# Developing the Water Flow Accounts of Region X

Brenda Lynn M. Castro
Philippine Statistics Authority – Regional Statistical Services Office X

## Abstract

The Water Flow Accounts of Region X is the pilot environmental accounts being developed by PSA-X in response to the request of the Regional Statistics Committee – X thru RSC-X Resolution No. 02, series of 2019 for the compilation of environmental-economic accounting in Region X to generate indicators that would give understanding and measurement on the contribution of the natural resources to the economic well-being of the region, as well as the cost imposed by pollution or resource degradation. The UN System of Environmental-Economic Accounting- 2012 Central Framework (SEEA-CF) serves as the framework of this study. This paper presents the Region X experience in the compilation of the Water Flow Accounts – from data collection to challenges in estimation.

Results show that largest portion (88.1%) of abstracted water for years 2018-2020 was sourced from surface water. Of the total abstracted water of the same period, 97.5 percent was used or consumed by the economic unit that abstracted it, 0.4 percent is for distribution, and 2.1 percent was lost water. In Region X, the power sector was the largest user of abstracted water for own use (91.8% while the largest consumer of distributed water was the household sector (86.1%). It is interesting to note that of the industries with reported water losses, the industry of water collection, treatment and supply recorded the largest percentage of water loss of 38.3 percent out of its total abstraction. Moreover, water use efficiency in the region was recorded at PhP 211 per cubic meter.

*Keywords: SEEA, water supply and use, water flow*

# I. Introduction

## Background

Since 2000, the economy of Northern Mindanao (Region X) has been expanding with an average annual growth rate of 6.0 percent. The region also has been consistently the second biggest contributor to the gross value added of Agriculture, Fishing and Forestry in the country since 2013. (Philippine Statistics Authority, 2021)

With this economic standing of the region, there is a need to have a coherent information to allow policymakers and program implementers understand how these natural resources are being used as inputs to the economic activities of the region. Such information allows the decision makers to assess whether the region is gearing towards sustainable development. Hence, RSC-X resolved to request the Philippine Statistics Authority (PSA) to compile environmental-economic accounts in Region X to generate indicators that would give understanding and measurement on the contribution of the natural resources to the economic well-being of the region, as well as the cost imposed by pollution or resource degradation.

SInce PSA is gearing towards the institutionalization of the economic-environmental and natural resources accounting (EENRA) among the 17 regions of the country, the request of RSC-X was granted making Region X as the fourth region in the country to compile ENRA.

Based on the Water Resources Assessment by the DENR, Northern Mindanao which is under Water Resources Region X, has a potential groundwater source of 2,116 MCM, the fourth biggest potential source among the 12 water regions of the country. In addition, the region also has a potential surface water source of 29,000 MCM, the top potential source among the 12 water regions. (Water Resources Utilization Section, Licenses, Patents and Deeds Division, Department of Environment and Natural Resources X, 2021)

Although the region has large water sources, water sufficiency is still a pressing concern in the region considering the growing number of industries which also have increasing demand for industrial and agricultural use. As of 2021, the region has 38,910 operating establishments (Philippine Statistics Authority, 2022) which drives the increase of water demand for industrial use. Also, the region has 121,352 hectares of potential irrigable areas of which 68.8 percent were irrigated as of 2021 (National Irrigation Administration X, 2022). In addition, Northern Mindanao population grew at an average of 1.46 percent annually from 2015-2020 reaching a total of 5.0 million in 2020 from 4.7 million in 2015 (Philippine Statistics Authority, 2021).

Consulting with the stakeholders during the SEEA-CF Appreciation Training last March 2021, water came out as a priority resource to be accounted in the region considering the numerous economic activities in the region and its population growth. Also, there were existing pressing concerns about water supply in the region.

The Water Flow Accounts describe the flow of water to and from the environment and the economy. This give information on where the water is sourced and how much water is used by the different sectors of the economy. The flow accounts will aid the planners and decision makers in managing water supply and demand and in improving water supply services and its infrastructure.

### Objective of the Study

This study aims to support the institutionalization of the SEEA-CF in the country with Water Flow Accounts as the pilot ENRA project of Northern Mindanao.

Specifically, this study aims to:

a. compile the Physical Flow Accounts of Water Resources in Region X; and
b. provide possible recommendations to address data gaps in the physical flow accounting of water resources in Region X.

## II. Conceptual Framework

### Scope and Coverage

The compilation of Water Accounts in Region X is based on the United Nations System of Environmental-Economic Accounting 2012 Central Framework. The framework integrates the economic and environmental data to describe the relationship between the economy and the environment and to determine the stocks and changes in stocks of environmental assets. One can see if the region is pursuing sustainable development, that is, improving its economic well-being while preserving environmental quality for future generation.

There were 3 main accounts discussed in SEEA-CF, namely: (1) asset accounts or stock accounts which record stocks and changes in stocks of environmental assets, (2) flow accounts which measure the flow of water, energy, and material from the environment to the economy and vice versa in both physical and monetary flows, and (3) environmental activity accounts which focus on environmental goods and services, as well as expenditures on environmental protection and resource management.

This study focuses on the flow of water. The framework presents enumerated six data entries on the water flow based on how the water is utilized: (1) Agriculture, forestry, and fishing, (2) Manufacturing (3) Electricity, Gas, Steam and Air Conditioning Supply, (4) Water Collection, Treatment, and Supply, (5) Other Industries, and (6) Households.

### Framework for the Water Flow Accounts (Philippine Statistics Authority, 2019)

The physical flow accounts for water resources describe the flows of water to and from the environment and the economy. The accounts cover the entire process of water supply and use – from the initial abstraction of water from the environment into the economy, to the flows within the economy done by the different industries and households, and finally, return flows from the economy back to the environment.

The flow accounts table is divided into sections that further elaborate the flows of water between the environment and the economy. The five sections are defined as follows:

- 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.
- Distribution and use of abstracted water – abstracted water will either be used by the same economic unit that abstracts or distribute to other economic units.

- 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 (reused water).

- 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.

- 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).

In addition, the flow accounts are also divided into two parts: the supply table and the use table. The supply table, as its name implies, focuses on where the water comes from. The environment provides all abstracted water to be supplied to the different sectors of the economy, either to be distributed or for own use. Once water is no longer needed for any economic activity, it is considered supplied back to the environment by the different sectors and households. On the other hand, the use table focuses on who uses or receives the water. The economic unit that performed the water withdrawal from the environment is the user and the abstracted water is either consumed by the same unit or is distributed to be used by other sectors. Once water is no longer needed by the user, it is released back and recorded as used by the environment. The two tables must satisfy the supply and use identity – the total supply must be equal to the total use. Table 1 shows the structure of the supply table of the flow accounts while Table 2 presents the use table. Gray cells are null by definition.

## Table 1: Supply Table, Physical Flow Accounts for Water Resources

| | Industries (by PSIC) | | | | | | Households | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL SUPPLY |
|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries (PSIC F-S) | Total Industry | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | |
| Inland Water Resources | | | | | | | | | | |
| *of which: Surface water* | | | | | | | | | | |
| *of which: Groundwater* | | | | | | | | | | |
| Other Water Sources | | | | | | | | | | |
| TOTAL SUPPLY ABSTRACTED WATER | | | | | | | | | | |
| **2. Water:** | | | | | | | | | | |
| For distribution | | | | | | | | | | |
| For own use | | | | | | | | | | |
| **3. Wastewater and reused water:** | | | | | | | | | | |
| Total Wastewater | | | | | | | | | | |
| *of which: wastewater to treatment* | | | | | | | | | | |
| *of which: own treatment* | | | | | | | | | | |
| Reused water produced (for distribution) | | | | | | | | | | |
| TOTAL WASTEWATER AND REUSED WATER | | | | | | | | | | |
| **4. Return flows of water:** | | | | | | | | | | |
| To inland water resources | | | | | | | | | | |
| To other sources | | | | | | | | | | |
| of which: losses in distribution | | | | | | | | | | |
| TOTAL RETURN FLOWS | | | | | | | | | | |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | |
| Evaporation of abstracted water | | | | | | | | | | |
| Transpiration | | | | | | | | | | |
| Water incorporated into products | | | | | | | | | | |
| TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS | | | | | | | | | | |
| **TOTAL SUPPLY** | | | | | | | | | | |

## Table 2: Use Table, Physical Flow Accounts for Water Resources

| | Industries (by PSIC) | | | | | | Households | Accumu-lation | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries (PSIC F-S) | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | | | | | | | | | | | |
| *of which: Surface water* | | | | | | | | | | | |
| *of which: Groundwater* | | | | | | | | | | | |
| Other Water Sources | | | | | | | | | | | |
| TOTAL USE ABSTRACTED WATER | | | | | | | | | | | |
| **2. Water (use):** | | | | | | | | | | | |
| Distributed water | | | | | | | | | | | |
| Own use of water | | | | | | | | | | | |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | | | | | | | | | | | |
| *of which: wastewater received from other units* | | | | | | | | | | | |
| *of which: own treatment* | | | | | | | | | | | |
| Reused water (distributed reuse) | | | | | | | | | | | |
| TOTAL WASTEWATER AND REUSED WATER | | | | | | | | | | | |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | | | | | | | | | | | |
| To other sources | | | | | | | | | | | |
| TOTAL RETURN FLOWS | | | | | | | | | | | |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| Evaporation of abstracted water | | | | | | | | | | | |
| Transpiration | | | | | | | | | | | |
| Water incorporated into products | | | | | | | | | | | |
| TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS | | | | | | | | | | | |
| **TOTAL USE** | | | | | | | | | | | |

## SDG Indicator Derived from Accounts: Water Use Efficiency (WUE)

Water use efficiency, as defined in the metadata prepared by Food and Agriculture Organization, is the value added of a given major sector divided by the volume of water used. The major sectors are the following:

a. *Agriculture* which is composed of irrigated agriculture, forestry, and fishing;
b. *MIMEC* which includes mining and quarrying, manufacturing, electricity, gas, steam, and air-conditioning supply, construction, and
c. *Services* which cover all service industries.

This indicator provides information on the efficiency of the usage of water resources. These sectoral water efficiencies (WE) are used to calculate the overall water efficiency in a particular region.

$$\boldsymbol{WE_A = \frac{GVA_A * \left(1 - p_{rainfed}\right)}{V_A}}$$

where:

$GVA_A =$
$gross\ value\ added\ by\ agriculture\ (excluding\ river\ and\ marine\ fisheries, and\ forestry$

$p_{rainfed} = proportion\ of\ agricultural\ GVA\ \ produced\ by\ rainfed\ agriculture$

$V_A$
$= volume\ of\ water\ used\ by\ agricultural\ sector\ (including\ irrigation, livestock, and\ aquaculture$

$$\boldsymbol{WE_{MIMEC} = \frac{GVA_{MIMEC}}{V_{MIMEC}}}$$

where:

$GVA_{MIMEC} = gross\ value\ added\ by\ MIMEC\ (including\ energy)$

$V_{MIMEC} = volume\ of\ water\ used\ by\ MIMEC\ (inlcuding\ energy)$

$$\boldsymbol{WE_S = \frac{GVA_S}{V_S}}$$

where:

$GVA_S = gross\ value\ added\ by\ services$

$V_S = volume\ of\ water\ used\ by\ services$

$$\boldsymbol{WUE = (WE_A * P_A) + (WE_{MIMEC} * P_{MIMEC}) + (WE_S * P_S)}$$

where:

$P_A = proportion\ of\ water\ used\ by\ agriculture\ over\ total\ use$

$$P_{MIMEC} = proportion\ of\ water\ used\ by\ MIMEC\ over\ total\ use$$

$$P_S = proportion\ of\ water\ used\ by\ services\ over\ total\ use$$

# III. Operationalizing the Framework

## A. Scope and Coverage

This study covers the compilation of physical flow accounts of water resources in Region X for the period 2018-2020. This pilot study disaggregated water supply and use into 4 specific industries namely: (1) Agriculture, forestry, and fisheries, (2) Manufacturing, (3) Electricity, gas, steam and air conditioning supply, and (4) water collection, treatment, and supply. Other major industries were lumped as one.

While water is continually flowing through the hydrological cycle such as precipitation, evaporation, infiltration and run-offs and is easily accessed, abstracted and returned to the environment by the different economic units, portion of the water volume might be unaccounted for (Philippine Statistics Authority, 2019). With this pilot study, the data used were those readily obtained within the Philippine Statistical System. This flow accounts will be continually updated whenever data becomes available.

## B. Data Sources

There are several data sources for the different elements of the physical flow accounts for water resources. The following are the data source agencies, as well as the description of the data provided:

1. National Water Resources Board (NWRB) provided data on the Water Permit Grants which provides information on the total number of water permits, allowable extraction rate, water source, and use of water such as municipal, industrial, irrigation, power, fisheries, livestock, recreation, other purposes.

2. National Irrigation Administration (NIA) provided inventory on irrigation systems which provided information on irrigated area by season. Also included is the parameter on the water requirement of 2 LPS for each hectare and the assumption of 10 months cropping period. This information is used to verify the volume of water used for irrigation.

3. Data on aquafarms and hatcheries were provided by the Bureau of Fisheries and Aquatic Resources (BFAR) which provided information on productive area and standard depth of pond of 0.8-1.0 meter. BFAR also provided the assumption of water replacement which is done every harvest season (every 3 months).

4. Livestock and poultry daily water requirements from the Department of Science and Technology – Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD), supplemented with the livestock and poultry inventory from the PSA were used to estimate the annual water use for livestock and poultry raising.

5. Data on water production, billed volume, water losses or non-revenue water, and volume of water for own use were provided by the local water districts of Region X.

6. Selected manufacturing industries (Coca-Cola - Villanueva, Asia Brewery Inc. - El Salvador, Del Monte Cannery - Bugo, and Highland Freshmilk - El Salvador) also provided information on water abstraction and use, wastewater, and water incorporated into products.

7. 2018-2020 population projection of Region X from the PSA was also used, together with the per capita water requirement obtained from a study of the Philippine Institute for Development Studies in 1999 entitled "Determination of Basic Household Water Requirements". Considering that not all households are connected to community water systems, this information was used to estimate own abstraction activities of these households.

8. In the absence of local data, water-use coefficients were collected from international sources namely: Guidelines for the Compilation of Water Accounts and Statistics and Consumptive Water-Use Coefficients for the Great Lakes Basin and Climatically Similar Areas, and Water Accounts Australia to estimate return flows.

## C. Estimation Methodology

### *Abstracted Water for Own Use*

The Summary of Water Permit Grants of the NWRB is the main source of data for water abstracted for own use. The industrial classifications were mapped to the purpose or use as indicated in the water permits:

| Purpose | Industrial Classification |
|---|---|
| Irrigation | Agriculture, Forestry, and Fishing (AFF) |
| Industrial, Municipal (Water purifier and refilling stations) | Manufacturing (MFG) |
| Power | Electricity, gas, steam, and air-conditioning supply (EGSA) |
| Domestic, Municipal, Others (water service providers and bulk water supply) | Water collection, treatment, and supply (WCTS) |
| Recreation and Other Purposes (except water supply) | Other Industries |

To estimate the total abstracted water for own use for AFF, MFG, and EGSA, allowed abstraction from water permit is used and calculated as follows:

$$\textbf{Abstraction for own use} = \left(\sum_{i=1}^{n} \textbf{abs}_i\right) * \frac{\textbf{60sec}}{\textbf{min}} * \frac{\textbf{60min}}{\textbf{hr}} * \frac{\textbf{24hr}}{\textbf{day}} * \textbf{365 days}$$

where:

$$abs_i = allowed\ abstraction\ of\ permittee\ i\ \ in\ cubic\ meter\ per\ second\ \ (CMS)$$

In addition, the volume of water allocated for livestock and poultry was estimated by considering the parameter for the per capita daily water requirement of major species multiplied to the livestock and poultry inventory of the PSA.

| Species | Average Per Capita Daily Water Requirement (in liters) |
|---|---|
| Chicken | 3.0 |
| Duck | 3.0 |
| Cattle | 75.0 |
| Carabao | 75.0 |
| Goat | 16.0 |
| Swine | 23.0 |

*Source: DOST-Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development*

$$\boldsymbol{Abstraction\ for\ livestock\ and\ poultry} = \mathbf{365} * \sum_{i=1}^{n} \boldsymbol{heads_i} * \boldsymbol{PCDWR_i}$$

where:

$heads_i = number\ of\ heads\ of\ the\ animal\ i$

$PCDWR_i = per\ capita\ daily\ water\ reuirement\ of\ animal\ i$

Moreover, water requirement for Fisheries was estimated by multiplying the total productive area of the aquafarms by the average standard depth of 0.9 m. Also, it is assumed that water is being replaced every 3 months (during harvest season).

$$\boldsymbol{Abstraction\ for\ fisheries} = \mathbf{4} * \sum \boldsymbol{total\ area} * \mathbf{0.9m}$$

where:

$area_i = area\ in\ sq\ m\ of\ farm\ i$

Water requirement for irrigation was also estimated to validate the estimates generated from NWRB data. Estimation is done by multiplying the total irrigated area by water duty per hectare (2 LPS or 0.002 CMS) and number of months for cropping season (10 months).

$$\boldsymbol{Water\ requirement\ for\ irrigation} = \mathbf{10} * \sum \boldsymbol{area_i} * \mathbf{0.002}\ \boldsymbol{CMS} * \frac{\mathbf{60}\boldsymbol{sec}}{\boldsymbol{min}} * \frac{\mathbf{60}\boldsymbol{min}}{\boldsymbol{hr}} * \frac{\mathbf{24}\boldsymbol{hr}}{\boldsymbol{day}} * \mathbf{365}\ \boldsymbol{days}$$

where:

$area_i = total\ irrigated\ area\ in\ sq\ ha\ of\ farm\ i$

Water abstraction for own use of the water collection industry is estimated using the proportion generated from the water district data on the volume of water consumed for own use. Such indicator is applied to the total abstracted water reported in the water permits of bulk water supply, LGU-run facilities and unnamed water system and actual water production from the local water districts.

$$\boldsymbol{Abs\ own\ use}_{\boldsymbol{water\ collection}} = \boldsymbol{p} * \left(\boldsymbol{Abs}_{\boldsymbol{NWRB\ water\ collection}} + \boldsymbol{Water\ Production}_{\boldsymbol{Water\ Districts}}\right)$$

where:

$p =$ *percentage of water for own use by water districts relative to its total water production*

Meanwhile, there are households which abstract water for own use, that is, those households which are not covered by local water service providers (i.e., deep wells as source of water). This is estimated by computing the differential between the water requirement of the Region X population and the volume of water sold to households by the local water districts.

$$\boldsymbol{Household\ abstraction\ for\ own\ use} = \boldsymbol{Water\ Req}_{\boldsymbol{pop}} - \boldsymbol{Water\ Sold}_{\boldsymbol{households}}$$

Water requirement of the Region X population was estimated by multiplying the projected population of the region with the per capita daily water requirement of 54 liters or 0.054 cu m (Inocencio, Arlene B.; Padilla, Jose E.; Javier, Esmyra P., 1999).

$$\boldsymbol{Population\ water\ requirement} = \boldsymbol{projected\ population} * \boldsymbol{0.054} * \boldsymbol{365}$$

### *Abstracted Water for Distribution*

Abstracted water for distribution is estimated using the proportion of water sold out of the total water production of the local water districts. This proportion is applied to the total abstraction of water to the NWRB data of water permits of bulk water supply, LGU-run facilities and unnamed water system and actual water production from the local water districts.

$$\boldsymbol{Abstracted\ water\ of\ water\ collection\ industry\ for\ distribution} = \boldsymbol{p} * \left(\boldsymbol{Abs}_{\boldsymbol{NWRB\ water\ collection}} + \boldsymbol{Water\ Production}_{\boldsymbol{Water\ Districts}}\right)$$

where:

$p =$ *percentage of water sold by water districts relative to its total water production*

### *Wastewater and reused water*

Wastewater of the industries is estimated using the percentage of wastewater reported by the industries relative to the total abstracted for own use.

$$\boldsymbol{Wastewater} = \sum_{\boldsymbol{i-1}}^{\boldsymbol{n}} \boldsymbol{p_i} * (\boldsymbol{Abstracted\ water\ for\ own\ use\ of\ the\ ith\ industry})$$

where:

$p_i =$
$percentage\ of\ wastewater\ of\ the\ ith\ industry\ relative\ to\ its\ total\ water\ production$

### *Return Flows*

For the industries, the volume of return flows was estimated using the water-use coefficient (WUC) parameters available in the literature. For this study, the WUCs used are based on the results of the study *Consumptive Water-Use Coefficients for the Great Lakes Basin and Climatically Similar Areas* and *Guidelines for the Compilation of Water Accounts and Statistics* as follows:

| Industry (i) | Water-Use Coefficients ($WUC_i$) |
|---|---|
| Agriculture, Forestry and Fishing | 0.68 |
| Manufacturing | 0.10 |
| Electricity, gas, steam and air-conditioning supply (power plant) | 0.00 |
| Other Industries | 0.10 |
| Households | 0.16 |

(Shaffer & Runkle, 2007) (United Nations Statitstics Division, 2014)

$$\boldsymbol{Volume\ of\ return\ flow} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{use_i} * (\boldsymbol{1 - WUC_i})$$

where:

$use_i = volume\ of\ water\ used\ of\ the\ ith\ industry$

### *Losses in Distribution*

Distribution losses were calculated using the percentage loss declared by the local water districts and other industries.

$$\boldsymbol{Volume\ of\ distribution\ loss\ in\ water\ districts} = \boldsymbol{abs\ for\ distribution} * \boldsymbol{percentage\ of\ water\ loss}$$

$$\boldsymbol{Volume\ of\ distribution\ loss\ in\ industry\ i} = \boldsymbol{abs\ for\ own\ use_i} * \boldsymbol{percentage\ of\ water\ loss}$$

### *Evaporation of abstracted water, transpiration, and water incorporated into products*

Estimates for water incorporated into products were generated by using the generated percentage of water incorporated into products by the manufacturing industries.

Evaporation and transpiration were calculated using the residual method to satisfy the supply and use identity, that is, total supply must be equal to total use.

### *SDG Indicator: Water Use Efficiency*

The GVA of the 3 major industries were sourced out from the Regional Accounts of the Philippines. Water use efficiency was calculated for each industry. For the MIMEC, water for hydropower generation is excluded since it is considered as non-consumptive use. The GVA for agriculture included river and marine fisheries and forestry since there is no available disaggregation of fishery and forestry. Proxy indicator for the proportion of agricultural GVA by rainfed agriculture was used since there is no available disaggregation of GVA by rainfed or irrigation. Such proxy indicator is the proportion of rainfed palay over the total palay production as follows:

| | **2018** | **2019** | **2020** |
|---|---|---|---|
| Irrigated Palay | 685,437 | 686,013 | 696,722 |
| Rainfed Palay | 75,963 | 75,125 | 85,103 |
| *p* | *0.11* | *0.11* | *0.12* |

(Philippine Statistics Authority)

## E. Activities Undertaken

- SEEA-CF Appreciation Training on 10-12 March 2021

In its aim to capacitate PSA X personnel and to engage regional data partners for the environmental-economic accounting, the PSA RSSO X, in coordination with the Environment and Natural Resources Accounts Division (ENRAD) of the Macroeconomic Accounts Service (MAS), conducted the Appreciation Training on the System of Environmental-Economic Accounting 2012 Central Framework on 10-12 March 2021 at N-Hotel, Kauswagan, Cagayan de Oro City. The training aimed to discuss the salient concepts of the SEEA-CF and the different environmental accounts. Resource persons from ENRAD and PSA Regional Offices - CAR, Caraga, and Central Luzon shared their experiences in the compilation of different environmental accounts. A total of 17 representatives from 9 regional line agencies, namely: NEDA (1), DENR (5), EMB (3), MGB (1), BFAR (2), DA (1), DAR (1), NIA (2), and BIR (1), attended the three-day training. Upon consultation with the group at the end of the training-workshop, Physical Flow Accounting of Water Resources was the identified pilot project of ENRA in Region X. Initial data assessment was also conducted for water flow accounting.

- First Meeting of the TWG-ENRA in Region X on 25 May 2021

A Technical Working Group on Environment and Natural Resources Accounting for Northern Mindanao was created by the Regional Statistics Committee-X to ensure data support from various data source agencies and to facilitate the compilation of Physical Flow of Accounts of Water Resources in Region X. The composition of the TWG-ENRA is presented in Annex A.

The TWG-ENRA had its first meeting on 25 May 2021. Discussions focused on the concepts of Physical Flow Accounting of Water Resources to elicit understanding among the TWG members and for them to be able to identify on the kind of data that they can provide to PSA in support to the compilation of Water Flow Accounts. During the meeting, the participating agencies confirmed on the data availability and also suggested other possible data sources. This served as the basis of PSA-X in its request for information and data sets.
Aside from the resource persons in ENRAD discussing the concepts of SEEA-Water Flow Accounting, representatives from Cagayan de Oro Water District and National Irrigation Administration shared how water is abstracted and utilized in their economic activities. Understanding their economic activities in using water provides supplemental information for consideration by the PSA-X Technical Staff in their estimation exercise.

- Series of Technical Sessions with ENRAD

  Series of technical sessions with ENRAD were conducted to firm up the Supply and Use tables by incorporating comments on additional parameters established by the international associations or organizations, linking of abstraction, use, and return flows. Estimation procedure at the national level was also shared as benchmark for PSA X in its estimation exercise.

- Field Validation Visits in March 2022

  Field validation was conducted to verify the assumptions made in the estimation process and to solicit inputs from the industries regarding their compilation of water production data and reporting to regulatory agencies.

  The team visited six sites of which three were manufacturing industries (Asia Brewery, Highland Fresh, and Del Monte Cannery) and 3 power industries (Power Source Philippines Energy Inc. in Kiwalan, STEAG Power, and Pulangui Power Plant). The team also had virtual consultation with Mindanao Generation and Cagayan de Oro Water District.

  During the field visit, it was found out that actual water abstraction data is submitted quarterly by the water permittees to NWRB and self-monitoring report on water consumption and water pollution data is also submitted quarterly to the EMB by the monitored establishments.

- Second Meeting of the TWG-ENRA in Region X on 09 September 2022

  The TWG-ENRA convened for another meeting in September 2022 to solicit comments on the initial estimates generated by PSA-X. The group confirmed

the trend of the estimates such as the major users of water and percent of distribution losses.

Few comments were raised for consideration in the SUT:

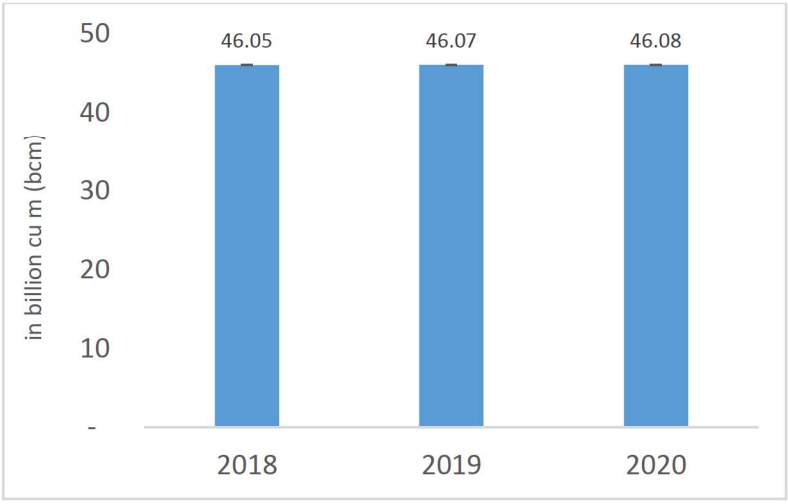
a. Water for hydro power plants in Lanao del Norte were sourced from Lake Lanao, which is outside Region X. This is duly noted by PSA-X for revision in the SUT.
b. Water abstracted from protected areas were not included. PSA-X took note of the observation and asked DENR if they can provide a comprehensive data on the concern for inclusion in the SUT.

## IV. Results and Discussion

### A. Results

Northern Mindanao's total water abstraction, or the total amount of water that is removed from its source, increased by 0.07 percent in 2020, that is, from 46.05 bcm to 46.08 bcm (Figure 1). For the same period, on the average, 88.1 percent of the total abstraction was from lakes, artificial reservoirs, rivers and streams while 10.8 percent was from groundwater.

**Figure 1. Total Water Abstraction: 2018-2020**




Moreover, 97.5 percent of the abstracted water was for own use while 0.4 percent was intended for distribution to other industries. The remaining amount (2.1 percent) was lost. This lost water was intended either for final consumption by the economic unit which abstracted it or for distribution to other industries. Among the reporting economic units with losses, Water collection, treatment & supply posted the largest percentage of water loss of 38.1 percent.

**Figure 2. Three-Year Average Shares on the Use of Abstracted Water: 2018-2020**

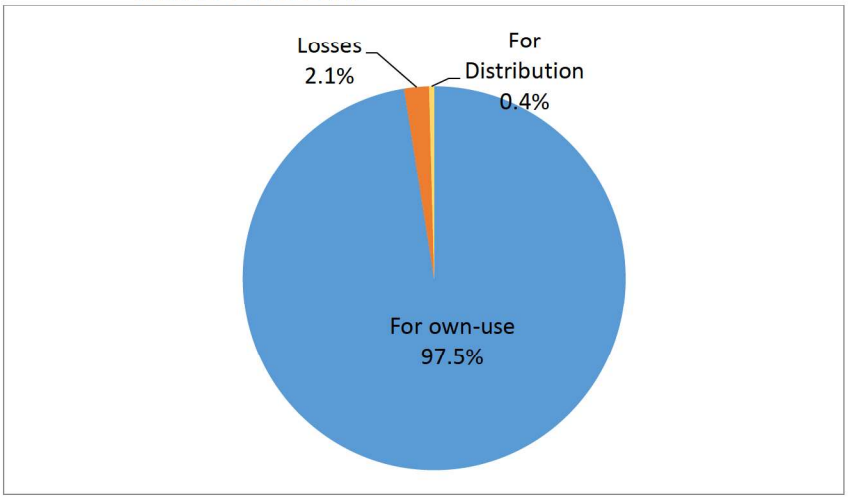



**Table 1. Water Losses (in cu m) by Industry: 2018-2020**

| Industry | Total Abstraction | Loss | Percentage Loss |
|---|---|---|---|
| Manufacturing | 597,324,817 | 547,037 | 0.09 |
| Electricity, gas, steam & air conditioning supply | 126,196,368,334 | 2,537,555,289 | 2.01 |
| Water collection, treatment & supply | 942,950,232 | 361,175,602 | 38.30 |

Water abstracted for own use decreased by 2.1 percent, that is, 45.3 bcm in 2018 to 44.3 bcm in 2020 (Figure 3). The decrease of water abstracted for own use was mainly attributed to the decrease in Electricity, gas, steam & air conditioning supply abstraction for own use by 2.3 percent. As shown in Table 2, the largest amount of self-abstracted water was by the power sector at 91.8 percent. It should be noted however that hydropower uses water in a non-consumptive manner, that is, water is immediately returned to its source after it was extracted.

**Figure 3. Abstracted Water for Own Use: 2018-2020**

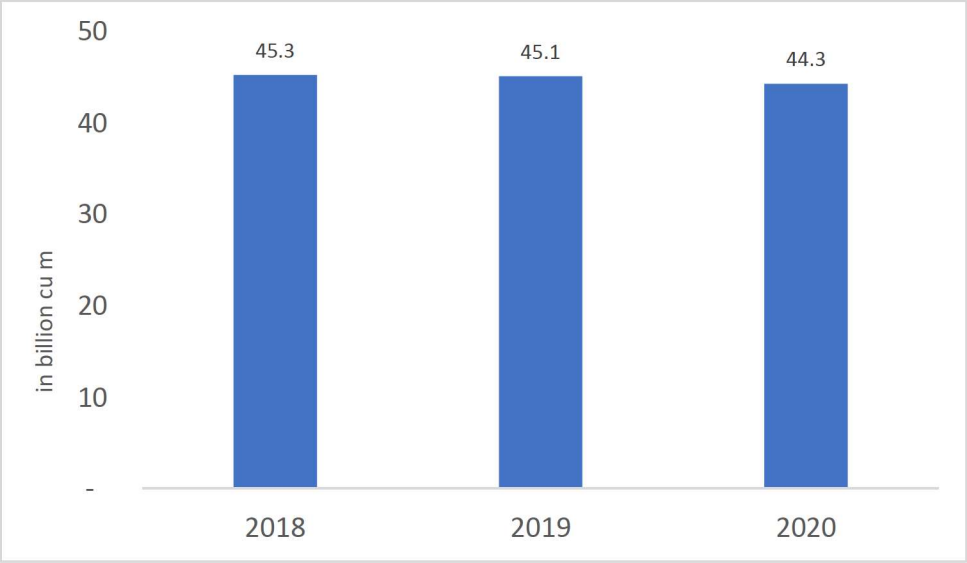
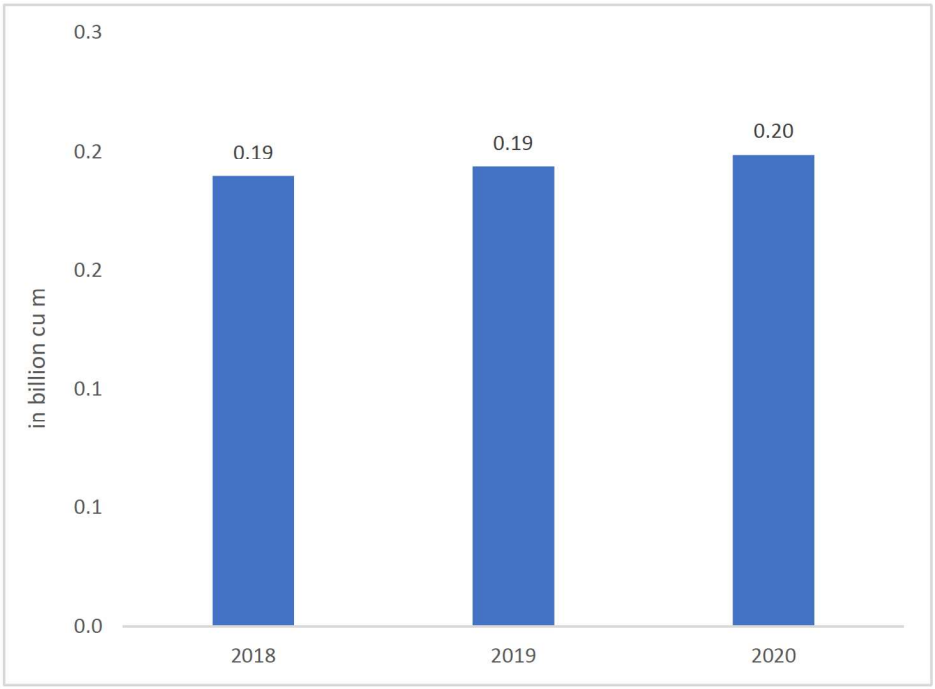



**Table 2. Three-Year Average Share of Abstracted Water for Own Use by Industry: 2018-2020**

| Industry | Average Share |
|---|---|
| Electricity, gas, steam & air conditioning supply | 91.8% |
| Agriculture, Forestry & Fishery | 7.2% |
| Manufacturing | 0.4% |
| Households | 0.1% |
| Water collection, treatment & supply | 0.0% |
| Other Industries | 0.5% |
| TOTAL | 100.0% |

Meanwhile, abstracted water for distribution increased by 4.8 percent, that is from 0.19 bcm in 2018 to 0.20 bcm in 2020. This is attributed to the increased demand of households for final consumption by 7.1 percent.

**Figure 4. Abstracted Water for Distribution: 2018-2020**



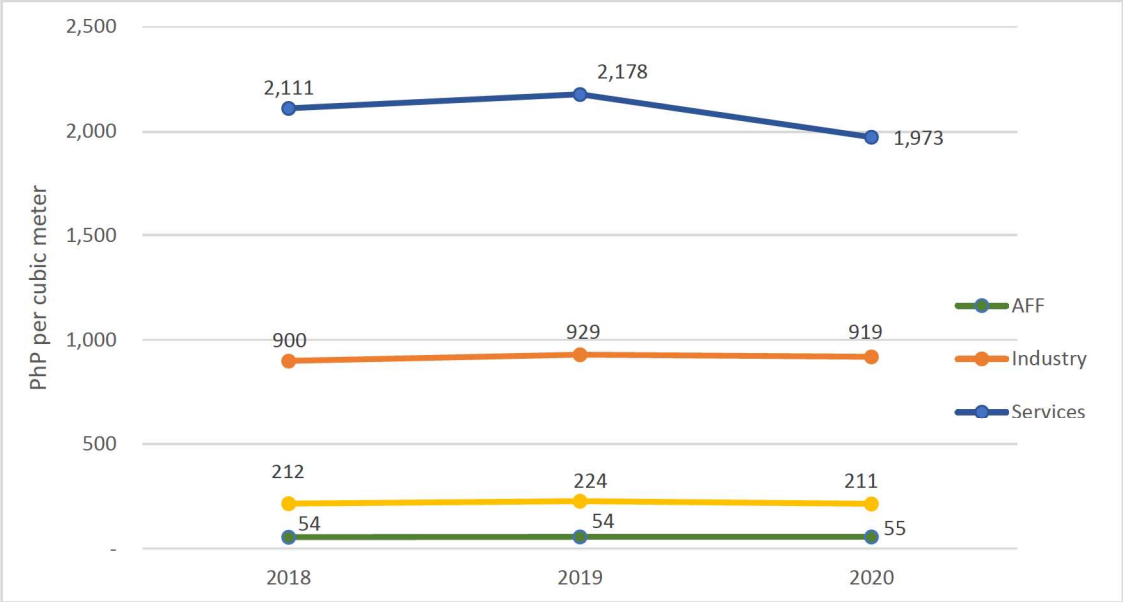

The households recorded the largest consumption of distributed water for 2018-2020 with an average share of 86.1 percent. Other industries (mostly services) followed with a share of 13.9 percent. (Table 3)

**Table 3. Three-Year Average Share of Distributed Water by Industry: 2018-2020**

| Industry | Average Share |
|---|---|
| Households | 86.05% |
| Other Industries | 13.89% |
| Manufacturing | 0.03% |
| Agriculture, Forestry & Fishery | 0.02% |
| Electricity, gas, steam & air conditioning supply | 0.00% |

Water use efficiency (WUE) or the value adder per volume of water used, decreased from PhP 212 per cubic meter in 2018 to PhP 211 per cubic meter in 2021. During the period, Services recorded the highest WUE, followed by Industry and Agriculture. (Figure 5)

**Figure 5. Water Use Efficiency by Major Industry: 2018-2020**




## B. Data Limitations

- During the conduct of the study, there is no available data for the actual water abstraction. The estimation of water abstraction is limited to the assumption that the NWRB permittees are abstracting water in full capacity, that is, amount of water abstracted = approved water abstraction rate per NWRB permit * 365 days. In addition, abstraction of water from protected areas are not included.

- Volume of industrial wastewater was estimated using the proportion of wastewater out of the total water used as submitted by selected industries. This information, as confirmed during the field visit, is being reported by the industries to the Environmental Management Bureau through the Self-Monitoring Reports.

- Agricultural wastewater was not taken into account due to data unavailability.

- There is no data available on the actual amount of captured rainwater. It has been a wide practice on the use of rainwater as inputs to economic activities (e.g. sprinkler systems, toilet flushing, etc.).

- A concern was raised in one of the technical sessions on the parameter used for the per capita daily water requirement of Filipino individuals (54 L per day) which is still based on a 1999 study. There could be changes on the water requirement especially with the additional hygiene requirements of the pandemic.

## V. Next Steps

To improve data support for the compilation of physical flow of water resources, the following activities will be undertaken:

- Consult with the National Water Resources Board, thru PSA ENRAD, for the possible generation of the actual water abstraction of the water permittees. Discussions may focus on the processing of submitted reports for access by data users such as the compilers of Water Flow Accounts.

- Coordinate with EMB Regional Office X for the generation of actual water used, volume of wastewater, and volume of treated wastewater based on the submitted Self-Monitoring Reports of the industries.

- Further consultation with DENR on the generation of data on abstracted water from protected areas. During the conduct of this study, DENR is still establishing the issuance of permits for the users of water in protected areas.

In addition, PSA-X will try to explore other ways of estimating amount of distributed water used by industries using the ratio of water supply to the total intermediate consumption of the different industries taken from the 2018 Supply and Use Table (SUT). With these ratios and data series of intermediate consumption of industries, water expenses of the different industries will be estimated. The same methodology will be applied to the estimation of water used by households. The ratio will be multiplied to the household final consumption expenditure.

Moreover, PSA-X may consider an updated parameter on per capita daily water requirement of individual. A study in August 2021 on defining domestic water consumption based on personal water use activities revealed a realistic indoor-only water use of 175 L per day, which was based on a survey of 11 countries worldwide (Crouch, Jacobs, & Speight, 2021). This will be subjected for approval by the Technical Working Group.

The physical flow accounts for water resources will be updated in 2023 to include additional data and updated parameters for the period 2018-2022. It is planned also to supplement the physical flow accounts with the monetary flow accounts. The monetary flow accounts will provide insights on the contribution of water collection, treatment and supply, and wastewater collection and treatment industries to the region's economy.

**Annex**

**ANNEX A**
**Technical Working Group on Environment and Natural Resources Accounting**
**Northern Mindanao**

| | |
|---|---|
| Chair: | Philippine Statistics Authority – X |
| Co-Chair: | Department of Environment and Natural Resources-X |
| Members: | |
| | Department of Health-X |
| | Department of the Interior and Local Government - X |
| | Environmental Management Bureau – X |
| | National Economic and Development Authority – X |
| | National Irrigation Administration – X |
| | National Power Corporation – Mindanao Generation |
| | National Water Resources Board |
| | Philippine Atmospheric, Geophysical and Astronomical Services Administration - X |
| | Cagayan de Oro Water District |
| | Ateneo de Cagayan-Xavier University |

## Annex Table 1. 2018 Physical Water Supply Table
*(in cubic meters)*

| | Industries (by PSIC) | | | | | | Households | | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL SUPPLY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | | | | | | | | | 7,411,173,183 | 38,143,376,556 | 45,554,549,740 |
| *of which: Surface water* | | | | | | | | | 7,253,280,000 | 33,314,219,117 | 40,567,499,117 |
| *of which: Groundwater* | | | | | | | | | 157,893,183 | 4,829,157,439 | 4,987,050,623 |
| Other Water Sources | | | | | | | | | 385,369,920 | 105,182,336 | 490,552,256 |
| **TOTAL SUPPLY ABSTRACTED WATER** | | | | | | | | | **7,796,543,103** | **38,248,558,893** | **46,045,101,996** |
| **2. Water:** | | | | | | | | | | | |
| For distribution | | | | 189,486,955 | | 189,486,955 | | | - | | 189,486,955 |
| For own use | 3,240,320,377 | 198,887,126 | 41,586,290,384 | 81,284 | 210,239,712 | 45,235,818,883 | 29,453,746 | | | | 45,265,272,629 |
| **TOTAL** | **3,240,320,377** | **198,887,126** | **41,586,290,384** | **189,568,240** | **210,239,712** | **45,425,305,838** | **29,453,746** | | | | **45,454,759,584** |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | - | 13,082,532 | 6,021,246,423 | - | - | 6,034,328,955 | - | | | | 6,034,328,955 |
| *of which: wastewater to treatment* | - | - | - | - | - | - | - | | | | - |
| *of which: own treatment* | - | 13,082,532 | 6,021,246,423 | - | - | 6,034,328,955 | - | | | | 6,034,328,955 |
| Reused water produced (for distribution) | - | - | - | - | - | - | - | | | | - |
| **TOTAL WASTEWATER AND REUSED WATER** | **-** | **13,082,532** | **6,021,246,423** | **-** | **-** | **6,034,328,955** | **-** | | | | **6,034,328,955** |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | 1,036,902,521 | 178,998,413 | 34,163,730,672 | 170,611,416 | 189,215,741 | 35,739,458,762 | - | | | | 35,739,458,762 |
| To other sources | - | - | 490,552,256 | - | - | 490,552,256 | 24,741,147 | | | | 515,293,403 |
| of which: losses in distribution | - | 195,560 | 479,165,727 | 110,980,124 | - | 590,342,412 | - | | | | 590,342,412 |
| **TOTAL RETURN FLOWS** | **1,036,902,521** | **178,998,413** | **34,654,282,928** | **170,611,416** | **189,215,741** | **36,230,011,018** | **24,741,147** | | | | **36,254,752,165** |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| To inland water resources | - | 41,379 | 7,621 | 3,960 | 21,023,971 | 21,076,932 | - | | | | 21,076,932 |
| To other sources | 2,203,417,856 | - | - | - | - | 2,203,417,856 | - | | | | 2,203,417,856 |
| of which: losses in distribution | - | 8,328,262 | - | - | - | 8,328,262 | - | | | | 8,328,262 |
| **TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS** | **2,203,417,856** | **8,369,641** | **7,621** | **3,960** | **21,023,971** | **2,232,823,050** | **-** | | | | **2,232,823,050** |
| **6. TOTAL SUPPLY** | **3,240,320,377** | **200,450,586** | **40,675,536,973** | **170,615,376** | **210,239,712** | **44,497,163,023** | **24,741,147** | **-** | **7,796,543,103** | **38,248,558,893** | **90,567,006,166** |

## Annex Table 2. 2018 Physical Water Use Table
*(in cubic meters)*

| | Industries (by PSIC) | | | | | | Households | Accumullation | Flows from the Rest of the World (Imports) | Flows from the Ervironment | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | 3,240,320,377 | 199,083,686 | 34,163,730,672 | 300,548,364 | 210,239,712 | 38,113,922,810 | 29,453,746 | | 7,411,173,183 | | 45,554,549,740 |
| *of which: Surface water* | 3,109,529,472 | 147,134,362 | 29,766,714,519 | 182,466,126 | 108,374,639 | 33,314,219,117 | - | | 7,253,280,000 | | 40,567,499,117 |
| *of which: Groundwater* | 130,790,905 | 51,949,325 | 4,397,016,153 | 118,082,238 | 101,865,073 | 4,799,703,693 | 29,453,746 | | 157,893,183 | | 4,987,050,623 |
| Other Water Sources | - | - | 105,182,336 | - | - | 105,182,336 | - | | 385,369,920 | | 490,552,256 |
| **TOTAL USE ABSTRACTED WATER** | **3,240,320,377** | **199,083,686** | **34,268,913,008** | **300,548,364** | **210,239,712** | **38,219,105,147** | **29,453,746** | | **7,796,543,103** | | **46,045,101,996** |
| **2. Water (use):** | | | | | | | | | | | |
| Distributed water | 42,691 | 65,669 | 4,962 | - | 27,418,477 | 27,531,798 | 161,955,157 | | - | | 189,486,955 |
| Own use of water | 3,240,320,377 | 198,887,126 | 41,586,290,384 | 81,284 | 210,239,712 | 45,235,818,883 | 29,453,746 | | | | 45,265,272,629 |
| **TOTAL** | **3,240,363,067** | **198,952,795** | **41,586,295,346** | **81,284** | **237,658,188** | **45,263,350,681** | **191,408,903** | | | | **45,454,759,584** |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | - | 13,082,532 | 6,021,246,423 | - | - | 6,034,328,955 | - | | - | | 6,034,328,955 |
| *of which: wastewater received from other units* | | | | - | | - | | | - | | - |
| *of which: own treatment* | - | 13,082,532 | 6,021,246,423 | - | - | 6,034,328,955 | - | | | | 6,034,328,955 |
| Reused water (distributed reuse) | - | - | - | - | - | - | - | | | | - |
| **TOTAL WASTEWATER AND REUSED WATER** | **-** | **13,082,532** | **6,021,246,423** | **-** | **-** | **6,034,328,955** | **-** | | **-** | | **6,034,328,955** |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | | | | | | | | | | 35,739,458,762 | 35,739,458,762 |
| To other sources | | | | | | | | | | 515,293,403 | 515,293,403 |
| of which: losses in distribution | | | | | | | | | | 590,342,412 | 590,342,412 |
| **TOTAL RETURN FLOWS** | | | | | | | | | | **36,254,752,165** | **36,254,752,165** |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| Evaporation of abstracted water | | | | | | | | 21,076,932 | | | 21,076,932 |
| Transpiration | | | | | | | | 2,203,417,856 | | | 2,203,417,856 |
| Water incorporated into products | | | | | | | | 8,328,262 | | | 8,328,262 |
| **TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS** | | | | | | | | **2,232,823,050** | | | **2,232,823,050** |
| **6. TOTAL USE** | **3,240,320,377** | **212,166,218** | **40,290,159,431** | **300,548,364** | **210,239,712** | **44,253,434,102** | **29,453,746** | **2,232,823,050** | **7,796,543,103** | **36,254,752,165** | **90,567,006,166** |

## Annex Table 3. 2019 Physical Water Supply Table
*(in cubic meters)*

| | Industries (by PSIC) | | | | | | Households | | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL SUPPLY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | | | | | | | | | 7,411,173,183 | 38,165,521,256 | 45,576,694,439 |
| *of which: Surface water* | | | | | | | | | 7,253,280,000 | 33,332,478,240 | 40,585,758,240 |
| *of which: Groundwater* | | | | | | | | | 157,893,183 | 4,833,043,016 | 4,990,936,199 |
| Other Water Sources | | | | | | | | | 385,369,920 | 105,182,336 | 490,552,256 |
| **TOTAL SUPPLY ABSTRACTED WATER** | | | | | | | | | **7,796,543,103** | **38,270,703,592** | **46,067,246,696** |
| **2. Water:** | | | | | | | | | | | |
| For distribution | | | | 193,353,574 | | 193,353,574 | | | - | | 193,353,574 |
| For own use | 3,240,785,794 | 198,980,859 | 41,437,722,421 | 95,545 | 220,361,585 | 45,097,946,205 | 24,387,528 | | | | 45,122,333,732 |
| **TOTAL** | **3,240,785,794** | **198,980,859** | **41,437,722,421** | **193,449,119** | **220,361,585** | **45,291,299,779** | **24,387,528** | | | | **45,315,687,307** |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | - | 15,629,057 | 4,751,882,695 | - | - | 4,767,511,751 | - | | | | 4,767,511,751 |
| *of which: wastewater to treatment* | - | - | - | - | - | - | - | | | | - |
| *of which: own treatment* | - | 15,629,057 | 4,751,882,695 | - | - | 4,767,511,751 | - | | | | 4,767,511,751 |
| Reused water produced (for distribution) | - | - | - | - | - | - | - | | | | - |
| **TOTAL WASTEWATER AND REUSED WATER** | **-** | **15,629,057** | **4,751,882,695** | **-** | **-** | **4,767,511,751** | **-** | | | | **4,767,511,751** |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | 1,037,051,454 | 179,082,773 | 34,163,730,672 | 174,104,207 | 198,325,426 | 35,752,294,533 | 20,485,523 | | | | 35,772,780,056 |
| To other sources | - | - | 490,552,256 | - | - | 490,552,256 | - | | | | 490,552,256 |
| of which: losses in distribution | - | 176,585 | 627,733,690 | 123,649,114 | - | 751,559,389 | - | | | | 751,559,389 |
| **TOTAL RETURN FLOWS** | **1,037,051,454** | **179,082,773** | **34,654,282,928** | **174,104,207** | **198,325,426** | **36,242,846,789** | **20,485,523** | | | | **36,263,332,313** |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| Evaporation of abstracted water | - | 45,237 | 6,180 | 4,126 | 22,036,158 | 22,091,702 | - | | | | 22,091,702 |
| Transpiration | 2,203,734,340 | - | - | - | - | 2,203,734,340 | - | | | | 2,203,734,340 |
| Water incorporated into products | - | 9,557,989 | - | - | - | 9,557,989 | - | | | | 9,557,989 |
| **TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS** | **2,203,734,340** | **9,603,226** | **6,180** | **4,126** | **22,036,158** | **2,235,384,030** | **-** | | | | **2,235,384,030** |
| **6. TOTAL SUPPLY** | **3,240,785,794** | **204,315,056** | **39,406,171,802** | **174,108,333** | **220,361,585** | **43,245,742,571** | **20,485,523** | **-** | **7,796,543,103** | **38,270,703,592** | **89,333,474,790** |

## Annex Table 4. 2019 Physical Water Use Table
*(in cubic meters)*

| | Industries (by PSIC) | | | | | | Households | Accumulation | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | 3,240,785,794 | 199,157,444 | 34,163,730,672 | 317,098,233 | 220,361,585 | 38,141,133,728 | 24,387,528 | | 7,411,173,183 | | 45,576,694,439 |
| *of which: Surface water* | 3,109,529,472 | 147,134,362 | 29,766,714,519 | 191,497,729 | 117,602,159 | 33,332,478,240 | - | | 7,253,280,000 | | 40,585,758,240 |
| *of which: Groundwater* | 131,256,322 | 52,023,083 | 4,397,016,153 | 125,600,504 | 102,759,426 | 4,808,655,488 | 24,387,528 | | 157,893,183 | | 4,990,336,199 |
| Other Water Sources | - | - | 105,182,336 | - | - | 105,182,336 | - | | 385,369,920 | | 490,552,256 |
| **TOTAL USE ABSTRACTED WATER** | **3,240,785,794** | **199,157,444** | **34,268,913,008** | **317,098,233** | **220,361,585** | **38,246,316,065** | **24,387,528** | | **7,796,543,103** | | **46,067,246,696** |
| **2. Water (use):** | | | | | | | | | | | |
| Distributed water | 49,856 | 63,223 | 5,633 | - | 28,196,336 | 28,315,048 | 165,038,526 | | - | | 193,353,574 |
| Own use of water | 3,240,785,794 | 198,980,859 | 41,437,722,421 | 95,545 | 220,361,585 | 45,097,946,205 | 24,387,528 | | | | 45,122,333,732 |
| **TOTAL** | **3,240,835,650** | **199,044,083** | **41,437,728,055** | **95,545** | **248,557,921** | **45,126,261,253** | **189,426,054** | | | | **45,315,687,307** |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | - | 15,629,057 | 4,751,882,695 | - | - | 4,767,511,751 | - | | - | | 4,767,511,751 |
| *of which: wastewater received from other units* | | | | - | | - | | | - | | - |
| *of which: own treatment* | - | 15,629,057 | 4,751,882,695 | - | - | 4,767,511,751 | - | | | | 4,767,511,751 |
| Reused water (distributed reuse) | - | - | - | - | - | - | - | | | | - |
| **TOTAL WASTEWATER AND REUSED WATER** | **-** | **15,629,057** | **4,751,882,695** | **-** | **-** | **4,767,511,751** | **-** | | **-** | | **4,767,511,751** |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | | | | | | | | | | 35,772,780,056 | 35,772,780,056 |
| To other sources | | | | | | | | | | 490,552,256 | 490,552,256 |
| of which: losses in distribution | | | | | | | | | | 751,559,389 | 751,559,389 |
| **TOTAL RETURN FLOWS** | | | | | | | | | | **36,263,332,313** | **36,263,332,313** |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| Evaporation of abstracted water | | | | | | | | 22,091,702 | | | 22,091,702 |
| Transpiration | | | | | | | | 2,203,734,340 | | | 2,203,734,340 |
| Water incorporated into products | | | | | | | | 9,557,989 | | | 9,557,989 |
| **TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS** | | | | | | | | **2,235,384,030** | | | **2,235,384,030** |
| **6. TOTAL USE** | **3,240,785,794** | **214,786,501** | **39,020,795,703** | **317,098,233** | **220,361,585** | **43,013,827,816** | **24,387,528** | **2,235,384,030** | **7,796,543,103** | **36,263,332,313** | **89,333,474,790** |

## Annex Table 5. 2020 Physical Water Supply Table
*(in cubic meters)*

| | Industries (by PSIC) | | | | | | Households | | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL SUPPLY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | | | | | | | | | 7,411,173,183 | 38,177,501,066 | 45,588,674,249 |
| *of which: Surface water* | | | | | | | | | 7,253,280,000 | 33,340,676,801 | 40,593,956,801 |
| *of which: Groundwater* | | | | | | | | | 157,893,183 | 4,836,824,264 | 4,994,717,448 |
| Other Water Sources | | | | | | | | | 385,369,920 | 105,182,336 | 490,552,256 |
| **TOTAL SUPPLY ABSTRACTED WATER** | | | | | | | | | **7,796,543,103** | **38,282,683,402** | **46,079,226,505** |
| **2. Water:** | | | | | | | | | | | |
| For distribution | | | | 198,656,664 | | 198,656,664 | | | | | 198,656,664 |
| For own use | 3,247,935,483 | 198,909,795 | 40,634,800,239 | 100,608 | 221,200,606 | 44,302,946,730 | 20,246,984 | | - | | 44,323,193,714 |
| **TOTAL** | **3,247,935,483** | **198,909,795** | **40,634,800,239** | **198,757,272** | **221,200,606** | **44,501,603,394** | **20,246,984** | | | | **44,521,850,378** |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | - | 14,513,915 | 6,265,506,281 | - | - | 6,280,020,196 | - | | | - | 6,280,020,196 |
| *of which: wastewater to treatment* | - | - | - | - | - | - | - | | | | - |
| *of which: own treatment* | - | 14,513,915 | 6,265,506,281 | - | - | 6,280,020,196 | - | | | - | 6,280,020,196 |
| Reused water produced (for distribution) | - | - | - | - | - | - | - | | | | - |
| **TOTAL WASTEWATER AND REUSED WATER** | **-** | **14,513,915** | **6,265,506,281** | **-** | **-** | **6,280,020,196** | **-** | | | **-** | **6,280,020,196** |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | 1,039,339,354 | 179,018,815 | 34,163,730,672 | 178,881,544 | 199,080,545 | 35,760,050,931 | 17,007,466 | | - | | 35,777,058,397 |
| To other sources | - | - | 490,552,256 | - | - | 490,552,256 | - | | - | | 490,552,256 |
| of which: losses in distribution | - | 173,891 | 1,430,655,872 | 126,546,364 | - | 1,557,376,127 | - | | - | | 1,557,376,127 |
| **TOTAL RETURN FLOWS** | **1,039,339,354** | **179,018,815** | **34,654,282,928** | **178,881,544** | **199,080,545** | **36,250,603,187** | **17,007,466** | | **-** | | **36,267,610,654** |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| Evaporation of abstracted water | - | 41,450 | 11,141 | 4,337 | 22,120,061 | 22,176,989 | - | | - | | 22,176,989 |
| Transpiration | 2,208,596,128 | - | - | - | - | 2,208,596,128 | - | | - | | 2,208,596,128 |
| Water incorporated into products | - | 8,337,626 | - | - | - | 8,337,626 | - | | - | | 8,337,626 |
| **TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS** | **2,208,596,128** | **8,379,076** | **11,141** | **4,337** | **22,120,061** | **2,239,110,744** | **-** | | **-** | | **2,239,110,744** |
| **6. TOTAL SUPPLY** | **3,247,935,483** | **201,911,807** | **40,919,800,350** | **178,885,882** | **221,200,606** | **44,769,734,128** | **17,007,466** | **-** | **7,796,543,103** | **38,282,683,402** | **90,865,968,099** |

## Annex Table 6. 2020 Physical Water Use Table
*(in cubic meters)*

| | Industries (by PSIC) | | | | | | Households | Accumulation | Flows from the Rest of the World (Imports) | Flows from the Environment | TOTAL USE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Agriculture, Forestry & Fishery (PSIC A) | Manufacturing (PSIC C) | Electricity, gas, steam & air conditioning supply (PSIC D) | Water collection, treatment & supply (PSIC E) | Other Industries | Total Industry | | | | | |
| **1. Sources of Abstracted Water:** | | | | | | | | | | | |
| Inland Water Resources | 3,247,935,483 | 199,083,686 | 34,163,730,672 | 325,303,635 | 221,200,606 | 38,157,254,082 | 20,246,984 | | 7,411,173,183 | | 45,588,674,249 |
| *of which: Surface water* | 3,115,158,656 | 147,134,362 | 29,766,714,519 | 194,067,105 | 117,602,159 | 33,340,676,801 | - | | 7,253,280,000 | | 40,593,956,801 |
| *of which: Groundwater* | 132,776,826 | 51,949,325 | 4,397,016,153 | 131,236,530 | 103,598,447 | 4,816,577,281 | 20,246,984 | | 157,893,183 | | 4,994,717,448 |
| Other Water Sources | - | - | 105,182,336 | - | - | 105,182,336 | - | | 385,369,920 | | 490,552,256 |
| **TOTAL USE ABSTRACTED WATER** | **3,247,935,483** | **199,083,686** | **34,268,913,008** | **325,303,635** | **221,200,606** | **38,262,436,418** | **20,246,984** | | **7,796,543,103** | | **46,079,226,505** |
| **2. Water (use):** | | | | | | | | | | | |
| Distributed water | 40,487 | 74,323 | 3,695 | - | 25,161,816 | 25,280,321 | 173,376,343 | | | | **198,656,664** |
| Own use of water | 3,247,935,483 | 198,909,795 | 40,634,800,239 | 100,608 | 221,200,606 | 44,302,946,730 | 20,246,984 | | | | 44,323,193,714 |
| **TOTAL** | **3,247,975,970** | **198,984,118** | **40,634,803,934** | **100,608** | **246,362,422** | **44,328,227,051** | **193,623,327** | | | | **44,521,850,378** |
| **3. Wastewater and reused water:** | | | | | | | | | | | |
| Total Wastewater | - | 14,513,915 | 6,265,506,281 | - | - | 6,280,020,196 | - | | | - | 6,280,020,196 |
| *of which: wastewater received from other units* | | | | - | | - | | | | - | - |
| *of which: own treatment* | - | 14,513,915 | 6,265,506,281 | - | - | 6,280,020,196 | - | | | - | 6,280,020,196 |
| Reused water (distributed reuse) | - | - | - | - | - | - | - | | | - | - |
| **TOTAL WASTEWATER AND REUSED WATER** | **-** | **14,513,915** | **6,265,506,281** | **-** | **-** | **6,280,020,196** | **-** | | | **-** | **6,280,020,196** |
| **4. Return flows of water:** | | | | | | | | | | | |
| To inland water resources | | | | | | | | | | 35,777,058,397 | 35,777,058,397 |
| To other sources | | | | | | | | | | 490,552,256 | 490,552,256 |
| of which: losses in distribution | | | | | | | | | | 1,557,376,127 | 1,557,376,127 |
| **TOTAL RETURN FLOWS** | | | | | | | | | | **36,267,610,654** | **36,267,610,654** |
| **5. Evaporation of abstracted water, transpiration and water incorporated into products:** | | | | | | | | | | | |
| Evaporation of abstracted water | | | | | | | | 22,176,989 | - | | 22,176,989 |
| Transpiration | | | | | | | | 2,208,596,128 | - | | 2,208,596,128 |
| Water incorporated into products | | | | | | | | 8,337,626 | - | | 8,337,626 |
| **TOTAL WATER EVAPORATED, TRANSPIRED AND INCORPORATED INTO PRODUCTS** | | | | | | | | 2,239,110,744 | - | | **2,239,110,744** |
| **6. TOTAL USE** | **3,247,935,483** | **213,597,602** | **40,534,419,289** | **325,303,635** | **221,200,606** | **44,542,456,614** | **20,246,984** | **2,239,110,744** | **7,796,543,103** | **36,267,610,654** | **90,865,968,099** |

## Bibliography


Crouch, M., Jacobs, H., & Speight, V. (2021, November 01). Defining domestic water consumption based on personal water use activities. *AQUA — Water Infrastructure, Ecosystems and Society, 70*(7), 189. Retrieved from https://iwaponline.com/aqua/issue/70/7

Inocencio, Arlene B.; Padilla, Jose E.; Javier, Esmyra P. (1999, February). Determination of Basic Household Water Requirements (Revised). *PIDS Discussion Paper Series, No. 1999-02*, p. 60. Retrieved from https://www.econstor.eu/bitstream/10419/187388/1/pidsdps9902.pdf?fbclid=IwAR3OoqGYyeOGNae7QhXKnEOBfMsS-h4FFyfzexh_OabOjwqTB0crcAY1TbU

National Irrigation Administration X. (2022). 2021 Status of Irrigation Development. Cagayan de Oro, Misamis Oriental, Region X.

Philippine Statistics Authority. (2019). *Developing the Water Accounts and Material Flow Accounts of the Philippines.* Quezon City: Philippine Statistics Authority.

Philippine Statistics Authority. (2021). *2020 Annual Poverty Indicators Survey.* Demographic and Health Statistics Division. Quezon City: Philippine Statistics Authority. Retrieved from https://psa.gov.ph/sites/default/files/%5BONSrev-cleared%5D%202020%20APIS%20Final%20Report_rev1%20wo%20comments_ONSF3_signed.pdf

Philippine Statistics Authority. (2021, August 23). *Census of Population and Housing.* Retrieved from Philippine Statistics Authority: https://psa.gov.ph/population-and-housing/node/165010

Philippine Statistics Authority. (2021, April 27). *Gross Regional Domestic Product.* Retrieved from Philippine Statistics Authority: https://psa.gov.ph/grdp

Philippine Statistics Authority. (2022, January 06). *News and Events.* Retrieved from Philippine Statistics Authority: https://psa.gov.ph/press-releases/id/165613

Philippine Statistics Authority. (n.d.). *Agriculture, Forestry, and FIsheries.* Retrieved from PSA OpenSTAT: https://openstat.psa.gov.ph/Database/Agriculture-Forestry-Fisheries

Shaffer, K. H., & Runkle, D. L. (2007). *Consumptive Water-Use Coefficients for the Great Lakes Basin and Climatically Similar Areas: U.S. Geological Survey Scientific Investigations Report 2007–5197.* US Department of the Interior. Reston, Virginia: US Geological Survey. Retrieved from https://pubs.usgs.gov/sir/2007/5197/pdf/SIR2007-5197_low-res_all.pdf

United Nations Statitstics Division. (2014, June 25-27). Retrieved from United Nations Department of Economic and Social Affairs Statistics: https://unstats.un.org/unsd/envaccounting/ceea/meetings/ninth_meeting/UNCEEA-9-6b.pdf

Water Resources Utilization Section, Licenses, Patents and Deeds Division, Department of Environment and Natural Resources X. (2021, May 25). Information, Education, and Communication on Water Use Regulation. Cagayan de Oro, Misamis Oriental, Region X.