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Alternative water sources for Metro Manila for water security and resilience[1]

GUILLERMO Q. TABIOS III[2]

Introduction

The Metropolitan Waterworks and Sewerage System (MWSS) has projected that water demand for Metro Manila will increase to 6,950 MLD (million liters per day) in 2025, 8,300 MLD in 2035, and over 10,000 MLD in 2045. Currently, the water demand is 5,600 MLD, in which 4,000 MLD is sourced from Angat Reservoir through Ipo and Novaliches Reservoir, 200 MLD from Laguna Lake, and about 800 MLD from groundwater. The Angat Reservoir as water source is already topped off at 4,000 MLD and its storage capacity is slowly decreasing due to sediment deposition. Laguna Lake may be tapped beyond its water permit grant of 300 MLD to perhaps as much as 2,000 MLD (Tabios 2016b), but this has to undergo serious public consultations and negotiations with other stakeholders of the freshwater supply in the lake. Groundwater has become unreliable due to water quality issues and pollution problems. Its usage has currently been reduced to 800 MLD from about 1,500 to 2,000 MLD being extracted in the 1980s, as indicated by the groundwater permits during that period.

In view of this, there is an urgent need to seriously plan and seek investments to sequence and stage alternative water sources for Metro Manila in order to meet its increasing water demands, which will almost double 25 years from now. There are available water sources, but for reasons such as lack of investments, environmental impasse, or simply, complacency on the part of government, these sources are not developed especially for purposes of water security, redundancy, or resilience. Seventy-five to eighty percent of Metro Manila's water use comes solely from the Angat Reservoir. However, it must be recognized that the Angat Reservoir has a risk of failure. These include possibilities of a dam-break due to a massive earthquake; breakage of transmission lines (i.e., tunnels and canals) between Ipo Dam to the Novaliches Portal and La Mesa Treatment Plants or into the Novaliches Reservoir and the Balara Treatment Plants; water contamination along the Bicti–Novaliches open channel conveyance system or as it transits the Novaliches Reservoir by natural means; or even worse, by terrorist attack.

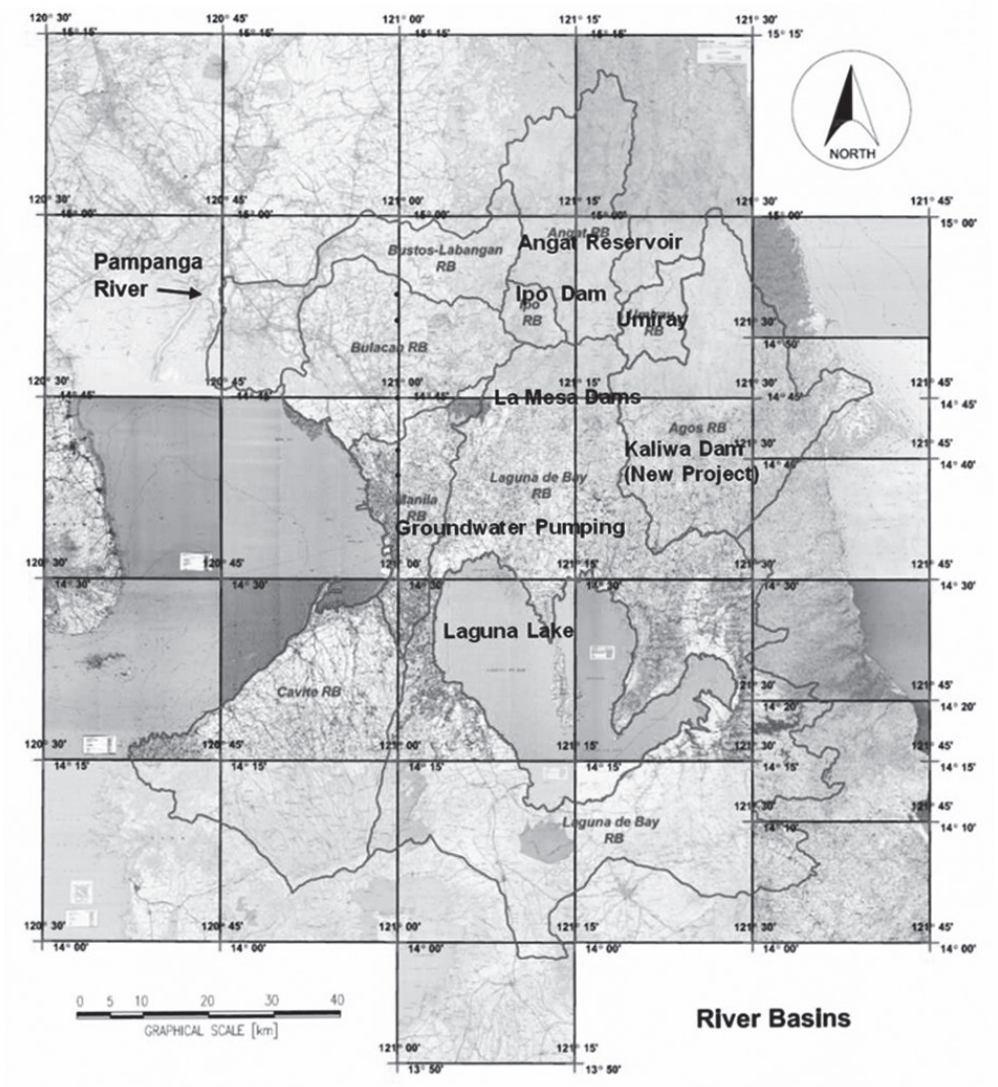
Alternative water sources for Metro Manila

There are several alternative potential water sources for Metro Manila that can be revisited. These are listed below and briefly described in the ensuing sections:

[1] This policy brief is based on the author's paper of the same title which is part of the research project "A Study on the Implications of Federalism in the National Capital Region and Considerations for Forming the Federal Administrative Region" of the University of the Philippines Center for Integrative and Development Studies (UP CIDS), the Department of the Interior and Local Government–National Capital Region (DILG–NCR), and the Local Government of Quezon City. The project is funded by the DILG–NCR.

[2] Professor, Institute of Civil Engineering (ICE) and Research Fellow, National Hydraulic Research Center (NHRC), College of Engineering (CoE), University of the Philippines Diliman, Quezon City • Email address: gtabios@up.edu.ph

FIGURE 1 Potential alternative water sources for Metro Manila



(1) Angat Reservoir with flow augmentation from the Sumag and Biliway River basins;

(2) Groundwater pumping from Metro Manila's aquifer;

(3) Laguna Lake water withdrawal;

(4) the Kaliwa-Kanan-Agos River Basin as source; and

(5) the Pampanga River.

The locations of these potential river basin sources are shown in Figure 1 above.

Angat Reservoir with Sumag and Biliway River inflows

In 2002, the Umiray River Transbasin Tunnel was constructed to augment the inflow of Angat Reservoir, which added as much as 777 MLD for conveyance to Metro Manila and another 230 MLD that goes to Bulacan Province. Another flow augmentation to Angat Reservoir being considered is to source water from Biliway River and Sumag River. Both rivers are tributaries that feed the Umiray River (downstream of the current Umiray River diversion structure to the tunnel). The Sumag and Biliway River flows are fairly significant, amounting to 10 to 15 CMS (m^3/sec) during the months of January and February at 90 percent-of-time reliability. However, there is not much increase during the months of March to May, which only see a gain of 1 to 2 CMS at 80 percent-of-time reliability. This is to note that 2 CMS is 170 MLD, which was the deficit in the water supply that resulted in a major water disruption in the East Zone Concession area of Metro Manila last March and April 2019.

The Umiray, Sumag, and Biliway Watersheds are located on the eastern slopes of Sierra Madre with Type II climate, that is, with evenly distributed rainfall throughout the year. This is in contrast to Type I climate with pronounced dry season (November to April) and wet season for the rest of the year where Angat Reservoir is located. Thus, the yield from watersheds on the eastern slopes of the Sierra Madre is so much greater than on its western slopes.

Groundwater pumping from Metro Manila's aquifer

As of 2012, about 10 to 15 percent of Metro Manila's water use is being drawn from groundwater based on the existing water permit grants issued by the National Water Resources Board (NWRB). Within Metro Manila's groundwater aquifer, which extends from Silang, Cavite (on the south) to Valenzuela, Bulacan (on the north), and bounded on the west by Manila Bay and on the east by Laguna Lake, the total amount granted by NWRB is about 1,340 MLD (about 15 CMS), but only about 780 MLD (9 CMS) is around Metro Manila. Based on the results of the 2004 study commissioned by NWRB to evaluate the status of groundwater resources in Metro Manila, NWRB has implemented a moratorium on issuing new groundwater permits in Metro Manila to allow its aquifer to recover the piezometric levels that lowered 20 to 50 meters from the original levels due to excessive groundwater pumping or extraction.

Upon comparing the observed piezometric levels in 2004 and 2012, it was found that there are areas in Quezon City, San Juan, and Makati that had regained their levels by 20 to 30 m (Tabios 2016a). With this finding, the question is if it is possible to lift the moratorium on groundwater permitting as source of domestic water supply in some areas in Metro Manila. To answer this, a groundwater simulation study for the next 40 years was conducted by Tabios (2016a). In the two scenarios, namely: (i) the groundwater extraction rates are equal to the existing NWRB groundwater permit grants which is about 780 MLD; and (ii) with extraction rates 1.5 times the existing groundwater extraction rates, the bottom-line result is that there is no significant change in heads from 2012 to 2055. Thus, it can be concluded that an additional of almost 650 MLD can be safely extracted on top of the current 780 MLD, which sums up to around 1,430 MLD.

Laguna Lake water withdrawal

Balancing the freshwater inflow to Laguna Lake and saline water from Manila Bay through Pasig River and Napindan Channels to attain the ecological and economic objectives of Laguna Lake may have led to a policy where only a maximum of 600 MLD can be extracted from the lake. However, in the early 1980s, the Manggahan Floodway was built to divert floodwaters from Marikina River to Laguna Lake instead of cascading straight to Pasig River during typhoons and *habagat* (extreme southwest monsoons) events. In this case, Laguna Lake has been getting this unnatural inflow, especially during the wet months of July to September, consequently modifying the flow regimes and dynamics of the lake. In view of these modified conditions, Tabios (2016b) conducted a water balance study over 40 years (1972–2012) of daily rainfall-to-runoff simulation to reassess the water availability in Laguna Lake. In the simulation, the long-term average lake outflows was estimated to be 158.5 CMS (13,700 MLD) which is the sum of Napindan River outflow of 140 CMS (12,100 MLD), irrigation withdrawals of National Irrigation Administration (NIA) of 16.2 CMS (1,400 MLD), and the domestic water supply withdrawal of Maynilad Water Services Incorporated (MWSI) of 2.3 CMS (200 MLD). Assuming that the annual volume of the lake is the same so that the annual inflow should be equal to the annual outflow in Laguna Lake, the flow diverted from Marikina River through Manggahan Floodway should only be about 13.4 CMS. That is 38% of the total Marikina River flow of 35.4 CMS which requires that the remaining 22 CMS flow directly to Pasig River. However, since the 80% dependable flow of Marikina River is about 5.5 CMS and only 10% of that amount is required for environmental or instream maintenance flow, the net of 21.45 CMS (or about 1,850 MLD) may be diverted to Laguna Lake for dilution with cleaner lake water before being extracted for domestic water supply. Alternatively, this could have simply been computed by taking the difference of the long-term average lake inflows from the surrounding watersheds of 180.5 CMS (including all Marikina River flows) minus the outflows of 158.5 CMS and minus the instream flow requirement of 0.55 CMS to arrive at the surplus of 21.45 CMS.

In essence, the 21.45 CMS (about 1,850 MLD) artificial or unnatural added inflow to Laguna Lake is considered exotic water since the historic lake

hydroperiods (i.e., wetting and drying temporal and spatial dynamics) and flow regimes do not include these flow diversions. Thus, utilizing this exotic water for Metro Manila's domestic water consumptive use in effect restores the historical hydroperiods and flow regimes of the lake. It is suggested that around 1,000 to 1,200 MLD be extracted from the lake.

New Centennial Water Project in 2012

In 1972, Laiban Dam in the Kaliwa River basin was identified as an alternative water source of Metro Manila and, in the early 1980s, the dam project started but stopped in 1986 due to change in administration despite the fact that about 20% of civil works were already completed. In 2012, President Benigno Aquino III revived the project, which covered the entire Kaliwa–Kanan–Agos River System for Metro Manila's future water security and redundancy since Metro Manila cannot simply rely on Angat Reservoir as the sole source of 85% of Metro Manila's water.

In view of this, a project staging and sequencing study was conducted by Tabios (2012) for developing the Kaliwa–Kanan–Agos River System which required evaluation of nine (9) alternative water resources project configurations composed of various infrastructures such as dams, diversion structures, and transmission lines. An optimization-simulation model was employed to determine the reservoir sizing, reservoir operations policies, and reliability analysis for water supply and hydropower generation for this Kaliwa–Kanan–Agos River System.

The result of the study showed that at 85% reliability, the Kaliwa Low Dam can provide 924 MLD for the target year of 2015, and similarly, the Laiban Dam can provide an additional 600 MLD at the target year of 2020. The Kanan Diversion can provide 563 MLD by the target year of 2025, while the Kanan Dam development can also provide a total of 976 MLD by 2028. The Agos Dam is targeted to be built in 2045 to provide an additional 1,743 MLD. The total additional water that the entire completed water system can supply by the year 2035 at 85% reliability is about 4,300 MLD. Of course, these target completion dates will shift because these projects have not yet been built.

It may be noted that project sequencing and staging is important because Metro Manila's water demand increases monotonically, so the water infrastructure investments can be timed accordingly. In other words, it would be too expensive and definitely too unwise to build the entire system now just to meet the water demand, say, in 2045.

Pampanga River Basin Transbasin water transfer

Finally, looking further north of Metro Manila, a large-scale transbasin water transfer can be developed from the Pampanga River/Pasac–Guagua River Basin.

To determine the water availability in the Pampanga River and Pasac-Guagua River Basins, a continuous watershed simulation model was conducted by the author for water balance computations of the basin hydrology based on 40 years of daily rainfall data from 1972 to 2012. According to the NWRB water permit grants, in the water balance computations, the existing surface water uses were discounted (as consumptive use), then reliability analysis (i.e., by flow duration analysis) of the remaining water availability was performed. At the Pampanga River before exiting to Pampanga Bay, the 80 percent-of-time dependable flow is 133 CMS or about 11,500 MLD which is the water available equal to or greater than that amount, 290 days a year, in the long-term. Essentially, this could be the amount that can be extracted and conveyed to Metro Manila. To avoid salinity treatment problems, the extraction point should be at some reasonable distance upstream of Pampanga Bay to lessen the dependable flow amount to be extracted, which may be from 7,500 to 8,000 MLD year-round.

Conclusions and recommendations

There is no denying that Metro Manila's water demand will keep on increasing. It is projected to reach 6,950 MLD in 2025 and marching to 8,300 MLD in 2035. Laguna Lake may be tapped up to 2,000 MLD, which is beyond the current cap of 300 MLD. However, this has to undergo serious public consultations and negotiations with other stakeholders of the freshwater supply in the lake. Groundwater as a source has become unreliable due to water quality issues and pollution problems so that its usage has been reduced to 800 MLD from about 1,500 MLD in the 1980s. Banking

on Angat Reservoir to supply 80% or so of Metro Manila's water demand is too risky considering reservoir sedimentation (Tabios 2018), dam-break from earthquake, failure of transmission, and even terrorist attack. Admittedly, this is too much of an alarmist or doomsday scenario, but it is also an idea of how to build resilient water systems. Thus, Metro Manila has to seriously consider developing new water sources not only for water security but also for redundancy.

As seen here, there are several alternative sources of water for Metro Manila. Generally, surface water sources identified will be primarily for large-scale and bulk water supply developments. Groundwater sources (which can be deployed faster) can be bulk water in the short-term, but mainly for water supply augmentation during critical dry periods (which may last for several months). On the other hand, the conjunctive use of surface water and groundwater of watersheds in the vicinity and slightly beyond Metro Manila can be a large-scale operational strategy to meet the future, increasing water demand of Metro Manila. Note that most studies conducted in the past investigated surface water and groundwater resources separately, not conjunctively.

With increasing water demand, changing land use that affect water sources, changing climate, and even socio-economic and political changes, adaptive planning and continuous updating of water resources plans and operations studies should be conducted.

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Telephone: 8981-8500 loc. 4266 to 68 / 3435-9283 • **Telefax:** 8426-0955
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UNIVERSITY OF THE PHILIPPINES
CENTER FOR INTEGRATIVE AND DEVELOPMENT STUDIES

Lower Ground Floor, Ang Bahay ng Alumni
Magsaysay Avenue, University of the Philippines
Diliman, Quezon City 1101

Telephone: 8981-8500 loc. 4266 to 4268 / 3435-9283 • Telefax: 8426-0955
Email: cids@up.edu.ph / cidspublications@up.edu.ph
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