Development of Physical Asset and Flow Accounts for Water Resources of the Philippines

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I. Introduction

Water is one of the most essential needs of human beings and is necessary in almost all economic activities. It is a key element in growing food, manufacturing all kinds of products, generating energy and ensuring the integrity of ecosystems and the goods and services they provide. For domestic consumption, water is used for drinking, food preparation, bathing, sanitation and laundry.

The Phippines, abundantly endowed with water resources, obtains its water supply from rivers, lakes, dams, and groundwater reservoirs. The country has 18 major river basins, 421 principal rives, 59 natural lakes and a network of groundwater reservoirs with a total area of about 50,000 square kilometers (Green Peace, 2007).

Although there are large water sources in the country, one of the key risks in water sufficiency is the exacerbated increasing and competing demand for water supply. This is due to the continuous growth of the population and expansion of economic activities. Since 2010, the country's population has increased 1.72% annually on average, and reached a total population of 100.98 million in 2015 from 92.34 million in 2010 (PopCen 2015). Additionally, economic growth drives the increase in water demand for industrial and agricultural use. The continuous abstraction of large volumes of water has resulted to the depletion and degradation of these resources. The water supply problem as brought about by decades of resource mismanagement, inadequate investments in physical infrastructure and the growing threat of climate change (SEPO 2011).

To help address this issue, the Philippine Economic-Environmental and Natural Resources Accounting (PEENRA) Project, spearheaded by the Philippine Statistics Authority (PSA), is currently developing the physical asset and flow accounts for water resources in the Philippines. The asset accounts present information on the stock of freshwater at the beginning and end of an accounting period while flow accounts describe flows of water from the environment into the economy, to the water flows within the economy, and finally, flows of water back to the environment. Both accounts follow the the United Nations System of Environmental-Economic Accounting (SEEA) 2012-Central Framework, a multipurpose conceptual framework for undersrtanding the interaction between the economy and the environment, and for describing the stocks and changes in stocks of environmental assets.

Compilation of the two accounts will eventually measure Sustainable Development Goal Indicator 6.4.2 Level of water stress and will also address the following areas of water policy: 1) improving water supply and sanitation services; 2) managing water supply and demand; 3) improving the state of the environment and water resources; and 4) adapting to the extreme hydrometeorological events.

This paper aims to present the progress on the development of physical asset and flow accounts for water resources in the Philippines, particularly on the activities conducted, data sources, issues and challenges encountered and next steps.

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II. Overview of the Framework

The System of Environmental-Economic Accounting 2012—Central Framework (SEEA-CF) is a multipurpose conceptual framework that describes the interactions between the economy and the environment, and the stocks and changes in stocks of environmental assets such as water, minerals, energy, timber, land and other biological resources. The following discussion focuses on physical asset and flow accounts for water resources.

According to the SEEA-CF, water resources consist of fresh and brackish water in the inland water system. This is comprised of surface water, ground water and soil water. ***Surface water*** covers all water that flows over or is stored on the ground surface. ***Groundwater*** is water that collects in porous layers of underground formations known as aquifers and yield significant quantities of water to wells and springs. ***Soil water*** consists of water suspended in the uppermost belt of soil.

A. Asset Accounts

The ***asset accounts*** present information on the stock of water at the beginning of an accounting period. The accounts then record additions and reductions in stocks within the accounting period. Finally, the stock of water at the end of the accounting period is computed after incorporating the changes in stock. Table 1 shows the structure of asset accounts for water resources.

Table 1: Asset Accounts for Water Resources

	Type of water resource						**Total**
	Surface water				**Groundwater**	**Soil water**	
	Artificial reservoirs	**Lakes**	**Rivers and streams**	**Glaciers, Snow and Ice**			
Opening stock of water resources							
Additions to stock							
Returns (from Economy)							
Precipitation							
Inflows from other inland water resources							
Discoveries of water in aquifers							
Total additions to stock							
Reductions in stock							
Abstraction (to Economy)							
for hydropower generation							
for cooling water							
Evaporation and actual evapotranspiration							
Outflows to the sea							
Outflows to other inland water resources							
Total reductions in stock							
Closing stock of water resources							

The ***opening and closing stocks*** refer to the volume of water available at the beginning and ending of the accounting period. A***dditions to stocks*** consist of: a) ***returns*** of water to the environment by economic units during the accounting period; b) ***precipitation*** on the territory of reference during the accounting period before evapotranspiration takes place; c) ***inflows*** into water resources during the accounting period; and d) ***discoveries of water in new aquifers***. ***Reductions in stock*** consist of the following: a) ***abstraction*** or water removed from any source, either permanently or temporarily, in a given period of time; b) ***evaporation and actual evapotranspiration***; and c) ***outflows*** of water resources during the accounting period.

B. Flow Accounts

The ***flow accounts*** contain information on the supply and use of water and provide an overview of water flows. It is divided into five sections, namely:

(i) ***Abstraction of water from the environment*** **-** This is defined similarly to the abstraction as reductions to stock in the asset accounts and is disaggregated by source and by industry.

(ii) ***Distribution and use of abstracted water*** – Abstracted must be either used by the same economic unit that abstracts or distributed to other economic units.

(iii) ***Flows of wastewater and reused water*** – Wastewater (discarded and no longer required by the owner or user) can be discharged directly to the environment (or return flow), supplied to a sewerage facility or supplied to another economic unit for further use (resused water).

(iv) ***Return flows of wastewater to the environment*** – This refers to all water that is returned to the environment and is recorded as being supplied to the environment.

(v) ***Evaporation, transpiration and water incorporated into products*** – Flows of evaporation are recorded when water is distributed between economic units after abstraction. Transpiration of water occurs when soil water is absorbed by cultivated plants as they grow and is subsequently released to the atmosphere. Amount of water incorporated into products are shown as supplied by the relevant industry e.g. water is used in the manufacture of beverages.

Table 2 shows the structure of the supply side of the flow accounts. The environment provides all abstracted water to be supplied to the different sectors of the economy. The sector *Water collection, treatment and Supply* supplies water to the different sectors. Alternatively, other economic units may also abstract water for their own use. Wastewater and reused water is supplied by economic units to other economic units, possibly after some treatment. Water is then released by the different economic units back to the environment, ideally, treated to maintain the water quality of the receiving water body. Apart from direct return flows, the economic units supply water to the environment through evaporation and transpiration. The difference between the amount of abstracted water and returns to the environment is assumed to be water incorporated into products.

Table 3, on the other hand, shows the use side of the flow accounts. It is similar to the supply table, but it focuses on the economic units receiving or using the abstracted water, wastewater and reused water. The return flows of water from the different economic units are recorded as *used* by the environment.

Table 2: Supply Table, Flow Accounts for Water Resources

	Agriculture, Forestry and Fishing	Mining and quarrying, manufacturing, and Construction	Electricity, gas, steam and air-conditioning supply	Water collection, treatment and supply	Sewerage	Other Industries	Households	Flows from the environment	Total Supply
(I) Sources of Abstracted Water									
Inland water resources									
Surface water									
Ground water									
Soil water									
Other water resources									
Precipitation									
Sea water									
Total supply abstracted water									
(II) Abstracted water									
For distribution									
For own-use									
(III) Wastewater and reused water									
Wastewater									
Wastewater to treatment									
Own treatment									
Reused water produced									
For distribution									
For own use									
Total supply wastewater and reused water									
(IV) Return flows of water									
To inland water resources									
Surface water									
Ground water									
Soil water									
Total									
To other sources									
Total return flows									
of which: Losses in distribution									
(V) Evaporation of abstracted water, transpiration and water incorporated into products									
Evaporation of abstracted water									
Transpiration									
Water incorporated into products									
TOTAL SUPPLY									

Table 3: Use Table, Flow Accounts for Water Resources

	Agriculture, Forestry and Fishing	Mining and quarrying, manufacturing, and Construction	Electricity, gas, steam and air-conditioning supply	Water collection, treatment and supply	Sewerage	Other Industries	Households	Accumulation	Flows to the environment	Total Use
(I) Sources of Abstracted Water										
Inland water resources										
Surface water										
Ground water										
Soil water										
Total										
Other water resources										
Precipitation										
Sea water										
Total										
Total use abstracted water										
(II) Abstracted water										
Distributed water										
Own-use										
(III) Wastewater and reused water										
Wastewater										
Wastewater received from other units										
Own treatment										
Reused water produced										
Distributed reuse										
Own-use										
Total supply wastewater and reused water										
(IV) Return flows of water										
To inland water resources										
To other sources										
Total return flows										
(V) Evaporation of abstracted water, transpiration and water incorporated into products										
Evaporation of abstracted water										
Transpiration										
Water incorporated into products										
TOTAL USE										

III. Activities Undertaken

As part of the learning process for the compilation of water accounts, several activities were conducted to familiarize and operationalize the framework, to gather inputs on the data sources and possible estimation procedures, and to gain understanding on the processes of the water abstraction and distribution.

A. Training and Data Assessment Workshop on SEEA Water Accounts

In April 2018, a training and data assessment workshop was conducted to give an overview on the SEEA-CF, focusing on water accounts. Lectures were delivered by resource persons from the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). Country experience on compiling water accounts were shared by representatives from Fiji, Malaysia and Samoa. Participants to the training were from the National Water Resources Board (NWRB), Local Water Utilities Administration (LWUA), National Power Corporation (NPC), National Irrigation Administration (NIA), Department of Environment and Natural Resources (DENR), Laguna Lake Development Authority (LLDA), Department of the Interior and Local Government (DILG) and Asian Partnership for the Development of Human Resources in Rural Areas (AsiaDHRRA). The main outputs of the workshop are physical asset and flow test accounts for water resources for the year 2015.

B. Meeting of the Technical Working Group for Water Resources Statistics

The TWG-WRS conducted its first meeting for 2018 last June. One of the agenda items was the presentation of the physical asset and flow test accounts for water resources for comments and additional inputs. The members suggested the agencies that may provide the specific information for the data needs of the accounts. They also recommended steps to address the data gaps and improving the test accounts. After this meeting, the PSA technical staff compiling the accounts identified data source agencies and requested the required information and data sets.

C. Study Visit to Dams in Central Luzon

A study visit to dams was conducted last September 2018 in pursuit of capacity-building and acquiring knowledge about the process of abstraction and distribution of water resources. Officials and staff from PSA Central Office, Regional Statistical Services Office (RSSO) II, III and CAR and Provincial Statistics Offices (PSO) of Bulacan and Nueva Ecija participated in the activity. They visited Angat and Bustos Dams in Bulacan, Casecnan and Pantabangan Dams in Nueva Ecija, and NIA offices. Through this activity, the participants gained knowledge on the processes and flows of water from source to hydropower generation plants and to irrigation and domestic water supply.

IV. Data Sources and Limitations

The physical asset and flow test accounts for water resources are continually being updated as the above-mentioned activities were conducted. The improvements were based on the suggestions of the TWG-WRS, newly provided data from agencies, review of literature and broader understanding of the processes. The following discussion reflects the current developments on the data support of the test accounts.

A. Flow Accounts

i. Abstraction

Households

The Metropolitan Waterworks and Sewerage System (MWSS) provided data on abstraction and distribution of water on the east and west zones of Manila and nearby provinces of Rizal and Cavite. Information provided covers, in physical terms, the amount of water production, distribution and losses (non-revenue water). It is also disaggregated by source (surface water and groundwater and by users (residential, semi-business, commercial, industrial and others).

The Local Water Utilities Authority (LWUA) also provided data on water production, distribution and losses reported by 522 water districts all over the country. It is also disaggregated by source (well, spring, river, lake, others) and by province. Although it has no disaggregation by users, it was clarified by LWUA that water districts mostly provide water to communities (households) and industrial use is only minimal.

Considering that not all households are connected to water systems, coefficients on household water requirements are applied to household counts from the Population Census 2015 to address the undercoverage. The parameter is based on a study of the Philippine Institute for Development Studies in 1999 entitled "Determination of Basic Household Water Requirements". Data on water permit grants from the National Water Resources Board, disaggregated by users and by source, were used to allocate the supplementary estimated water abstraction by source.

Industries

The data for abstraction and distribution of water by industry were estimated from the data on water expenses from the Annual Survey of Philippine Business and Industry (ASPBI) 2015. Water expenses were reported in monetary terms and were converted to volume using a weighted average of water prices from LWUA, Maynilad Water Services Inc. (MWSI) and Manila Water Company Inc. (MWCI).

The National Irrigation Administration (NIA) provided data on the amount of water used for irrigation, covering both national and community irrigation systems. Data provided is disaggregated by source. Additionally, per-capita daily water requirements for major livestock species were also provided by the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD). This information, together with livestock and poultry inventory from the CountryStat of PSA, provided supplementary data on water supplied to the agriculture sector.

Sea Water

Abstraction of sea water as input to economy was estimated using the data on salt production from the Mines and Geosciences Bureau (MGB). Volume of sea water abstracted for salt production was estimated using the amount of salt production, in metric tons. After salt production, sea water is assumed to be returned to the environment via evaporation.

ii. Wastewater

Industries

The Philippine Economic Zone Authority (PEZA) provided data on the amount of wastewater produced in economic zones throughout the country. However, out of 379 economic zones, only 21 economic zones managed by PEZA provided data. Furthermore, disaggregation by industry is unavailable. It was mentioned during the TWG-WRS meeting that the Environmental Management Bureau (EMB) has data on wastewater, however, it is currently not centralized and should be requested from their regional offices.

Households

Parameter on estimating domestic wastewater was obtained also from the "Determination of Basic Household Water Requirements" study by PIDS in 1999. Alternatively, the parameter generally accepted is that 80% of household water consumption turns into wastewater.

iii. Data limitations

According to PEZA, each economic zone has one common sewerage system. The data on the amount of wastewater produced by economic zones, then, cannot be disaggregated by industry. Furthermore, there is currently no data on reuse of water.

Similarly, there is no available data on flows of soil water to the economy. Possible data sources for this include special studies on amount of precipitation retained in soil and utilized by the agriculture sector. The same applies with transpiration.

During the workshop with UNESCAP, it was mentioned that there are industries capturing precipitation for use, however, data is not available on the amount of rainwater collected and the industry doing the collection.

B. Asset Accounts

i. Opening stock.

The stock of water in artificial reservoirs of the six major dams in the country were provided by the National Irrigation Administration (NIA) and National Power Corporation (NPC). Volume of water in artificial reservoirs are measured using their elevations and its corresponding elevation rule curves.

Data on streamflow or river discharge of selected rivers are also regularly monitored by Department of Public Works and Highways (DPWH). Due to the bulkiness of river data, it is practical to consider the major river in each of the 18 river basins. This was also the methodology used in the Philippine Asset Accounts: Forest, Land/Soil, Fishery, Mineral and Water Resources.

Although there are ten major lakes in the Philippines, data on volume of water is readily available only for the Laguna Lake through the Laguna Lake Development Authority.

During the workshop with UNESCAP, it was mentioned that fishponds also occupy a significant portion of the country's land cover and hence, it was considered also as a water resource. The data on the volume of water in fishponds is provided by the Bureau of Fisheries and Aquatic Resources. This is estimated using the area covered by fishponds and the average height of water in ponds of 1.2 meters.

ii. Precipitation and evaporation

Data on precipitation was provided by the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). The data are provided by monitoring stations. Data on land cover was provided by the National Mapping and Resource Information Authority (NAMRIA). The precipitation as addition to stock was estimated in this manner: average precipitation per region (one to five monitoring stations per region) were applied to areas with land cover categories *Inland Water* and *Fishponds*. Average precipitation is measured in centimeters while land cover is measured in hectares. The resulting value is the volume of precipitation directly falling into water bodies. The same procedure was applied in estimating evaporation.

iii. Inflows and outflows

Data on inflows and outflows of water in artificial reservoirs are also available with NIA and NPC through their water balance tables. These tables detail the amount of water that flowed into and out of the reservoirs. One of the limitations, however, is that they do not provide information on the water source and the receiving water body. For other water bodies, further literature review will be done.

iv. Data limitations

Other additions and reductions to stock for physical asset accounts for water resources such as abstraction and returns will be sourced from physical flow accounts. Hence, the asset accounts rely on the accuracy and exhaustiveness of the flow accounts.

Although data are available, most of the inputs are still incomplete (e.g. covers only major rivers, reservoirs and lakes). Also, there is no updated data on stocks of groundwater as mentioned during the TWG-WRS meeting.

V. Next Steps

Additional data will be requested to further improve the test accounts. These include data on wastewater from the regional offices of EMB and water balance tables from NIA. Review of literatures and best country practices on the compilation of water accounts will also be done to come up with parameters for estimating other entries such as groundwater recharge, retention of precipitation to soil and returns of water from economy disaggregated by sector, among others.

A follow-up consultative workshop with the UNESCAP will be conducted to present the results of the physical asset and flow test accounts for their comments and suggestions. The participants during the training and data assessment workshop will again be invited in this workshop for them to be informed on the developments of the water accounts.

The preliminary results of the physical asset and flow accounts for water resources will be presented in a dissemination forum at the end of 2018. Data source agencies, TWG-WRS members and other stakeholders will be invited to the forum. It is envisioned that the accounts and methodology will continually be improved towards the institutionalization of the Water Accounts of the Philippines.

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