry	98.5
Flushing the toilet	95.9
Watering plants	67.1
Pet care	14.6
Cleaning the house	7.3
Washing the car	6.1
N	343

*Multiple responses included

Given its prominence as a water source for Baguio residents, BWD must ensure that its water is clean, adequate and affordable. Survey data show that BWD consumers generally perceive the water they receive to be clean since it has no smell (67.3 per cent) and no colour (64.7 per cent). They are, however, divided as to its adequacy and affordability. Over a third of consumers reported that their BWD water supply is more than adequate (37.6 per cent) and a similar proportion reported that their water supply is 'just enough' (34.1 per cent) to meet household needs. In terms of cost, the majority (50.1 per cent) considered it to be within their means while 20 per cent gave a neutral response; 8 per cent of BWD consumers claimed that it is not affordable.

Table 6. Perceived adequacy of Baguio Water District water supply

Adequacy of BWD Water	Frequency	Percentage
Very inadequate	5	1.5
Inadequate	10	2.9
Just adequate	117	34.1
Adequate	82	23.9
More than adequate	129	37.6
N	343	100.0 per cent

The amount of water from BWD consumed by Baguio residents was determined by asking them about their latest bill, as well as their lowest and highest bills in 2014 (see Table 7). These figures are based mainly on respondent recall as most were unable to present their BWD bills. Apparently, it is not the practice of households to archive such documents for future reference. Nonetheless, households reported that they have some idea of how much water they consume on average and which bills are unusually small or large. Based on the data collected, around a third of households consumed 10 cubic metres or less based on their last billing. The BWD charges a flat rate for 10 cubic metres or less and progressively more per cu m for higher consumption. When asked what their lowest BWD bill last year had been, a substantial segment of Baguio residents (approximately half) reported consuming the minimum level of water at some point during the year (as far as they could recall). This proportion falls dramatically to only 17.5 per cent of households which reported using 10 cubic metres or less as their highest consumption level in the past year. This suggests that households adjust their consumption to what is available. When BWD supply is abundant, residents consume more than when the supply is limited. Otherwise, normal consumption levels are supported by non-BWD sources. The figures in Table 7 have not yet been adjusted for the number of people in the household using the water. Obviously, when the number of water users increases, as in the case of boarding houses, apartments or transient houses, water consumption also increases. Consumption levels greater than 30 cubic metres a month are not that prevalent – only 10 per cent of households reported consuming this much water in the last month prior to the citywide survey taking place.

Table 7. Monthly water consumption, Baguio Water District customers (cubic metres)

	Latest BWD bill	Lowest BWD bill in 2014	Highest BWD bill in 2014
10 or below	92 (31.4)	117 (53.2)	37 (17.5)
10.01 to 20	112 (38.2)	60 (27.3)	88 (41.5)
20.01 to 30	56 (19.1)	20 (9.1)	35 (16.5)
30.01 to 40	11 (3.8)	3 (1.4)	25 (11.8)
40.01 to 50	12 (4.1)	0	6 (2.8)
More than 50	10 (3.4)	20 (9.1)	21 (9.9)
N	293	220	212

Percentages in parenthesis

To correct for differences in the number of users per household, the authors' calculations on average per capita water consumption was determined by dividing the latest BWD bill by household size. Estimates show that, on average, a Baguio resident consumes 4.8 cubic metres per month of BWD water (SD = 5.34). This translates to approximately 160 litres per day per person for cooking, bathing, laundry and cleaning. It is probably worth mentioning at this point that the study's use of the water diary method found that the per capita daily amount of water used by non-metered, non-BWD connected residents can be as low as 26.04 litres, far below the proposed/prescribed 150-litre minimum per capita daily water requirement, or as high as 124.17 litres (for more information on the water dairy method, see Appendix 2).

4.3.4 Private water delivery services in Baguio City

A very important development in the way the water needs of Baguio residents are addressed is the rise of establishments offering water delivery services to customers. Water is delivered using water tankers with capacities ranging from 10 to 20 drums.[14] Clients call to put in an order and wait for it to be delivered. Data show that the waiting time for water to be delivered ranges from under one hour to up to three days depending on how long the delivery company's order list is and the distance of the water source to its destination (see Table 8). Six out of 10 households receive their order within half a day indicating the relative efficiency of the water service.

Table 8. Waiting times for water to be delivered

Waiting time	Frequency	Percentage
Within one hour	56	37.3
Within half a day	39	26.0
Within the day	37	24.7
Next day	10	6.7
Within 3 days	2	1.3
First come, first served	6	4.0
N	150	100.0

Thirty-one per cent of all households rely on water delivery services for their water supply. Out of 153 households, 70 per cent ordered water from commercial water distributors at least once in the first quarter of 2015. The last time the rest ordered water was at some time in the last year. Half of the households who had used water delivery services in 2014 considered them to be their main source of water.

On average, water costs 28 Philippines pesos (approximately US$0.62) per drum although it is sold as low as ₱15 (US$0.33) or as high as ₱50 (US$1.10) depending on how far and accessible the destination is. Respondents reported that they ordered an average of 10 drums per order although the amount could range from half a drum to as much as 40 drums. Given that water tankers can carry 10 to 20 drums, it is the practice of some households to purchase delivered water collectively. This is done by households who do not have enough water containers or enough money to buy 10 drums at once. In terms of the purpose for which delivered water is used, most households claim that they use it for cooking, washing dishes, bathing, laundry and flushing the toilet. It is also used to a lesser extent for watering plants and pet care. Note that water from tankers is not generally used for drinking.

14 In the context of water deliveries, a drum is equivalent to 200 litres.

Table 9. Household uses of delivered water

Purpose	Percentage
Cooking	88.2
Washing dishes	98
Bathing	97.4
Laundry	95.3
Flushing the toilet	90.2
Watering plants	57.5
Pet care	17.6
Cleaning the house	1.3
Washing the car	7.2
N	153

*Multiple responses included

The reliance of households on water delivery services is seen in the number of times they order water per month and the amount of money they spend on it. Many regular users of delivered water order water six times a month and spend 1,057 Philippine pesos (US$23.26) of their budget, on average. The total number of drums of delivered water per month is estimated to be 30.56 on average. After correcting for household size, this translates to an average of 5.58 drums per person per month or 1.116 cubic metres.

Table 10. Amount of delivered water consumed per household per month

Number of drums	Frequency	Percentage
10 or less	27	34.6
11 to 20	19	24.4
21 to 40	21	26.9
41 to 80	7	9.0
135 to 300	4	5.1
N	78	
Mean per HH	30.56	
Mean per capita	5.59	

Comparing the patterns of consumption of delivered water for BWD-connected households and non-BWD households is instructive. As seen in Table 11, the mean values derived for the former are consistently lower (but statistically insignificant) than that of the latter, indicating that BWD-connected households have a relatively smaller dependence on water delivery. BWD concessionaires use water delivery services merely to augment whatever supply they get from the local utility. On average, they order water from commercial water distributors three times a month compared to seven times for those without BWD lines. They consume around 13 drums per month per household compared to 33.47 drums for non-BWD subscribers. Their expenditure on delivered water averages at ₱891 (US$19.60) per month compared to ₱1,082 (US$23.81) for those without a BWD connection.

The reasons most-often cited by BWD-connected households for purchasing delivered water include no BWD supply (12.8 per cent) and weak water pressure/inadequate BWD supply (8.7 per cent). Half of those without a BWD line cite this as their reason for using water delivery services. Households who have guests as well as those who operate transient houses depend on this source to increase their water supply amidst higher demand.

Table 11. Comparative consumption of delivered water, BWD vs non-BWD households

	Mean	
	HHs with BWD supply	**HHs without BWD supply**
Number of times per month water is ordered	2.90	6.89
Amount spent on delivered water per month (pesos)	890.70	1,081.92
Number of drums of water delivered per month	13.46	33.47
Per capita consumption per month (drums of water)	2.08	6.19

4.3.5 Water from springs, wells and community water sources

Out of 500 households included in the survey, 77 (15.4 per cent) were found to derive their water needs from a natural spring or creek found near their residence. Households without a BWD connection are 5.5 times more likely to have access to water from springs or creeks than BWD-connected households. Knowledge of the existence of available natural water sources also differs between the two groups with almost twice as many households without a BWD line saying there are springs or creeks used by residents in their area. Half reported that such sources are found within their *barangay*. Only a quarter of those with a BWD connection said the same.

Forty households (8 per cent of the sample) have access to water from a private deep well but only 36 of them own this facility. The other four households buy water from a neighbour's private deep well. Households without a BWD connection are 7.6 times more likely to have access to water from a deep well. This probably explains why a BWD connection is neither necessary nor desired by some residents.

Community water systems, on the other hand, provide water to 29 households (5.8 per cent of the sample). A community water system may be described as a community or private water system that utilises a water source (such as a spring or deep well), stores the water in tanks and delivers it through water distribution pipes to individual houses.

There are relatively more households who know about the existence of such water systems in their area than there are those who use water from these sources.

Table 12. Access to natural water sources, deep wells and community water systems

	HHs with BWD supply* N %	HHs without BWD supply* N %
HHs which use water from spring/creek	22 (6.4)	55 (35.0)
HHs which use available natural water sources	110 (32.1)	86 (54.8)
HHs which say natural water sources are found within the *barangay*	95 (27.7)	77 (49.0)
HHs which use water from a private deep well	9 (2.6)	31 (19.7)
HHs which own private deep well	8 (2.3)	28 (17.8)
HHs which use water from community sources	15 (4.4)	14 (8.9)
HHs which know of community water sources in their area	48 (14.0)	27 (17.2)
N	**343**	**157**

*Multiple responses included

Spring water is used for most domestic purposes including cooking, dish washing, bathing and flushing the toilet, as reported by seven out of 10 households who have access to this type of water. Close to 90 per cent of these households also use spring water for their laundry. The proportion of households with access to private deep wells who use this water for the same purposes is relatively higher. Using water from a deep well for washing dishes, bathing and laundry was reported by over 92 per cent of households. Eighty per cent also use deep well water for cooking. It is important to note that among those who rely on non-BWD sources of water, 17 per cent derive drinking water from a natural spring while 20 per cent get potable water from a private deep well.

Table 13. Household uses of water from springs, deep wells and rainwater

Purpose	Spring* N %	Private deep well* N %	Rainwater* N %
Cooking	55 (71.4)	32 (80.0)	14 (5.7)
Drinking	13 (16.9)	7 (20.0)	0 (0.0)
Washing dishes	59 (76.6)	37 (92.5)	61 (24.7)
Bathing	58 (75.3)	37 (92.5)	59 (23.9)
Laundry	68 (88.3)	38 (95)	141 (57.1)
Flushing the toilet	61 (79.2)	35 (87.5)	204 (82.6)
Watering plants	42 (54.5)	27 (67.5)	163 (66.0)
Pet care	6 (7.8)	4 (10.3)	60 (24.3)
Cleaning the house	2 (2.6)	4 (10.3)	39 (15.8)
Washing the car	1 (1.3)	1 (2.6)	11 (4.4)
N	**77**	**40**	**247**

*Multiple responses included

4.3.6 Rainwater

Survey data also show that rainwater harvesting by households for different purposes is reported by only 49.4 per cent of households in the city. Six out of 10 non-BWD-connected households store rainwater compared to only four out of 10 BWD concessionaires. Among the most important uses of rainwater are watering plants (66 per cent) and laundry (57.1 per cent). Bathing, dish washing and pet care needs are likewise reported by around a quarter of those who use rainwater.

Virtually all households who practice rainwater harvesting use a drum, pail or basin to collect water from the gutter of their homes (98 per cent of the 247 households who reported using rainwater). The use of cisterns is negligible at a mere 1 per cent of the 500 households sampled in the citywide survey. This means that most rainfall becomes surface runoff that could have been harvested for domestic use if households adopted rainwater-harvesting practices. The potential of rainwater harvesting as a means of addressing water shortages is immense. As the survey data show, 95 per cent of the BWD-connected households who collect rainwater do this even when there is ample BWD supply. If the practice of rainwater harvesting was to be adopted by all or most households in the city and if this was done on a larger scale than just the use of drums, pails and basins, then fewer households would depend on water delivery services for most of their domestic needs.

4.3.7 Drinking water

The drinking water of Baguio residents is supplied mainly by water-refilling stations which purify or filter water for consumption. Eighty-five per cent of all households consider this to be their main source of drinking water. The rest boil their drinking water (3.8 per cent), filter their own water (5.4 per cent), or drink unfiltered water from BWD, spring or deep well (4 per cent). Only 1.4 per cent use commercial bottled water.

Before the advent of water-refilling stations,[15] Baguio residents boiled their own drinking water. This is supported by the data collected, showing that 45 per cent used to do this in the past. Now, only a quarter of households do this. And for many of them, boiling is done only when purified water from the refilling station runs out. This can be attributed to the general perception, then and now, that tap water from BWD is not safe for drinking unless boiled first. With the presence of many substitutes, residents have now shifted to commercially available drinking water that is cheap, convenient and accessible. Boiling water is described as inconvenient, time-consuming and fuel-intensive. A five-gallon bottle of purified water that retails at an average price of 27 Philippine pesos (less than US$0.60) is a more attractive option.

Authors' estimates on the number of five-gallon bottles of purified water consumed per household show that on average, households buy 8.83 bottles per month. On a per head basis, this was computed to be 2.02 bottles or 10.1 gallons per person per month, according to survey data.[16]

4.3.8 Water recycling

The collection of used water from different household activities for recycling purposes was reported by 79 per cent of households in the city. Water used for laundry is recycled by 95.7 per cent of these households. A secondary source of water for recycling is water used for washing which was cited by 25 per cent of these households. Most households use a basin to wash their dishes (59.2 per cent) which allows them to collect the used water for recycling. Many households who use flowing tap water when doing the dishes are conscious about conserving water by turning on the tap only when rinsing the dishes and collecting whatever water they can for later use.

15 Interviews with key informants revealed that Baguio had a water-refilling station in as early as 1992 (see Appendix 5).

16 For further discussion on water-refilling stations and other water-related businesses in Baguio City, see Appendix 5.

Table 14. Activities from which used water is collected for recycling

Activity	Frequency*	Percentage
Cooking	32	8.1
Washing hands/face	19	4.8
Bathing	43	10.9
Washing dishes	105	26.6
Laundry	378	95.7
N	**395**	

*Multiple responses included

Recycled water is commonly used for flushing the toilet (78.5 per cent), watering the plants (49.9 per cent) and cleaning the house (25.1 per cent). Toilets are generally flushed manually with the use of a pail or bucket (76 per cent). Laundry is typically done with a washing machine that is not automatic (54 per cent) or by hand. These practices allow residents to re-use water and control the amount they use. Watering plants is rarely done with the use of a watering hose (11.2 per cent) or sprinkler (1.2 per cent). Instead, residents usually use a bucket and dipper.

Baguio residents thus find ways to obtain the water they need on a daily basis. For the majority of households, most of the water they need is supplied by the BWD. Households that consider the supply they receive from the local utility to be adequate for their needs are likely in general to be water secure. In contrast, households with insufficient water due to low water pressure and short and/or disrupted water distribution schedules experience water challenges every day. Water delivery services fill the gap that BWD is unable to supply. This, however, requires that households have the purchasing power to access such a source of water. Assuring quality and safety standards for these water services is also important.

There are springs and creeks known to residents which are possible sources of domestic water. But developing them could be expensive. Further, there is the potential for over-extraction or even possible contamination when such resources are ‘open access’ without rules regarding their use, access and control. In the context of a highly urbanising area where population pressures impose further constraints on the local utility’s ability to meet growing needs, water security issues are unsurprisingly at the fore of public policy debates.

4.3.9 Waste-water management

Information from the household survey conducted for this study shows that only 22.2 per cent of households are connected to the city’s sewerage system while 68.4 per cent are not. Approximately one in ten households (9.4 per cent) does not know whether the house is connected to the city’s sewerage system. When asked whether the household has a septic tank, 90.9 per cent said ‘yes’, 7.9 per cent said ‘no’ and 1.2 per cent did not know.

Given that a significant proportion of domestic water use as shown by the data from the water diary method is for bathing and sanitation (see Appendix 2), the ability to capture and manage waste water becomes an important aspect of water and waste-water management. Concerns about the proper waste-water management of domestic water use are also motivated by concerns related to health impacts since water-borne diseases may also be spread by poor sanitation facilities. Understanding how households organise their access to a sanitation facility will be an important consideration when planning an efficient and sustainable water-management system.

4.3.10 Survivability

The citywide questionnaire also contained questions related to the issue of survivability. Respondents were asked the following questions:

- If the water supply was cut off for three days, would your household have sufficient water for its needs? and
- How long could your household sustain its water needs if the city's supply was cut off indefinitely?

The tables below show the responses to these questions. Interestingly, approximately two-thirds of respondents said they would have sufficient water for three days if the water supply was disrupted.

Table 15. If the water supply was cut off for three days, would your household have sufficient water for its needs?

Response	Frequency	Percentage
Yes	339	67.8
No	159	31.8
Don't know	2	0.4
Total	**500**	**100.0**

As to the number of days that households could sustain their water needs if the water supply was disrupted, 18 respondents out of 500 (3.6 per cent) said that their households could sustain their water needs indefinitely on account of their access to a natural spring near their place of residence. Two respondents (0.4 per cent) said their households could manage for 60 days but not longer. Eight respondents (6 per cent) believed their households could manage for 30 days at most; 27 respondents (5.4 per cent) said their households could manage for 14 days at most, while 98 respondents (19.6 per cent) believed their households could sustain their water needs for only 7 days. Interestingly, the cumulative percentages show that only 14.6 per cent believed their households could sustain their water needs beyond the first 7 days of an indefinite water disruption.

Table 16. How long could your household sustain its water needs if the city's water supply was cut off indefinitely?

Number of Days	F	Cumulative frequency	per cent	Cumulative percentage	How long could your household sustain its water needs?
Unlimited (rely on spring)	18	18	3.6	3.6	Indefinitely
60	2	20	0.4	4.0	At most 60 days
45	1	21	0.2	4.2	At most 45 days
31	1	22	0.2	4.4	At most 31 days
30	8	30	1.6	6	At most 30 days
28	1	31	0.2	6.2	At most 28 days
21	4	35	0.8	7	At most 21 days
15	1	36	0.2	7.2	At most 15 days
14	27	63	5.4	12.6	At most 14 days
12	2	65	0.4	13	At most 12 days
10	7	72	1.4	14.4	At most 10 days
8	1	73	0.2	14.6	At most 8 days
7	98	171	19.6	34.2	At most 7 days
6	3	174	0.6	34.8	At most 6 days
5	43	217	8.6	43.4	At most 5 days
4	55	272	11.0	54.4	At most 4 days
3	76	348	15.2	69.6	At most 3 days
2	80	428	16.0	85.6	At most 2 days
1	64	492	12.8	98.4	At most 1 day
0	1	493	0.2	98.6	Less than 1 day
Don't know	6	499	1.2	99.8	
No response	1	500	0.2	100	
Total	500		100		

4.4 Relevant data from other government agencies

This section discusses data obtained from pertinent government agencies in Baguio related to sanitation and the quality of water from refilling stations and water delivery facilities in the city. It also looks into the issues of water security and sanitation as they affect poor households in Baguio. Data for this section were obtained from the Sanitation Division of the Baguio Health Department and the Department of Social Welfare and Development (DSWD-CAR, 2012).

4.4.1 Sanitation and quality of water of refilling stations/water delivery services

This section relies on water sample test results to establish the quality of water from refilling stations and water delivery facilities. It also discusses data on the quality of BWD water.

Survey results show that 85 per cent of households rely on water-refilling stations for their drinking water. BWD tap water is generally perceived as unsafe for drinking although, as shown by the survey results, respondents felt that BWD water is clean because it has no smell (67.3 per cent) or colour (64.7 per cent). Residents who rely on water from private deep wells said that their water is clean, at times even cleaner than BWD water.

Section 9 of the sanitation code of the Philippines states 'Standards for drinking water and their bacteriological and chemical examinations, together with the evaluation of results, shall conform to the criteria set by the National Drinking Water Standards' (Department of Health, 1976). The sanitation division of the Baguio Health Department conducts tests following the standard methods of detection and values for microbiological quality (see Part V. General Requirements, Item 1.3 of DOH, AO No. 2007-0012) to assess whether water samples conform to the standards. As the administrative order states 'frequent examinations for fecal indicator organisms remain as the most sensitive and specific way of assessing the hygienic quality of water'. A sample is given an overall mark of passed or failed.

The results for tested water samples from water-refilling stations/water delivery by month for 2013 and 2014 are presented in the table below. These results are disturbing. On average 42 per cent of samples in 2013 and 47 per cent of samples in 2014 **failed** the standards set for drinking water. The highest value for 'fail' in 2013 was 64 per cent of total water samples in the month of November and in 2014, it was even higher at 66 per cent of total water samples in the month of April.

Table 17. Water quality tests: pass/failure rates for refilling stations/water delivery services

	2013				2014				Change from 2013 to 2014
Month	Pass	Fail	Total	per cent Fail	Pass	Fail	Total	per cent Fail	Increase (+), decrease (-)
Jan	97	25	122	21	47	29	76	38	+
Feb	46	58	104	56	23	25	48	53	-
Mar	40	33	73	31	36	33	69	48	+
Apr	72	26	98	26	18	35	53	66	+
May	58	27	85	32	23	25	48	52	+
Jun	57	49	106	46	23	31	54	57	+
Jul	30	29	59	49	32	22	54	41	-
Aug	20	18	38	47	33	24	57	42	-
Sept	33	33	66	50	36	12	48	25	-
Oct	21	9	30	30	16	29	45	64	+
Nov	43	78	121	64	27	15	42	36	-
Dec	22	27	49	55	17	12	29	41	-
AVE				42				47	

Source: logbook entries of the sanitation division, Baguio Health Department.

Some information on the quality of BWD water may be indicated in the results of 25 water samples tested by the sanitation division of the Baguio Health Department in 2013. The water samples were collected from the tanks, deep wells and even taps of the BWD. Contamination of BWD water can take place despite the fact that water from BWD is treated with chlorine because of the condition of the water tanks, deep wells and the water distribution pipes. Eleven water samples recorded **negative** for indicator organisms following the Philippine National Standards for Drinking Water (PNSDW, 2007). This 44 per cent of the total sample met the required standards.

If we compare this to the averages of 42 per cent fail rate and 58 per cent pass rate for water samples taken from refilling stations in 2013 (see Table 17), one could make a preliminary conclusion that the BWD water quality in 2013 was poorer than that of water purchased at refilling stations for drinking. This corroborates the finding that almost 90 per cent of households in the survey have moved to purchasing purified water from refilling stations for drinking. Household respondents state that this practice saves time and other costs attendant to boiling water from BWD for drinking. In doing so, the households have already exhibited their preference for purified water from refilling stations over BWD water for drinking.

4.4.2 Water insecurity in poor and vulnerable households

This section discusses the issue of water insecurity in relation to poor and vulnerable households in Baguio City. The data available only allows analysis of 'poor' *barangays* and their access to water from the BWD, and only includes households in the 19 *barangays* randomly selected for the study's survey. However, sound general assertions can be made based on the available data.

The 'incidence of poverty' for Baguio *barangays* as of 31 December 2012[17] was obtained from the Department of Social Welfare and Development, Cordillera Administrative Region (DSWD-CAR, 2012). The data was collected during the first round of assessment in 2009 in relation to the implementation of the National Household Targeting System for Poverty Reduction (NHTS-PR). However, only pockets of the city were included in the survey as the 'incidence of poverty' is 26.5 per cent in Baguio, equal to the number of poor households (4,436) as a proportion of the total assessed households (16,740) (ie less than the 49 per cent or lower 'incidence of poverty' threshold set by the survey).[18] The 'incidence of poverty' per *barangay* follows this calculation. As for data on access to BWD water, this study relies on the survey results, particularly on the responses to questions on whether respondents have a direct BWD connection.

Table 18 shows the *barangays* selected for the survey and the percentages of households in each of the *barangays* that (a) are assessed to be poor and (b) have no BWD connection. Meanwhile, Figure 7 shows the poverty incidence rates of the 19 Baguio *barangays* that were randomly selected for the study.

Except for Barangay Camp Allen, the proportion of poor of households in the other 18 *barangays* is around 25 per cent or greater, with *barangays* Pinsao Proper (46.85 per cent), Bakakeng Norte (47.73 per cent) and BGH Compound (52.87 per cent) showing very high poverty incidence rates.

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17 A second round of data collection for the National Household Targeting System for Poverty Reduction (NHTS-PR) is currently being completed. This time the method of data collection is the saturation method. However, the data from the second round will only be released by the end of 2015.

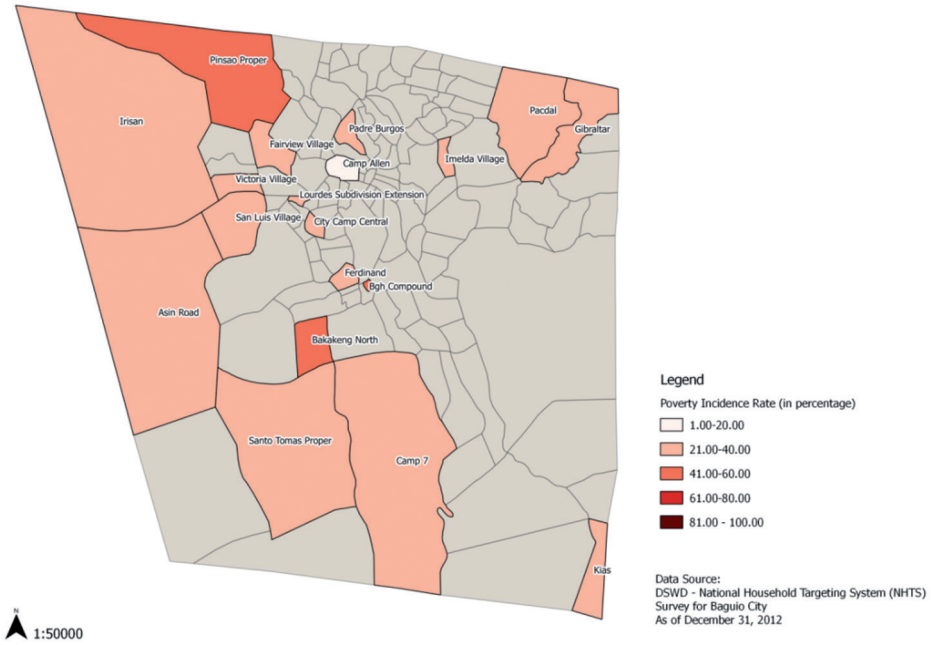
18 The NHTS-PR is a data management system that identifies **who** *and* **where** *the poor are in the country. The data follows the definition of the poor 'according to the national poverty line'. Since Baguio City has a poverty incidence of 49 per cent and lower, the 2009 household assessment (which uses a two-page questionnaire with 34 observable and verifiable variables) was undertaken* **only** *in 'pockets of poverty' in the city. It would have been complete enumeration or saturation for the whole city if it had a poverty incidence of 50 per cent or above. This is the source of the incidence of poverty data reported here.*

Table 18. Proportion of poor households per barangay and percentage of households with no BWD connection

Barangay	**Proportion of poor households to assessed households %**	**Households with no BWD connection %**
1. Asin	35.74	16
2. Bakakeng Norte	47.73	20
3. BGH Compound	52.87	0
4. Camp 7	30.99	16
5. Camp Allen	9.93	16
6. City Camp Central	29.05	8
7. Fairview	30.31	20
8. Ferdinand (Happy Homes-Campo Sioco)	31.33	28
9. Gibraltar	31.93	52
10. Imelda village	27.27	4
11. Irisan	26.54	62
12. Kias	30.68	36
13. Lourdes subd. extension	32.39	12
14. P Burgos	28.33	44
15. Pacdal	34.34	8
16. Pinsao proper	46.85	52
17. San Luis village	35.10	28
18. Sto Tomas proper	32.70	32
19. Victoria village	24.48	64

Sources: data on proportion of poor households obtained from DSWD-CAR (2012). Data on households with no BWD connection derived from the results of the study's survey.

Figure 7. Poverty map of Baguio City



Source: map prepared by Jeffrey H. Javier using QGIS 1.8 (Open Source GIS mapping software). Data source obtained shapefiles are from the Philippine GIS Data Clearing House and the Department of Environment and NaturalResources-Cordillera Administrative Region (DENR-CAR). Information shown on the map was based on DSWD-CAR (2012) data.

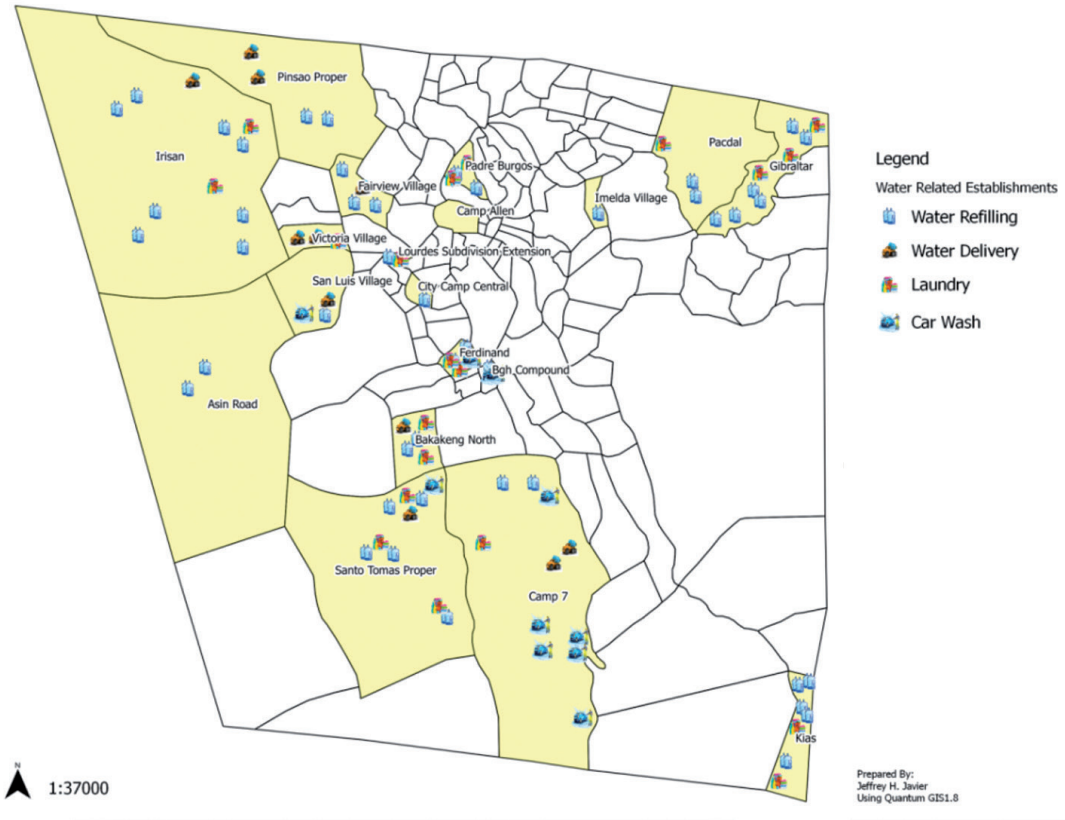
Interestingly, all households in the 'mostly poor' BGH Compound reportedly have a BWD connection. At the same time, 16 per cent of households in 'mostly not poor' Camp Allen have no BWD connection. It is only in Pinsao Proper where the high proportion of poor households (46.85 per cent) actually coincides with no BWD connection (52 per cent). These findings seem to suggest that there is no direct correlation between poverty and having a BWD connection. However, the data only highlights the limitation mentioned above – ie that of equating water security in Baguio City with having a BWD connection. It probably bears repeating that not all Baguio *barangays* are served by the BWD and four *barangays* (Kias, Irisan, Apugan-Loakan and Happy Hollow) rely on their own community water systems for their water supply.

Although the BWD has a significant role to play in ensuring water security in Baguio City, it would be wrong to say that connecting all households in the city to the BWD's pipe system would automatically mean the attainment of water security for Baguio residents. Available data thus show that one in every four households in Baguio may be considered 'poor' and that there is no direct correlation between 'incidence of poverty' and 'having a direct BWD connection.' As to whether there is a direct correlation between 'incidence of poverty' and 'water insecurity', the paucity of much-needed data prevents an analysis of how the two are actually correlated in the case of Baguio.

Still, it is clear that access to safe and potable water is a major concern for Baguio residents and that, contrary to its mandate, BWD is not the main source of drinking water for most residents of the city. Although it appears that water sources are actually physically available to most Baguio residents, drinking water is mostly purchased from water-refilling stations. Figure 8 indicates the relative accessibility of water-refilling stations and other water-related businesses to most Baguio residents.

It bears noting, however, that the seeming 'adequacy of domestic water' cited in previous sections of this paper still requires users to have the ability to purchase said domestic water. Considering that income determines the level at which the need for water can be satisfied, it was thus relevant to ask how access to drinking water is perceived from the point of view of poor households. As notes earlier, 85 per cent of households rely on water-refilling stations as their primary source of drinking water. This suggests that the price of purified water is accessible to a segment of Baguio's poor which is estimated to be about approximately a quarter of the city's population.

Figure 8. Map indicating number of water-related establishments by type per *barangay*



Source: map prepared by Jeffrey H. Javier using QGIS 1.8 (Open Source GIS mapping software). Data source for shapefiles obtained from the Philippine GIS Data Clearing House and the Department of Environment and Natural Resources-Cordillera Administrative Region (DENR-CAR). Information shown on the map was based on the results of the 'walk-through' activity conducted in April 2015 whose primary purpose was to count water-related establishments in the survey sites.

4.4.3 Sanitation in poor households

This section discusses the issue of sanitation as it affects poor households in Baguio City. The discussion is based DSWD-CAR (2012).

Among the 4,436 poor households, the highest ranked **main** source of water is a spring, river or stream (27 per cent), followed by a 'water peddler' (26 per cent) and a shared tap (19 per cent). Only 15 per cent of poor households have their **own** tap or private and exclusive connection to a water supply and distribution system. The remaining poor households share the use of piped water from a well, have their own piped water from a well or use rainfall as their main water source.

Since the main water source for poor households are bodies of water like springs, rivers or streams which have a higher probability of contamination, the water that these households normally access may be of a quality less safe and potable, especially during the rainy season. That water purchased from a peddler is the second main water source for almost as many poor households shows that they also buy water. Another assertion that can be made is similar to the finding from the data from this study's household survey, is that **sharing** a water source with a neighbour is also common among poor households. As much as 19 per cent cited a shared tap as their household's main source of water.

Among the 4,436 poor households of Baguio City, toilet facilities include a water-sealed toilet (71 per cent), closed pit (14 per cent) and open pit (5 per cent). Interestingly, 9 per cent of households stated that they do not have a toilet facility. This means that as many as three in ten poor households do not have a water-sealed toilet facility and hence do not have an 'improved sanitation' facility.[19]

4.5 Summary of initial findings

This study has revealed that at present BWD water supply lags behind water demand and this is expected to continue to be so in the coming years. The study's March 2015 citywide survey data, however, show that majority of Baguio residents find their water supply to be either adequate or more than adequate. Although these claims are seemingly contradictory, BWD is not the sole source of water for residents. They rely on a variety of water sources, such as springs, rivers and deep wells. Yet importantly, data support the claim that the city lacks an adequate supply of water of acceptable quality mainly because tests on the quality of BWD water and water from refilling stations and delivery services reveal disappointing results. Water samples from these sources do not satisfactorily meet national standards for drinking water.

Baguio residents have adopted a variety of adaptive strategies to deal with water insecurity such as rainwater harvesting and storage, water recycling and community water systems. These behaviours seem to bode well for urban resilience. But the issue of the possible over-extraction of water resources is suggested by the proliferation of water-related businesses and private deep wells.

Prompted by this issue and the need to find solutions to water insecurity, this working paper now discusses recommendations for possible institutional and technology-based interventions. The legal and policy dimensions of water use in Baguio are given attention mainly because existing laws and policies may have contributed to the proliferation of water businesses, especially water-extracting utilities, in the city.

19 See UNICEF (undated).

5 Recommendations for addressing water security

This section outlines recommendation to address the issue of water security in Baguio City. First, it discusses legal and policy dimensions, followed by possible technology-based recommendations.

5.1 Legal and policy dimensions of water use

This section reviews legal and policy considerations relating to the ownership, control and utilisation of water as a resource in the Philippines and the city of Baguio. Prompted by the threat of over-extraction of Baguio's water to the sustainability of the city, the research team thought it wise to review the legal instruments and government policies that have influenced water consumption in the city. The objective was to identify possible legal and policy-based solutions to some of the problems related to water security. The section ends with some recommendations for improving water-use laws and policies in the city.

5.1.1 Ownership of water and water rights

By constitutional and statutory mandate all waters within the territorial borders of the Philippines and regardless of source are understood to be owned by the Philippine state. This unequivocal claim is expressed in Section 2, Article XII of the 1987 Philippine Constitution which declares that '[A]ll lands of the public domain, waters […] and other natural resources are owned by the State' (Republic of the Philippines, 1987a). The same pronouncement is also found under Presidential Decree (PD) No. 1067 otherwise known as 'The Water Code of the Philippines' (Republic of the Philippines, 1976). Under this statute, the government under Article 3 declares that '[A]ll waters belong to the State' (ibid). PD 1067 even went further as to declare that notwithstanding how long one has had in his/her actual possession the source of the water, this can never translate into private ownership. Article 3 of PD 1067 further provides, '[A]ll waters that belong to the State cannot be the subject of acquisitive prescription' (ibid).

Compare this to the case of public lands where despite the constitutional provision claiming state ownership of all lands, the law nonetheless allows the transformation of this public property to private property by virtue of extended possession. But this principle does not apply to water. PD 1067 even asserts government ownership of waters located on private lands. The only water that the state allows individuals to have 'exclusive control' over and right of disposal are those waters that are already 'capture[d] and collect[ed] […] by means of cisterns, tanks or pools' (Article 7, PD 1067). Notice, however, that the law uses the word 'control' and not ownership. This goes to show how jealously the state guards its assumed title over water, attributed to the long-standing Regalian doctrine – a principle which establishes the foundation of the state's title over all resources within the confines of its territory. Aside from this however, the water code does point to the scarcity of water supply as well as the importance of water in 'national development' for protecting this resource against private ownership.

The government does, however, permit individual citizens to use and appropriate these waters but only with the state's imprimatur although, the Water Code requires that a water right must first be granted by the government with a water permit (Article 13, PD 1067). There are very limited instances when water rights may be exercised without a water permit, for example for domestic purposes such as washing or bathing.

The government agency that is tasked with protecting state interests in relation to water is the National Water Resources Council (NWRC). Under Article 85, PD 1067, the NWRC is empowered to regulate the 'appropriation, utilisation, exploitation, development, control, conservation, or protection of water resources.' The NWRC was created in 1974 (Republic of the Philippines, 1974) and later renamed the National Water Resources Board (NWRB) (Republic of the Philippines, 1987b).

In 1973, the government passed Presidential Decree (PD) No. 198 which created Local Water Districts (Republic of the Philippines, 1973). This law centralises the right to capture and distribute waters to the local water district, to the discrimination of all other entities or persons. Section 5, Chapter II of PD 198 grants local water districts the right, among others, to 'acquire, improve, maintain and operate water supply and distribution systems for domestic, industrial, municipal and agricultural uses for residents and lands' (ibid). PD 198 also empowers water districts to:

> *Prohibit any person, firm or corporation from vending, selling, or otherwise disposing of water for public purposes within the service area of the district where district facilities are available to provide such service, or fix terms and conditions by permit for such sale or disposition of water.*

The water district thus is the sole entity with the rights to distribute water for a fee, unless of course the water district allows other entities to perform similar functions within its service area. In the case of the City of Baguio, the Baguio Water District (BWD) is tasked to perform this function, although approximately 25 per cent of the city's population remains unconnected to the BWD water supply (Baguio City Council, 2007).

5.1.2 Water regulations in Baguio City

BWD has been providing water to the residents of Baguio City for three decades now. Supported by the Local Government Code of 1991 (Republic of the Philippines, 1991), in 2007 the city council passed Baguio City Ordinance No. 13, Series of 2007, 19 February 2007, known as the Baguio City Water Code (Baguio City Council, 2007). The ordinance aims to provide the 'legal and policy framework for a holistic management of the water resource and pertinent facilities in the city'. It has instituted multifarious regulatory and verification mechanisms over water extractors, distributors and suppliers. For instance, aside from requiring water permits from the national government, the city likewise obliges water extractors, distributors and suppliers to secure City Water Permits before undergoing any activity relative to water resources within the city limits. Section 17 of the ordinance (ibid) provides that:

> *City water permit(s) may be secured for any of the following purposes:*
>
> a) *To excavate/dig/drill – to be secured from the City Building Official on project/term basis.*
>
> b) *To build water facilities such as intake structure, storage, treatment, transmission and distribution – to be secured from the City Building Official on project/term basis.*
>
> c) *To operate and maintain water supply systems including sourcing, transmission/distribution, storing and treatment, wastewater system including collection, treatment and disposal; other related facilities – to be secured annually from the City Treasury Office.*
>
> d) *To distribute or sell water for drinking and other domestic purposes – to be secured annually from the City Treasury Office.*
>
> e) *To recycle or re-use water for drinking and other domestic uses – to be secured annually from the City Health Services Office; for other uses – to be secured from the City Environment and Parks Management Office.*

However, in Section 5, the permit to 'allow a proponent to operate and maintain the entire water supply system' is the water supply system operation permit. This seems to refer to a water supplier who provides water to the end-user using permanent pipelines (as BWD does)[20] as opposed to a water supplier who merely brings water to the end-user using a water tanker.

Aside from the city water permit, there are other documents that the Baguio City Water Code requires depending on the type of activity. To extract, source and/or drill for water, Section 19 of the ordinance requires clearance from BWD that the extracted water will be used for purposes other than domestic use or if the extraction is within 100 meters of BWD's water source regardless of the use of the extracted water (Section 18). Otherwise a clearance from the City Water Resources Board (CWRB) will suffice (Section 19). The CWRB is a body created under the ordinance to perform functions related to the registration and/or accreditation of individuals engaged in water-related activities.

Beside the clearance from CWRB or BWD, water extractors must submit a 'certification by well driller' stating the name of the owner and location together with specific characteristics of the instrument being used to draw water as well as the details of the constructed well (Section 20). Thereafter, the owner of the well is supposed to secure a 'certification of annual verification of extraction' from the CWRB (Section 22).

For building water facilities, a clearance from the CWRB is also needed in addition to the city water permit (Section 25). For distributing water other than drinking water, the requirements include (a) an annual accreditation of water distributor which includes the presentation of a certificate of water quality from an accredited water examiner/s and an environmental monitoring certificate from the City Environment and Parks Management Office, Baguio City (CEPMO) (Section 23) and (b) clearance from the CWRB (Section 25). For distributors of drinking water, the requirements are the same except that instead of submitting an environmental monitoring certificate, a 'certificate of potability of drinking water' is required instead. This is issued by the Local Drinking Water Quality Monitoring Committee (LDWQMC). Table 19 summarises the requirements needed to secure water permits by type of applicant.

There are also mechanisms established by the city government of Baguio to maximise capture of the vast quantity of rainwater that falls in the city during the rainy season. As early as 1997, the city council passed Resolution 344 which states that the 'City Government could install rainwater storage and utilisation systems in big buildings like the City Hall and Justice Hall and other residential buildings' (Baguio City Council, 1997). In addition, in 2011 the city council also issued Resolution 210 which endorses the establishment of 'Rainwater Harvesting Facilities in public schools and *barangays* in the City of Baguio' (Baguio City Council, 2011) Technically, however, these resolutions are only recommendations and not required by law.

A stronger provision with regard to rainwater harvesting is found in the Baguio City Water Code. Under No. 6.1., Section 14 of the ordinance, the city government requires that 'all new buildings shall include in its design adequate provision for rain water capture for purposes of flushing, watering of plants and cleaning'. Although a commendable requirement, its implementation is another matter.

20 For example, JP Menecio Water Distribution and Delivery in Irisan, Baguio City.

Table 19. Table of documentary requirements for water permits

Type of applicant	Documentary requirements	Issuing office
Water extractor or driller for domestic use	City water permit	City building official
	CWRB clearance	CWRB
	BWD clearance, if extraction is within 100 metres of BWD water source	BWD
	Certification of well driller	Accredited well driller
	Annual verification of extraction	CWRB
Water extractor or driller for other use(s)	Water permit	NWRB
	City water permit	City building official
	BWD clearance regardless of location of extraction	BWD
	Certification of well driller	Accredited well driller
	Annual verification of extraction	CWRB
Distributor of drinking water	Water permit	NWRB
	City water permit	City treasurer's office
	CWRB clearance	CWRB
	Annual accreditation as water distributor Certificate of water quality Certificate of potability	CWRB Accredited water examiner LDWQMC
Distributor of water other than drinking water	Water Permit	NWRB
	City Water Permit	City treasurer's office
	CWRB Clearance	CWRB
	Annual accreditation as water distributor Certificate of water quality Environmental monitoring certificate	CWRB Accredited water examiner CEPMO

5.1.3 Recommendations for improving water-use laws and policies

It appears that the city government of Baguio has put in place legislation for establishing systems to maximise and develop water sources. Legislation, however, does not by itself achieve this purpose as the test of its success is measured by its implementation. The following points are raised to prompt honest discussion among policymakers and implementers:

1. Although the Baguio City Water Code presents a comprehensive and considered piece of legislation, there are some issues. For example, the requirement for a city water permit appears to be a revenue-generating edict, as the city treasurer's office is empowered to issue water permits to water distributors. This also raises questions related to the expertise of this office regarding water and water-related issues. Perhaps it would be more beneficial if the Baguio City Water Code focuses only on the matter of **maximising and protecting water sources** and limits the city government's functions on regulation without including a financial burden to those seeking city water permits.

2. With regard to the resolutions on **rainwater harvesting**, it would be highly commendable if the recommendations to build rainwater impoundments on government offices were enacted. This would set an example for other establishments to follow.
3. The Baguio City Water Code likewise requires that new buildings include **rainwater catchments**. For better monitoring, it would be more efficient if this monitoring for this requirement was done before the city government issues building permits and/or occupancy permits. At the moment, checking whether rainwater catchment facilities are obviously missing is only apparent once the building work is completed.

It must be noted at this point that the BWD itself has a list of recommendations for addressing water security issues in the city (see Table B6 in Appendix 1). Both sets of recommendations and the suggested technology-based intervention below could help to build institutional resilience, consistent with the framework presented in the earlier parts of the paper.

5.1.4 Technology-based recommendations

This section discusses technology-based intervention that has the potential of contributing to urban resilience among residents in Baguio City.

In late 2014, a group of University of the Philippines Baguio professors completed a study entitled 'Rainwater Purification System and a Proposal for a Rainwater Harvesting System.' The study was prompted by the observation that while Baguio City receives the most amount of rainfall compared to other places in the Philippines, it also experiences water shortages as evidenced by the BWD's scheduled water distribution. This group of UP professors began a study that involved designing a system to harvest and purify rainwater. In December 2014, the group submitted their report and announced that they had succeeded in building 'a fully functional purification system using porous mullite ceramic as raw material for the filter' (Abucay *et al*., 2014: 1).

The purification system consists of two filters. According to the researchers, the first filter has proved effective in filtering 'most of the unwanted particulates even before water is fed into the second filter' (Abucay *et al*., 2014: 3). Test results showed that impurities were removed from water samples. Ammonia concentration was reduced from 0.198ppm to a non-detectable limit; nitrates were lowered to 1.285ppm from 1.481ppm and phosphorous was reduced by 1.1ppm after stage-two filtration (Abucay *et al*., 2014: 4). While bacteria and fungi cannot be eradicated by these water filters, they can be reduced significantly. The application of an antibacterial coating on the system would address the problem of bacteria.

Compared to commercially available filters, the porous mullite ceramic filter used in the study has pores whose sizes are in the submicron range. Most significantly, the researchers claim that **their filter can make water potable**. In fact, they also report that 'these ceramic filters have been deployed in Tacloban immediately after Typhoon Haiyan' (Abucay *et al*., 2014: 4). Considering that locally available materials were used to construct the filter, the researchers say that using the filter is cost-effective. A household unit costs 5,000 Philippines pesos (around US$110). Researchers claim the filters can last for life just as long as they are used with care and cleaned every six months.

As for their rainwater harvesting system, it basically involves collecting water from roofs and gutters and diverting the water to a tank, which is then connected to the purification filter. Water that passes through the filter reaches the household through an ordinary tap. Technology-based interventions such as this could be adopted by Baguio City households to enhance their resilience vis-à-vis water security.

6 Synthesis and analysis of findings

This section attempts to synthesise the findings of the study. The United Nations Inter-Agency Mechanism on All Freshwater Related Issues, Including Sanitation (UNWATER) (2014) defines **water security** as:

> *[T]he capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters and for preserving ecosystems in a climate of peace and political stability.*

Among the many agencies that operate in the city of Baguio, the Baguio Water District has the clear mandate 'to provide adequate and potable water at affordable rates to all consumers' (BWD, undated; Commission on Audit, 2012). Stated differently, the BWD's mandate directly concerns water security. The agency may be seen as having the mandate to ensure that the population of Baguio City – or its consuming public – has the capacity to sustainably and equitably access adequate quantities of potable water. The findings of this working paper highlight at least seven points vis-à-vis water security in the city and the role and performance of the BWD.

6.1 Adequacy of water supply: a question of quantity or quality?

The adequacy of Baguio's water seems to be a matter of perspective. At least two competing perspectives are emerging from the analysis of the data. On the one hand, there is what may be termed as a 'BWD-centered' perspective in support of the agency fulfilling its mandate of ensuring the provision of safe and affordable water to all Baguio residents. As one would expect, the BWD-centered perspective is supported by the BWD's official data.

On the other hand, there is the rival 'non-BWD-centered' perspective that pays more attention to how Baguio residents and other stakeholders are actually responding to the issue of water security in the city. The non-BWD-centered perspective draws support from a cursory reading of the findings of this study's survey. Unlike the former, this perspective is more open to exploring alternative, non-BWD-centered initiatives to ensure water security in the city.

Official BWD data (Royeca, 2015a) show that water supply lags behind water demand. Note here that the data refer to water that the BWD produces and distributes to consumers. The BWD-centered perspective basically argues that water supply is inadequate – ie that BWD-supplied water is inadequate to meet the demands of all Baguio residents.

Meanwhile, seen from the non-BWD-centered perspective, the data on alternative sources of water and adaptive strategies – eg tapping non-BWD water sources, rainwater harvesting and storage, water recycling, and the formation of community water systems – including information indicating the proliferation of private deep wells, suggest that the water supply is not as inadequate or scarce as the BWD-centered position implies. A resident can get what he wants when he needs it, as stated in the survey results section. It is the supply of water that passes through the BWD's pipeline system that is inadequate. Survey data on the adequacy of BWD water in the assessment of its consumers reveal that 61.5 per cent of consumers say BWD water is either adequate or more than adequate. This indicates that more than 60 per cent of BWD connected households are **water secure**, despite complaints about BWD's water and service. Moreover, the survey also revealed that 56.6 per cent of non-BWD consumers are not interested in having a BWD connection, suggesting that they are satisfied with their non-BWD sources of water. The non-BWD-centered perspective thus argues that Baguio residents in general are water secure.

The BWD-centered perspective may be faulted for assuming that the situation of BWD-connected consumers may be taken to represent the situation of all Baguio residents. However, the non-BWD-centered perspective may also be faulted for ignoring the fact that water security does not only mean access to adequate quantities of water but to adequate quantities of **acceptable quality** water. As this working paper has shown, test results reveal that in general the quality of both BWD and non-BWD water, particularly water from refilling stations, does not meet national drinking standards. In short, Baguio's supply of acceptable quality water appears inadequate.

6.2 Are adaptive behaviours adopted in Baguio also resilient?

Baguio residents have adopted adaptive behaviours such as water harvesting, water recycling, establishing community water systems, and scheduling activities around the BWD's water distribution schedule. This observation bodes well for Baguio City. Indeed, such behaviour needs to be promoted further in the city. But this also suggests that water security in Baguio City is not only a function of the (physical) availability of its water supply. It may also be a function of (psychological) expectations about the provision of water as an urban service. The data suggest that Baguio residents are satisfied with their non-BWD water sources and BWD's scheduled water distribution.

Porio's study of '300 urban poor households living in 14 riverine communities of three flood prone areas of Metro Manila' (2011: 425) provides an interesting comparison to this study of Baguio households. In contrast to Porio's low-lying flood prone areas, Baguio has a mountainous topography, prone to landslides and erosion. The city's historical lack of a constant water service for most households has made households adopt a 'water-scarce lifestyle' much as the households of the riverine communities in Porio's study adopted a 'water-based lifestyle' – eg increasing the number of floors of their homes; building makeshift bridges [and] building Styrofoam boats for transport' (Porio 2011: 425).

Baguio residents have adopted adaptive behaviours consistent with a water-scarce lifestyle. But does this equate to resilience? As argued in the initial parts of this working paper, resilience ought to be seen as 'bouncing forward' instead of 'bouncing back.' It appears that while Baguio residents have adopted adaptive strategies to meet their water-related and sanitation needs and somehow find their situation to be acceptable, resilience-related initiatives look more like efforts aimed at 'getting by' instead of finding effective ways to thrive and promote human development. Efforts have mostly been directed at obtaining **more water** instead of **more potable water**. While water seems accessible to many, no one seems to be paying attention to the issue of water access for the poor and vulnerable. Moreover, it appears that most efforts are aimed at social or human resilience, with very little attention given to ecological resilience. Baguio residents' adaptive behaviours seem to fail to satisfy the requirements of resilience as 'bouncing forward.'

6.3 Can the Baguio Water District fulfil its mandate?

Thus far, BWD has not successfully fulfilled its mandate. Adequate quantities of potable or safe drinking water have yet to be made available by the BWD to all water consumers in the city. Data from the BWD (Royeca, 2015a) show that its water supply actually lags behind water demand in the city; not all Baguio households are connected to its pipe system; and water is not available to all its consumers on a constant basis. Reiterating a point raised earlier, results of water-quality tests conducted in 2013 by the Baguio Health Department on 25 water samples from BWD tanks, deep wells and taps found that 56 per cent of the total BWD sample failed the country's national standards for drinking water. In short, BWD cannot yet ensure delivery of safe drinking water to its consumers.

Some *barangays* in the city have their own community water systems and are not served by the BWD. Some residents still mostly rely on natural, non-BWD water sources such as springs and creeks, while the majority now depend on commercial non-BWD sources like refilling water stations for most of their drinking water needs and water delivery services for most of their other water-related needs.

6.4 Commercial versus BWD water supplies: what are the pros and cons?

The proliferation of commercial water-refilling stations and water delivery services point to the emergence of commercial firms as providers of vital services that governmental or quasi-governmental agencies are unable to render or render well. The establishment of water-refilling stations in most *barangays* of the city has undoubtedly brought about greater access to potable water and greater convenience for Baguio residents who used to regularly boil BWD water. Competition among the refilling stations has actually resulted in the lowering of the price of drinking water purchased from these stations. The relatively new set-up has allowed households to save money on liquefied petroleum gas (LPG) commonly used for cooking; to use time that would otherwise be spent boiling water for some other (possibly more meaningful) activities; and to ensure (presumably) the quality of their drinking water.

The availability of BWD and a variety of non-BWD sources of water appears to bode well for urban resilience. The reliance of some residents on natural water sources suggests that Baguio residents can probably withstand disruptions in the water supply in the city. It must be noted, however, that the authors do not have access to figures on how many people can be exclusively served by natural water sources.

Have the establishment of water-refilling stations in most Baguio *barangays* and the proliferation of commercial water delivery services actually improved access to water for **all** residents, including those belonging to poor households? Physical availability is one thing; financial accessibility – having the ability to purchase commercially available water – is another. Further research is needed on the affordability of water from refilling stations, especially from the perspective of poor households. The data in this study nonetheless suggest that a segment of Baguio's poor households can afford to buy water from refilling stations.

The current situation in Baguio City – where non-BWD and BWD sources of water co-exist – indicates the availability and accessibility of water in the city. But undoubtedly, having constant and easy access to drinking water from one's own tap is certainly much more convenient than purchasing water from a nearby refilling station, and a form of convenience normally associated with modern conceptions or expectations of urban living.

To an extent, the proliferation of water-refilling stations, water delivery systems and the use of natural water sources have allowed the BWD to pay less attention to fulfilling its mandate. But much more importantly, this development also highlights that the current arrangements could result in a future where no agency assumes crucial responsibility for or is qualified, knowledgeable or capable of ensuring water security. More will be said regarding this matter after the next point.

6.5 Is the current water situation in Baguio City sustainable?

The BWD has a limited water security mandate. While the agency is tasked with ensuring an adequate and affordable supply of potable water to Baguio consumers, in addition to safeguarding watersheds and forest reserves, it does not have the mandate to regulate the construction of deep wells in the city. For one thing, the BWD does not have the power to give or deny permits to potential deep-well builders. Nor does it have the expertise or authority to ensure the quality of all types of water that reach households and are used by Baguio consumers.

This highlights the fact that the BWD's mandate only covers about half (or less) of what constitutes the UNWATER's understanding of water security. The BWD does not specifically have as part of its mandate the task of 'ensuring protection against water-borne pollution and water-related disasters'. And while the BWD assumes responsibility for the protection of watersheds, as a water distribution agency, it obviously does not have the mandate to preserve **all** ecosystems in the city.

This observation underscores the point that Baguio City actually needs a more coordinated, integrated and working regulatory framework to check over-extraction of water resources. A 'laissez-faire' scenario where residents may rely on a variety of water sources – eg natural non-BWD sources, commercial non-BWD sources and BWD sources – may probably bode well for social or human resilience inasmuch as the water needs of individuals may be addressed and satisfied in a number of ways. But unfettered competition for scarce water resources may not bode well for ecological resilience. When individuals are only concerned about satisfying their own needs and ensuring their own survival, a 'tragedy of the commons' scenario may ensue. Currently, such a laissez-faire arrangement is likely already the case in Baguio and the over-extraction of water resources may be imminent. When over-extraction of water prevents underground water sources from recharging, the result would not only be failure to achieve ecological resilience but the breakdown of human resilience as well.

This study underscores the need for regulation of the extraction of water as a public resource whose over-extraction is likely to prove unsustainable and detrimental for the city in the long run. Incidentally, the incumbent mayor of Baguio City seems to share the sentiment against over-extraction of water resources resulting from the construction of deep wells. He was reported as saying, 'the city faces problems with unaccounted deep wells and settlements along watersheds'. The mayor concluded that 'Baguio City still lacks the ability to ensure efficient and sustained delivery of basic water services' (Baguio Midland Courier, 26 April 2015, 1 and 42).[21]

Apart from the proliferation of water-related business in the city, some government bodies or offices in Baguio appear to have adopted a mindset of focusing on revenue generation, as observed in the section on the legal and policy dimensions of water use. There are undoubtedly compelling and reasonable grounds for imposing fees for the issuance of water permits and generating revenue for government may be one of them. But this seems short sighted, especially when considering that such revenue-generating practices may significantly contribute to the over-extraction of water resources and the failure to uphold ecological resilience.

21 There is also the issue of waste-water management in Baguio City. The attention to domestic water must necessarily include waste water as the latter is a natural result of the use of water for domestic purposes.

6.6 Is waste-water management in Baguio City sustainable?

The Baguio City government has, for the most part, paid little attention to waste-water management. The household survey conducted for this study found that only 22.2 per cent of households are connected to the city's sewerage system. The issues of waste management and the construction of a more extensive sewerage system are important matters to consider especially when one is interested in avoiding the contamination of water sources in the city, in addition to finding ways to maximise the use of rainwater or water that leaves households. It bears noting here that waste management is not part of the mandate of the BWD.

This observation raises the need for Baguio City to adopt a more holistic and integrated institutional framework for addressing its water needs and other ecology-related matters. Having a number of uncoordinated agencies, each with their 'compartmentalised' mandates, areas of expertise and jurisdictions, will not meet the challenges of a growing population and dwindling water resources, in addition to the threats of climate change. The city particularly needs to address the threat of over-extraction of water resources. A holistic and integrated regulatory framework should take advantage of scientific knowledge of water and the water cycle so as to maximise the benefits that can be derived from water and minimise water-related problems (eg disease and disasters). In relation to Baguio City, the regulatory framework should not only cover the extraction, treatment and distribution of water to residents; it should also cover the recovery, treatment and recycling of waste water that leaves the households of residents. More importantly, the framework should not only be limited to water usage. Since water resources are only a part of the ecological system, the regulatory framework needs a broader ecology-centered focus. Urban development has partly been blamed for Baguio's water situation. This suggests that land-use planning should also be covered by the city's regulatory framework.

6.7 Urban resilience requires institutional resilience

In Baguio City, there is a need to promote institutional resilience. The city also needs to cultivate a culture of rule implementation and compliance. Thus far, the city has been successful in making rules and policies: the problem has been implementation. The non-enforcement or rules is a serious problem that continues to plague Philippine society. No one knows exactly how this can be addressed. What is clear is that addressing the issue involves adopting an appropriate mindset. Such a mindset must be guided by the notions of human resilience, ecological resilience and institutional resilience.

In addition, since institutional resilience is associated with the adoption of technology-based interventions, the findings of this study reiterate the need for a scientifically informed approach to policymaking in the city. As for specific forms of technology-based interventions or activities, the authors strongly advise the widespread adoption of rainwater harvesting practices (with the caveat that the dangers of eg water-borne diseases should be taken into account and avoided) and the development of water purification and filtration systems for Baguio households. The authors also call for the expansion of the city's sewerage system to maximise the use of Baguio's water. Recent initiatives of the city government of Baguio aimed at drafting and adopting a water code and an environmental code appear to be steps in the right direction.

7 Concluding remarks

This working paper offers updated data on water security in Baguio City. Its reliance on city-level data, in the form of survey results, may be seen as a noteworthy contribution to the study of urban resilience and water security in Baguio City. It argues that water security ought to be studied using a mix of data-gathering methods in light of both the physical and social aspects of the subject matter. The authors believe the paper has succeeded in providing substantial information about water security in Baguio City. It draws attention to the threat of the over-extraction of water and the need for the city to pay greater attention to ecological and institutional resilience, issues that need to be addressed if Baguio City wants to develop sustainably. While resilient practices have been adopted, the over-extraction of a public good demands effective regulation and the adoption of innovative technologies, policies and collective arrangements.

References

Abucay, J, Agulo, I and Pascua, C (2014) Rainwater purification system and a proposal for a rainwater harvesting system. A terminal report submitted to the Cordillera Studies Center.

ACCCRN (2013) What is Urban Climate Change Resilience? Asian Cities Climate Change Resilience Network. See: https://sites.google.com/site/nguyenninhhaigialai/quy-hoach-dho-thi/sustainable-urban-development/whatisurbanclimatechangeresilience

Baguio City Council (undated) Comprehensive Land Use Plan (CLUP) of Baguio City, 2012–2020, Vol. 1.

Baguio City Council (1997) Encouraging the installation of rainwater storage and utilization systems in the city of Baguio with the city government piloting the project in big government buildings like the city hall and the justice hall and other structures as one of its local environmental initiatives to alleviate the recurrent water problem: Resolution No. 344, Series of 1997, 29 September 1997.

Baguio City Council (2007) Water code of the city of Baguio: Baguio City Ordinance No. 13, Series of 2007, 19 February 2007.

Baguio City Council (2011) Endorsing the rainwater harvesting project for implementation in public schools and barangays in the city of Baguio: Resolution No. 210, Series of 2011, 13 June 2011.

Baguio Health Department (2013) Logbook entries of the sanitation division.

Baguio Health Department (2014) Logbook entries of the sanitation division.

Baguio Water District (undated) Vision & mission statements and strategic goals. See: www.baguiowaterdistrict.gov.ph/transparency/about-us/profile/vision-mission-statements

Comanda, Z (14 June 2015) 14 barangays in Baguio prone to sinkholes. *Manila Bulletin*. See: www.mb.com.ph/14-barangays-in-baguio-prone-to-sinkholes

Commission on Audit (2012) Executive summary. See: http://tinyurl.com/coa-2012-baguio

Cruz, G *et al.* (1993) Urbanization in medium-sized towns in Third World countries: a comparative study of the Philippines, Thailand and Kenya: a report on Baguio City. Baguio City: Cordillera Studies Center, University of the Philippines Baguio.

Cruz, G and Calugan, M (1997) 'An assessment of the housing situation in Baguio City, Philippines. In Schneider, H and Vorlaufer, K (eds): *Employment and housing: central aspects of urbanization in secondary cities in cross-cultural perspective*. Avebury.

Department of Health (1976) The code on sanitation of the Philippines: Presidential Decree No. 856. Reprinted in 1998 with the support of UNICEF.

Dodman, D, Ayers, J and Huq, S (2009) Building resilience. In: *State of the world: into a warming world.* The WorldWatch Institute. See: www.worldwatch.org/node/5984

DSWD-CAR (2012) Number of identified poor households, city of Baguio, as of 31 December 2012. Department of Social Welfare and Development, Cordillera Administrative Region, National Household Targeting Unit, Republic of the Philippines.

Ebbinghausen, R (11 November 2013) Natural disasters threaten Philippine growth. *Deutsche Welle* website. See: www.dw.com/en/natural-disasters-threaten-philippine-growth/a-17219526

Estoque, R and Murayama, Y (2012) Examining the potential impact of land use/cover changes on the ecosystem services of Baguio City, the Philippines: a scenario-based analysis. *Applied Geography* 35: 316–326.

Estoque, R. and Murayama, Y (2013) City profile: Baguio. *Cities* 30: 240–251.

Fontanilla, GJ (30 June 2015) Water crisis looms in Baguio. *Sunstar* newspaper. See: www.sunstar.com.ph/baguio/local-news/2015/06/30/water-crisis-looms-baguio-416272.

Gonzales, M (2007) Integrated water management in Baguio City, Philippines. United Nations Economic and Social Commission for Asia and the Pacific. See: www.unescap.org/resources/integrated-water-management-baguio-city-philippines

ICLEI (2012) Glossary of key terms. Local Governments for Sustainability (ICLEI) See: http://resilient-cities.iclei.org/resilient-cities-hub-site/resilience-resource-point/glossary-of-key-terms/

Leyco, C (26 January 2015) PH's urban population density worsens – World Bank. *Manila Bulletin*. See: www.mb.com.ph/phs-urban-population-density-worsens-world-bank/#0sIbcDOOpi6j1JHf.99

Manahan, GV and Torres, EF (1989) Planning and development in a highland city: the case of Baguio, the Philippines. Quezon City: University of the Philippines.

Mason, L (2013) Seasonal water insecurity in urban Philippines: examining the role of gender, resources and context. PhD dissertation, Washington University.

Nolasco-Javier, D, Kumar, L and Tengonciang, AM (2015) Rapid appraisal of rainfall threshold and selected landslides in Baguio, Philippines. *Natural Hazards,* 78 (3): 1587–1607.

Nolasco-Javier, D, Deocariza, M and Aquitania, V (2014) Climate change, vulnerability assessment and adaptation scenarios and strategies for Baguio City, Benguet Province, Philippines – final report (revised). Report prepared for the International Council for Local Environmental Initiatives – Local Governments for Sustainability Southeast Asia Secretariat.

Opiña, R (1 September 2014) When development becomes a bane. *Baguio Midland Courier*. See http://baguiomidlandcourier.com.ph/baguio14_article.asp?mode=baguio_day2014/supplements/opina.txt

Palangchao, HF (28 June 2015) Now at 17,000 m^3 per day water supply shortage at 27,000 cu.m by 2022. *Baguio Midland Courier*. See: http://baguiomidlandcourier.com.ph/front.asp?mode=%20archives/2015/june/6-28-2015/front1.txt

Philippine Information Agency (10 February 2015) Study shows Baguio's vulnerability vs climate change, but offers opportunity in risks. See: http://tinyurl.com/pia-10-february-2015

Philippine Statistics Authority (2010) 2010 census of population and housing: national capital region. See: http://preview.tinyurl.com/psa-2010-census-housing

Philippine Statistics Authority (2010) Census and Housing Population: Population and Annual Growth Rates for The Philippines and Its Regions, Provinces and Highly Urbanized Cities.

PNSDW (2007) Administrative Order No. 2007–0012, Office of the Secretary, Department of Health, Republic of the Philippines. Philippine National Standards for Drinking Water 2007*,* dated 9 March 2007.

Porio, E (2011) Vulnerability, adaptation and resilience to floods and climate change-related risks among marginal, riverine communities in Metro Manila. *Asian Journal of Social Science* 39: 425–445.

Republic of the Philippines (1973) Provincial Water Utilities Act of 1973. Presidential Decree No. 198.

Republic of the Philippines (1974) Creating a national water resources council, reconstituting its membership, vesting the same with powers to coordinate and integrate water resources development and providing funds therefor. Presidential Decree No. 424.

Republic of the Philippines (1976) The water code of the Philippines. Presidential Decree No. 1067:

Republic of the Philippines (1987a) Philippine constitution. See: www.gov.ph/constitutions

Republic of the Philippines (1987b) Reorganizing the Department of Public Works and Highways, redefining its powers and functions and for other purposes. Executive Order No. 124-A, amending Executive Order 124.

Republic of the Philippines (1991) The Local Government Code of the Philippines. Republic Act No. 7160.

Rivera, D (29 May 2014) PHL economy slows down in first quarter due to natural disasters. *GMA News Online.* See: http://tinyurl.com/rivera-29-may-2014

Rockefeller Foundation (2009) Building climate change resilience. Rockefeller Foundation White Paper. See: http://acccrn.net/sites/default/files/publication/attach/10_RF_WhitePaper_Resilience.pdf

Royeca, S (2015a) Official Baguio Water District documents sent to lead author, 2 February 2015.

Royeca, S (2015b) Baguio City Water Supply Situationer, June 2015.

Sunstar (4 March 2013) PopCom: migration threatens Baguio. *SunStar* website. See http://archive.sunstar.com.ph/baguio/local-news/2013/03/04/popcom-migration-threatens-baguio-271261.

Sunstar (5 April 2013) Baguio facing water crisis. *Sunstar* newspaper. See: www.sunstar.com.ph/baguio/local-news/2013/04/05/baguio-facing-water-crisis-276046

UNESCAP (2015) Overview of natural disasters and their impacts in Asia and the Pacific, 1970–2014. United Nations Economic and Social Commission for Asia and the Pacific. See: http://tinyurl.com/unescap-2015-natural-disasters

UNICEF (undated) Access to water and sanitation: a few definitions. See: www.unicef.org/wcaro/french/4493_4620.html.

UNWATER (2014) Water Security. United Nations Inter-Agency Mechanism on All Freshwater Related Issues, Including Sanitation. See: www.unwater.org/topics/water-security/en

WHO (undated) Water sanitation and health. World Health Organization. See: www.who.int/water_sanitation_health/mdg1/en

World Bank (2014) Philippine economic update: pursuing inclusive growth through sustainable reconstruction and job creation. See: http://tinyurl.com/wb-philippines-update-2014

Wutich, A (2009) Estimating household water use: a comparison of diary, prompted recall and free recall methods. *Field Methods*, 21: 49–68. See: http://fmx.sagepub.com/content/21/1/49.abstract

WWF-Philippines (2013) Business risk assessment and the management of climate change impacts. World Wide Fund for Nature (WWF) Philippines-BPI Foundation, Inc. See: http://tinyurl.com/wwf-ph-2015-business-risk

Appendix 1. Updated BWD data: General Manager Salvador Royeca's June 2015 Baguio City Water Supply Situationer

Table B1. Barangays served by Baguio Water District

*Barangays** in Baguio City	129
Barangays served by BWD	122
Barangays not served by BWD	7

Source: Royeca (2015b). *Number of *barangays* includes Bagong Lipunan Barangay (market area) because there are existing BWD facilities within it.

Table B2. Barangays not served by the BWD

***Barangays* supplied by own water system** ■ Kias ■ Fort Del Pilar
***Barangays* supplied by Camp John Hay** ■ Scout Barrio
***Barangays* supplied by springs and private water delivery trucks** ■ Apugan-Loakan ■ Atok Trail ■ Lucnab ■ Happy Hollow

Source: Royeca (2015b).

Table B3. BWD water facilities

Pumping stations (deep wells and booster pumps)	65
Deep wells	57
Springs	5
Pipelines 50–100mm diameter 150–300mm diameter 400–500mm diameter	 122.8km 46.9km 11.5km

Source: Royeca (2015b).

Table B4. Total active connections

Year	No. of connections
2004	26,828
2005	27,346
2006	28,449
2007	28,909
2008	30,557
2009	32,022
2010	33,532
2011	34,424
2012	35,491
2013	36,786
2014	37,599

Source: Royeca (2015b).

Table B5. BWD water service connections (as of May 2015)

Classification	No. of connections	%
Residential	34,054	88.41
Commercial	4,144	10.76
Government	311	0.81
Wholesale	3	0.01
Metered deep well	6	0.01
TOTAL	**38,518**	**100**

Source: Royeca (2015b). Percentage computed by researchers.

Table B6: Initiatives to address challenges

Initiatives to address increasing demand
■ Continuous exploration for new sources
■ Well rehabilitation – eg Lucban Elementary School drilling (ongoing)
Non-revenue water-reduction initiatives
■ Adoption of district metering area (DMA) to analyse systems' losses on a smaller scale or on a per-subsystem basis
■ Flow and pressure management
■ Intensified leak detection and repair
■ Elimination of illegal connections
■ Extensive water meter calibration and replacement of defective water meters
■ Standardisation of operations
Forest/watershed management initiatives
■ Promote/participate in tree planting activities
■ Assist in firefighting during forest fires
■ Excavation of ditches in watersheds to maximise groundwater infiltration
■ Fencing projects in watersheds
Water supply development programmes
■ Well drilling and well rehabilitation
■ Non-revenue water management
■ Rainwater harvesting facilities
■ Bulk water supply

Source**:** Royeca (2015b).

Appendix 2. The water diary method

Wutich (2009) endorsed the water diary method as a more reliable method for estimating household water use compared to free recall and prompted recall, particularly for households that lack water meters. Unlike free recall and prompted recall, the water diary method is more likely to capture food preparation, hygiene and household cleaning tasks in households without water meters. It is primarily for this reason that the water diary method was employed in this study. Considering that a significant percentage of Baguio residents – around 30 per cent according to the survey data – are not directly connected to the Baguio Water District's pipe system, adopting water diary method seemed appropriate for the study.

Tables C2 and C3 show the results of using the water diary method. Participants were from households with either no direct BWD connection or which shared a BWD connection. The most useful information obtained from the water diary method is that the per capita daily amount of water used by non-metered, non-BWD connected residents can be as low as 26.04 litres, far below the proposed/prescribed 150-litre minimum per capita daily water requirement, or as high as 124.17 litres. Compared with the 160 litres cited in the survey results as the average amount of water needed for cooking, bathing, laundry and cleaning, the data suggest that some residents can survive with considerably less than the prescribed water requirement.

Using the water diary method

A standard diary form was developed for the study. It was intended to capture water use for a 14-day period. Participants were invited to record their household water use for 14 days from late March to early April 2015. The water diary sought to (a) identify the sources and types of water used by the participants; (b) identify the activities for which water was used; and (c) measure the amounts of water used for such activities.

To measure how much water was used for specific activities, each participant was provided with plastic drinking containers, a water dipper, a pail and a 105 litre plastic water container. Participants were asked to record their use of water in terms of the number of pails, dippers, or plastic containers used for specific activities.

As to the sources and types of water, the water diary classified these as follows: (a) own BWD connection, ie BWD water using one's direct and private connection (b) shared BWD water, ie BWD water accessed via somebody else's private connection (c) water via delivery truck (d) bottled water eg five-gallon bottles usually delivered by local water-refilling stations or bought at grocery stores (e) water from a protected spring (f) water from an unprotected spring (g) harvested or collected water, usually rainwater (g) water from other sources eg nearby creek, private deep well etc.

Participants must be Baguio residents, preferably without a private BWD connection. Participants were asked to faithfully complete their diaries. Most participants were non-academic employees of the University of the Philippines Baguio, including contractual workers. As co-workers of the authors, most of the participants were reliable. Care was taken to ensure that participants were diverse, particularly in terms of their water sources.

The completed diaries were collected by a member of the research team. The information contained in the diaries was then summarised. It must be noted that the amount of water used was translated to litres from the original number of pails, dippers, or plastic drinking containers. Below is the conversion table:

Table C1. Conversion table for water containers

1 plastic water drum	8 pails	105.000 litres
1 pail	11 water dippers	13.125 litres
1 water dipper	6 plastic drinking containers	1.193 litres
1 plastic drinking container		0.198 litres

A total of 20 participants were given water diaries. Of the 20, 16 water diaries were returned to the study team. Of the 16, 12 diaries captured water use in non-BWD households (without a direct private BWD connection). Of these 12, five mainly relied on non-BWD sources (eg water that was delivered, bottled or from springs) while seven ‘shared’ water with a neighbour or landlord with a private BWD connection.

Table C2, particularly the columns on the right, shows the water use of the participants according to activity. From the table, some observations can be made. First of all, drinking water, beverage preparation and cooking or food preparation constitute a small percentage of the participants’ water use. Secondly, personal hygiene and indoor sanitation activities require considerable amounts of water for most participants. Thirdly, water recycling is practiced by most of the participants’ households.

Table C2. Water sources based on water diaries

Respondent Identifier	HH size	HH type	Per capita daily water use[a] (litres)	14-day HH water usage including recycled water (litres)	Percentage of usage according to water source							
					Shared BWD Connection	Delivery truck	Bottled water[b]	Protected spring	Unprotected spring	Harvested water	Recycled water	Deep well
Non-BWD 01	1	Boarding house	58.31	816.28					94.47	5.53		
Non-BWD 02	4	Nuclear family	51.15	2,864.46		100						
Non-BWD 03	5	Nuclear family	66.04	4,622.50			0.91		75.34		23.75	
Non-BWD 04	1	Boarding house	75.02	1,050.25			0.13		58.4		41.47	
Non-BWD 05	4	Nuclear family	55.08	3,084.70		86.41	0.82				12.76	
BWD shared 01	1	Single individual household	98.74	1,382.42	86.06		0.64				13.29	
BWD shared 02	4	Nuclear family	109.4	7,657.96	92.11						7.88	
BWD shared 03	4	Nuclear family	50.16	2,809.22	100							
BWD shared 04	5	Nuclear family	69.4	4,857.66	94.84		1.64				3.51	
BWD shared 05	6	Nuclear family	26.04	2,187.11	97.92		2.08					
BWD shared 06	4	Nuclear family	124.17	6,953.64	31.51			2.32		0.76	22.89	42.52
BWD shared 07	5	Nuclear family	62.54	4,377.63	98.59		1.41					

a Includes used, harvested and recycled water

b Includes 5-gallon water from refilling station and bottled water usually bought at grocery stores.

Table C3. Water use based on water diaries

Respondent Identifier	HH size	HH type	Per capita daily water use[c] (litres)	14-day HH water usage incl. recycled water (litres)	% recycled water used in HH	14-day HH water usage minus recycled water (litres)	% for drinking & food preparation	% for personal hygiene	% for laundry	% for indoor sanitation[d]	% for other activities[e]
Non-BWD 01	1	Boarding house	58.31	816.28	0	816.28	5.53	70.35	1.61	22.51	0
Non-BWD 02	4	Nuclear family	51.15	2,864.46	0	2,864.46	4.61	36.28	38.49	12.83	7.79
Non-BWD 03	5	Nuclear family	66.04	4,622.50	23.75	3,524.799	2.98	40.66	27.8	27.55	1.01
Non-BWD 04	1	Boarding house	75.02	1,050.25	41.47	614.745	2.64	42.26	3.75	44.31	7.04
Non-BWD 05	4	Nuclear family	55.08	3,084.70	12.76	2,690.95	1.60	31.09	27.65	37.2	2.47
BWD shared 01	1	Single individual household	98.74	1,382.42	13.29	1,198.67	0.8	34.25	12.34	48.77	3.84
BWD shared 02	4	Nuclear family	109.4	7,657.96	7.9	7,054.21	2.99	26.96	34.62	31.72	3.71
BWD shared 03	4	Nuclear family	50.16	2,809.22	0	2,809.22	6.76	35.56	23.36	34.11	.21
BWD shared 04	5	Nuclear family	69.4	4,857.66	3.51	4,687.03	5.3	18.48	11.89	59.47	4.86
BWD shared 05	6	Nuclear family	26.04	2,187.11	0	2,187.11	3.75	34.36	36.61	22.67	2.62
BWD shared 06	4	Nuclear family	124.17	6,953.64	39.83	4,184.26	1.02	15.44	37.21	38.41	7.92
BWD shared 07	5	Nuclear Family	62.54	4,377.63	0	4,377.63	2.32	29.59	21.89	37.64	8.56

c Includes recycled water.
d Washing dishes, flushing the toilet, and other household cleaning tasks.
e Includes watering plants, washing vehicles, bathing pets, etc.

It is worth mentioning that the research team was divided on how to 'count' recycled water. One view was that the amount of recycled water used by households ought to be excluded from the total amount of water used when computing the percentage of water used according to source. If the interest is in the **actual amount or supply** of water that is available to households, excluding recycled water from the list of water sources seems justified.

The other view, meanwhile, maintains that recycled water ought to be computed as part of the denominator, especially when one considers that recycled water is mainly used for tasks that apparently are very important to households, eg flushing toilets. If the emphasis is on the **actual usage** of water, it seems right to consider recycled water as part of the denominator when computing percentages of water usage per activity. In any case, the tables provide data on recycled water as part of the denominator and as excluded from the denominator.

Appendix 3. Community and private water systems, water-refilling stations

This section describes in more detail non-BWD sources of domestic water in Baguio City. Data presented here were obtained through key informant interviews.[22] It contains concrete examples of non-BWD water distribution arrangements and supports the claim that Baguio residents, particularly those not connected to BWD, have adopted adaptive behaviours to deal with the water situation in Baguio City.

Community water systems

These are developed with NGO assistance for groups of households in Baguio City. An NGO, the Jaime V. Ongpin Foundation, Inc. (JVOFI), has assisted four community-based water systems. The oldest is located in Barangay Kias and was established in 1987; the second in Barangay Irisan was in the early 2000s; the third in Barangay Apugan-Loakan in around 2004–2006; and the fourth in Barangay Happy Hollow. These projects followed a similar pattern of development. The initiative to develop a water system began with community residents seeking assistance from and entering into cooperation with JVOFI. JVOFI sought the assistance of donors who provided funds for the purchase of a water pump and distribution pipes, the construction of a water catchment and structures to protect the water source. The community members organised themselves into a cooperative to manage the water distribution system with the NGO covered the costs of capacity building for members to enable the cooperative to effectively administer the water system (eg pricing, collection, maintenance and repair etc).

For Barangay Kias, the water system was intended to serve the whole *barangay*. The assistance for the development of the water system began even before the NGO formally existed. Technical assistance was provided by BWD. For Barangay Irisan, BWD had no funds to expand its services to this location, a specific 'purok', (or section of the *barangay*) and hence posed no objection to residents partnering with the NGO to establish a water system. Initially, the system served 150 households. When it expanded in 2012, the number of households increased to about 400 households. The NGO continued to supervise the operation of the water cooperative until 2012–2013 when the cooperative took over. The water cooperative also amortised the cost of the water pump and pipes initially used to set up the water system. This fund is now used for the repair and replacement of parts. When the expansion of the water system took place in 2012, BWD installed additional pipes for the new households which would be served by the water system.

For Barangay Apugan-Loakan, the water system came out of a programme for watershed conservation supported by the NGO. It paid for water source development and the set-up of the water distribution system. Around 100 households are served by this system. To date, there has been no BWD input into this specific project.

22 *Interviews were conducted with personnel from the NGOs mentioned in this section and members of the water cooperatives in the identified barangays.*

The above three water systems are Level III.[23] The fourth water system established with the assistance of this NGO is a Level II[24] water system in Happy Hollow.[25] At present this is being upgraded to a Level III system and it has extended its operations to serve households residing in neighbouring municipalities of Baguio City like Itogon.

Private water systems

There are cases of private water systems developed by organisations using a deep well as a water source located within their properties. The use of the water is also private and exclusive. An example is a religious organisation that developed two deep wells for the use of its chapel and its housing compound where its church ministers and their families (about 15 households) reside. The deep wells were developed when the BWD water supply to the organisation became insufficient. Expenses for the operation and maintenance of the deep well serving the chapel are paid for from church donations collected weekly while the costs for the deep well serving the housing compound are charged to the 15 households using the water. The organisation has also assigned a person to oversee the daily operation of the two deep wells. The deep wells fill the water tanks for the chapel and the housing compound. The person in charge of the water system claims that the water supply obtained from the water system is adequate to meet the organisation's water needs. There is no intention to re-apply for a BWD connection.

Another example is of a private water system using deep wells located on the property of the owner. This is the case of a water system in one *barangay*. The water supply generated is not for private and exclusive use but for commercial use. This water distribution business was established in May 2014 and supplies water to 27 households within the 24-hectare 'compound' that originally belonged to the owner's clan. The owner disclosed that his initial investment in the water system was 900,000 pesos (US$19,802) to install a large water tank on the highest point of his hilly property. The tank stores the water pumped from the deep well and water is delivered to the households below using gravity. Unlike BWD, water from this water system is not chlorinated. However, he claims that the water from his water system is clean and 'really clear'. The owner also claims that water quality is tested regularly.[26]

The owner of this water system states that he does not have any plans to expand the water distribution service beyond the 24-hectare compound. The owner also claims that the price of the water service (300 pesos or US$6.60 per month) for water consumption within 0–9 cubic metres is cheaper than BWD's minimum charge of 370 pesos (US$8.14) for 0–10 cubic metres for Residential A consumers. According to the owner, most clients of the water system pay only the flat rate since their water consumption does not exceed the 9 cubic metres limit per month.

Water refilling stations and water delivery services

Water for domestic use can also be accessed through water-refilling stations and water delivery services. Water can be purchased at water-refilling stations in five-gallon containers owned by the buyer. Water from a delivery service comes via a water delivery vehicle and is measured in drums. One drum is equivalent to 200 litres and can cost 20–30 pesos (US$0.44-0.66). The minimum order for water delivery is 5 drums.

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23 *Level III (waterworks system or individual house connections) – a system with a source, a reservoir, a piped distribution network and household taps. It is generally suited to densely populated areas. This level of facility requires a minimum treatment of disinfection (PNSDW 2007, DOH AO No. 0012: 5).*

24 *Level II (communal tap system or stand posts) – a system with a source, a reservoir, a piped distribution network and communal taps, located no more than 25 metres from the farthest house. The system is designed to deliver 40 to 80 litres per capita per day to an average of 100 households, with one tap per 4–6 households. It is generally suitable for rural and urban areas where houses are densely clustered to justify a simple pipe system (PNSDW 2007, DOH AO No. 0012: 5).*

25 *Happy Hollow was declared an Ancestral Domain Area under the Indigenous Peoples' Rights Act of 1997.*

26 *These claims have not been verified by the researchers.*

Appendix 4. Data from 'walk-through' activity: average prices for water products

1. Water delivery: ₱27 (less than US$ 0.60) per drum
   - Prices range from ₱26 to ₱30 (US$0.57–0.66) per drum depending on how far the client's location is from the water source.
   - One firm mentioned that water from its private deep well is sold to water delivery stations at ₱8 (less than US$0.18) per drum (without delivery costs).
   - 2. Purified water: ₱25 (US$0.55) per five-gallon container
   - Collection price ranges from ₱20 to ₱25 (US$0.44–0.55) per container
   - Delivery price ranges from ₱20 to ₱30 (US$0.44–0.66) per container
   - Generally, the delivery price is higher than the collection price, although several water-refilling stations charge ₱5 (US$0.11) less per container when it is delivered. According to informants, this is done as a marketing strategy to cultivate a 'suki' or preferred customer status for buyers of a specific water refilling station.
   - Alkaline water is a new product being sold on the market. It is being supplied by one water refilling station at prices higher than that of ordinary purified water – ₱35 (US$0.77) for collection and ₱45 (US$0.99) for delivery.
3. Laundry services: ₱30 (US$ 0.66) per kg (assorted) and ₱50 to ₱60 (US$1.10–1.32) per kg (blankets, comforters)
4. Car wash: ₱60 (US$1.32) for taxis/public utility jeepneys (PUJs) & ₱120 (US$2.64) for private cars/vans

The average output (using very crude calculations):

1. Water delivery: ₱35,414,816.31 ÷ ₱27 = 1,311,660 drums

   If one drum equals 200 litres and 1000 litres equals 1 cubic meter:

   This is equivalent to 262,332 cubic metres per annum.

2. Purified water/water refilling station: ₱57,961,988.28 ÷ ₱25 = 2,318,480 bottles (five gallons)

   At five gallons = 18.93 litres and 1000 litres = 1 cu m, this is equivalent to 43,889 cubic metres per annum.

Appendix 5. Water-related businesses in barangays

Table F1. Water-related businesses in the city barangays as per the household survey done in February to March 2015

	Number of establishments by type				
Barangay	**Water refilling**	**Water delivery**	**Laundry**	**Car wash**	**TOTAL**
Asin	2	0	0	0	2
Bakakeng Norte	2	1	2	0	5
City Camp Central	1	0	0	0	1
Gibraltar	6	0	3	0	9
Imelda	1	0	0	0	1
Irisan	8	1	2	0	11
Kias	5	0	2	0	7
Lourdes Subdivision Extension	1	1	0	0	2
Pacdal	2	0	1	0	3
San Luis	1	1	0	1	3
Santo Tomas Proper	5	1	3	1	10
BGH Compound	1	0	0	2	3
Ferdinand	2	0	3	1	6
P Burgos	2	0	2	0	4
Camp 7	2	2	1	5	10
Pinsao Proper	0	0	0	0	0
Fairview	0	0	0	0	0
Victoria village	0	0	0	0	0
Camp Allen	0	0	0	0	0
TOTAL	**41**	**7**	**19**	**10**	**77**

Most firms in the list obtained from the Business Permits and Licensing Division of Baguio City are engaged in multiple lines of businesses. The combined businesses may be closely related, ie water refilling and water delivery or dormitory, laundry and convenience store; while others are not, ie liquefied petroleum gas (LPG) and water delivery. Firms that declare any one of the water-related activities are included in the count. In cases where a firm's lines of business include more than one water-related activity, the establishment is counted under the first line of business declared by the business license holder. For example, if a firm is engaged in water refilling and water delivery and declares water refilling as its first business activity, it will be counted under water refilling. If a firm's activities include water refilling and laundry and declares water refilling as its first business activity, it is counted under water refilling. This procedure is followed to avoid double counting.

The table below summarises information from the list of business permits processed in 2014 for firms declaring at least water-related activity among its lines of business. The firms are classified into laundry services, water delivery, purified water, water refilling station and car wash. Note that purified water and water-refilling stations operate in the same way and may therefore be treated as one category of water-related businesses.

Table F2. Water-related businesses in Baguio City, 2014

Type	No. business permits	Gross sales (₱)	Average sales per firm (₱)
Laundry services	137	39,567,091.16	288,810.88
Water delivery	37	35,414,816.31	983,744.90
Purified water	35	27,456,375.92	807,540.47
Water-refilling station	88	30,505,612.36	358,889.56
Car wash	9	3,136,746.16	627,349.23
Total	**306**	**136,080,641.90**	**444,707.98**
Share in total for Baguio City	**1.75 per cent**	**0.33 per cent**	

Source: Business Permits and Licensing Division, Baguio City

The data on gross sales found in column 3 of Table F2 pertain to receipts generated from all of the firm's business activities. Unfortunately, there is no way of determining the specific contribution to sales for each line of business per firm from this data set. Hence, the values for sales will be overstated as these include revenues from the other business activities. However, since self-declaration of gross sales is usually expected to be undervalued, this may counter-balance the overstatement described earlier, although by how much is not known. It should be noted that one firm, the Danes Food Corporation, was removed from the above listing as its sales of over 29 million pesos (US$638,000) is an outlier value. Also, this firm is often cited by the personnel of water-refilling stations and commercial laundry establishments as their source of water.[27] Its omission from the calculation will avoid double counting. In the absence of any other sources of data on production, an estimate of the quantity of water 'sold' by these firms has been constructed using the reported values of gross sales divided by the average price for the different outputs produced by the water-related businesses.

The estimate for the annual output of water delivery services is 262,332 cubic metres and that of water-refilling stations is equal to a much lower value of 43,889 cubic metres. The former constitutes 2–3 per cent and the latter constitutes only 0.35–0.5 per cent of the annual production of BWD in 2014. The higher value adjusts for the unaccounted-for water[28] of BWD which averaged 29.9 per cent.

27 *This information was obtained from the household survey by interviewers who counted the number of water-refilling stations and water-related businesses located in their specific sites.*

28 *Unaccounted water in percentages equals distributed water minus metered water volume divided by distributed water multiplied by 100.*

The study found 79 water-related establishments in operation in the 15 (out of 19) *barangays* included in the household survey.[29] This information is summarised in the table below.

Table F3. Type and frequency of water-related establishments in the 15 barangays of the household survey

Type of establishment	Frequency*	Percentage
Water refilling station	39	49
Water delivery services	9	11
Commercial laundry	21	27
Car wash services	10	13
N	**79**	

*Multiple responses included

Water delivery and water-refilling businesses are relatively recent phenomena in Baguio City. The data reveal that only 1 out of 39 water-refilling stations identified began operations in 1992. The rest (97.4 per cent) were established between 2002 and the first quarter of 2015. Water purification appears to be a profitable business endeavour because 11 out of 39 water-refilling stations were established in the last year alone. For water delivery services, 2 out of the 6 firms who responded to queries have been in business since the late 1990s while the remaining 4 were established only from 2002 onwards. Car wash stations and commercial laundry services have been operating for an average of 5 and 6 years respectively. The mean years of operation for each type of business are shown in the following table.

Table F4. Mean years of operation by type of water-related business

Type	Mean years of operation	Number	Percentage of total
Water refilling	5.26	39	53
Water delivery	11.33	6	8
Laundry	6.00	19	25
Car wash	5.00	10	14
		74	100

That there are now 37 firms with a business permit to operate a water delivery service in 2014 is certainly a dramatic increase to the single water delivery service that operated in the 1970s in Baguio City. If the mean years of operation found among the six water delivery firms are representative of all water delivery firms, the increase in the number of firms engaged in water delivery services in Baguio took place in the last decade and most likely in response to the growth in population.

29 *The distribution of the water-related establishments per barangay is in Table F1.*

Appendix 6. List of key informant interviews

Interview with concerned personnel at the National Household Targeting System (NHTS) unit of the Department of Social Welfare and Development, Cordillera Administrative Region, 17 February 2015.

Interview with Engineer Candido Delos Santos, Sanitation Division, Health Services Office, City Government of Baguio, 23 April 2015.

Interview with Rhoda Fe Buenavista and Ester Liberato (project managers) of the Jaime V. Ongpin Foundation Inc. (JVOFI), 10 April 2015.

Towards establishing water security and urban resilience in the city of Baguio

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80-86 Gray's Inn Road, London WC1X 8NH, UK

Tel: +44 (0)20 3463 7399

Fax: +44 (0)20 3514 9055

email: humans@iied.org

www.iied.org