Cordillera Administrative Region (CAR)

Physical Asset and Flow Accounts for Water Resources:

2008-2018

System of Environmental – Economic Accounting 2012
Central Framework

REPUBLIC OF THE PHILIPPINES
PHILIPPINE STATISTICS AUTHORITY
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CORDILLERA ADMINISTRATIVE REGION

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Tappiya Falls
Banaue, Ifugao, Philippines

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Foreword

Accounting the natural resources of the Cordillera Administrative Region (CAR) started in 2016 with the institutionalization of the Environment and Natural Resource Accounting (ENRA) Project of the Regional Statistical Services Office (RSSO)–CAR. With the guidance of the CAR ENRA Steering Committee and the technical assistance of the subject-matter task forces and technical working groups created by the CAR Regional Statistics Committee (RSC), the region has already compiled the region's physical and monetary asset accounts for land, timber and mineral resources. This time, the water resources accounts of the region are compiled and now presented.

The CAR Physical Asset and Flow Accounts for Water Resources: 2008-2018 is the sixth report on environmental accounting of the Cordillera. The region is able to come up with both the flow accounts and the more challenging stock accounts for water resources. The environmental accounting activity of RSSO-CAR is framed by the System of Environmental-Economic Accounting 2012—Central Framework (SEEA Central Framework).

SEEA-Central Framework is a statistical framework that is composed of comprehensive sets of tables and accounts, and serves as a guide in the compilation of consistent and comparable statistics and indicators for policymaking, analysis and research. The SEEA-Central Framework reflects the evolving needs of its users, new developments in environmental-economic accounting and advances in methodological research. The environmental accounting framework organizes data that support informed discussions and guide policies and programs related to the interrelationships between the economy and the environment.

The PSA extends its sincerest gratitude to the members of the Task Force on Water Resources Accounting for providing data, and more notably for lending their expertise that greatly enhance the compilation process of the water resources of the region. We will continue our collaborative efforts in building the region's databank of environment statistics to support the preparation, monitoring and implementation of environmental programs and the Sustainable Development Goals (SDG).

VILLAFE P. ALIBUYOG
Regional Director
Philippine Statististics Authority-CAR

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Acronyms

ASPBI	Annual Survey on Philippine Business and Industry
BCEZ	Baguio City Economic Zone
BFAR	Bureau of Fisheries and Aquatic Resources
BWD	Baguio Water District
CAR	Cordillera Administrative Region
CEPMO	City Environment and Parks Management Office
CF	Central Framework
CIS	Communal Irrigation System
CPH	Census on Population and Housing
DAO	Department Administrative Orders
DENR	Department of Environment and Natural Resources
DOST	Department of Science and Technology
EMB	Environmental Management Bureau
ENRA	Environment and Natural Resource Accounting
ENRAD	Environment and Natural Resources Accounts Division
LTWD	La Trinidad Water District
MAS	Macroeconomic Accounts Service
MGB	Mines and Geosciences Bureau
NAMRIA	National Mapping and Resource Information Authority
NEDA	National Economic and Development Authority
NIA	National Irrigation Administration
NIS	National Irrigation System
NPC	National Power Corporation
NWRB	National Water Resources Board
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PCAARRD	Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development
PEENRA	Philippine Economic-Environmental and Natural Resources Accounting
PEZA	Philippine Economic Zone Authority
PMD	Planning Management Division
PSA	Philippine Statistics Authority
PSNA	Philippine System of National Accounts
RSSO	Regional Statistical Services Office
SDG	Sustainable Development Goals
SEEA	System of Environmental-Economic Accounting
SOCD	Statistical Operations and Coordination Division
TF	Task Force
UN	United Nations
WRR	Water Resources Regions
WWRRDEC	Watershed and Water Resources Research Development Extension Center
MCM	Million Cubic Meter
ha	Hectares
mm	Millimeter

Executive Summary

This study attempts to measure the water reserves and determine the flow of water from the environment to the economy, within the economy, and from the economy back to the environment of Cordillera Administrative Region (CAR). The accounting will be compiled through the System of Environmental-Economic Accounting 2012 – Central Framework (SEEA CF).

The SEEA CF serves as the framework for this study. SEEA CF is a multi-purpose conceptual framework that integrates economic and environmental data that describes the interaction and relationship between the economy and the environment and the stocks and changes in stocks of environmental assets. It contains international standards, concepts, definitions, and classifications for comparable statistics and accounts around the globe.

This compilation was organized into two different, but connected, accounts – the Physical Asset and Physical Flow accounts. Physical Asset accounts also known as the stocks accounts record the stocks and changes in stocks and present information on the amount of water available at the beginning and end of an accounting period, referred to as opening and closing stocks. Physical Flow accounts describe the flows of water to and from the environment and the economy. It covers the entire process of water supply and use – the flow of water from the environment to the economy, within the economy, and from the economy supplied back to the environment.

Physical Asset Accounts

Additions to Stock

The main driving force in the increase in stocks for surface water was Surface Runoff contributing an annual average of 42% or an average of 902.60 MCM increase per year, after deducting outflow which is 98% of the surface runoff. Precipitation contributed a yearly average of 32% or 703.40 MCM followed by returns and inflows to dams with 25% and 1% equal to 531.61 MCM and 17.69 MCM increase per year.

Precipitation

From 2008 to 2018, the highest annual volume of precipitation was recorded in 2009 at 980.90 MCM, 2008 and 2018 were followed with 840.43 MCM and 810.47 MCM, respectively. On the other hand, the lowest volume of precipitation was recorded in 2014 at 503.83 MCM.

In general, precipitation in the region showed a decreasing trend. From 840.43 MCM at the beginning of the accounting to 810.47 MCM at the end. This reflects an annual average reduction of 3.00 MCM or an average of 3.3% decrease yearly.

Returns

Returns displayed an increasing trend, from 431.10 MCM in 2008 to 571.39 MCM in 2018 an annual average increase of 0.1% annually or 0.27 MCM average increase per year.

The highest recorded return was in 2016 at 580.90 MCM and on the other hand, the lowest was recorded in 2008 at 431.10 MCM.

There was only one instance when the return declined, this was recorded in 2017 at 557.51 MCM from 580.90, a decrease of 23.39 MCM.

Surface Runoff

From the start to the end of the accounting period, the highest amount of surface runoff was recorded in 2009 at 62,494.34 MCM, 2008 and 2018 followed at 53,500.69 MCM and 51,949.21 MCM, respectively. In the year 2014, the lowest recorded surface runoff was posted at 31,905.85 MCM.

Although the figures for Surface Runoff were high, 98% of it goes out of the river systems immediately, and only 2% of the runoff remains in the rivers and streams. The main driver for additions to stocks was precipitation.

Surface Runoff has the same trend with respect to Precipitation since it utilized precipitation for its estimation.

Inflows to Dams

The highest inflow to dams was 53.16 MCM recorded in the year 2014, 2010 followed by 47.15 MCM. On the other hand, the lowest inflow was recorded in 2013 and 2014 at 2.78 MCM and 3.16 MCM, respectively.

Inflows displayed an overall decreasing trend, from 15.27 MCM at the start of the accounting to 9.57 MCM at the end, which means an average decrease of 0.57 MCM per year or 205.5% annually.

Reductions in Stock

Most of the reductions in stocks were attributed to abstraction amounting to an annual average of 87% amounting to an average of 1,768.45 MCM increase per year. This was followed by evaporation with an annual average of 12% equal to a 246.77 MCM yearly increase. Lastly, Outflow from Dams contributed an annual average of 1% or 14.68 MCM increase per year.

Abstractions

Abstractions such as reductions in stocks displayed an increasing trend. From 1,268.96 MCM in 2008, it increased to 1,969.70 MCM in 2018, an increase of 700.11 MCM or an annual average growth rate of 4.7% or 70.01 MCM per year.

There was only one instance that abstraction decreased, this was recorded in the year 2017, from 2,017.75 MCM in 2016 it decreased by 114.2 MCM to 1,903.55 MCM the following year.

The highest recorded abstraction for the entire series was in 2016 at 2,017.75 MCM while the lowest abstraction was in 2008 at 1,268.96 MCM.

Evaporation

In 2013, the highest evaporation was recorded at 476.84 MCM, followed by 2010 and 2012 at 336.57 MCM and 338.07 MCM, respectively. Meanwhile, the least evaporation was recorded in 2018 at 148.66 MCM. The average evaporation throughout the whole accounting period amounted to 246.77 MCM.

In general, evaporation displayed a decreasing trend. From annual evaporation of 185.75 MCM in 2018, it decreased to 148.66 MCM in 2018. This was translated to an annual average decrease of 3.71 MCM or 5.0% annually.

Outflow to Other Territories

Outflow displayed the same trend with Surface Runoff, this is because outflow is just part of the runoff that passed through the river system.

It is notable that outflow had the highest contribution to the total reductions to stock, but outflow is not the main driver since it only passed through the river and was cancelled out by Surface Runoff.

Throughout the whole accounting, the highest outflow amounting to 61,880.79 MCM was recorded in 2009. 2008 and 2018 followed with 52,980.87 MCM and 51,433.54 MCM, respectively. On the other hand, the lowest recorded outflow was in 2014 at 31,599.44 MCM followed by 2013 and 2017 at 36,406.26 MCM and 37,071.96 MCM, respectively.

Outflows from Dams

Generally, outflows from dams displayed an increasing trend. From 4.74 MCM in 2008, it increased to 10.91 MCM in 2018, or an average increase of 105.45 MCM per year, equal to an average of 0.6% increment annually.

From 2008 to 2018, the highest outflow was recorded in the year 2016 at 37.53 MCM, followed by 2013 and 2012 at 27.41 MCM and 25.77 MCM, respectively. Conversely, the lowest outflow was recorded in 2014 at 4.27 MCM, followed by 2015 and 2008 at 4.65 MCM and 4.74 MCM, respectively.

Physical Flow Accounts

The SEEA Central Framework describes three types of flows. These are: flows from the environment to the economy; flows within the economy; and flows from the economy to the environment. With the available data, flows from the environment to the economy were broadly covered in this study, illustrating the sectors and industries utilizing the abstracted water from the environment.

Flows from the environment to the economy covers five major sectors/industries/districts according to the usage of abstracted water, namely: Agriculture, Forestry, and Fishing (subdivided into Irrigation, Fishing, and Livestock), Mining and Quarrying, Electricity Generation, Others (subdivided into Commercial, Industrial, Municipal, and Recreation), and Water Supply.

From the Environment to the Economy

Irrigation posted the highest abstraction from surface water with an average of 88%. Electricity generation followed with 11% and Aquaculture with 1%. The remaining industries had minimal abstractions.

Irrigation

Irrigation displayed an increasing trend, from an abstraction of 1,044.29 MCM at the beginning of the accounting to 1,743.28 MCM at the end. This reflected an annual average increase of 1,542.55 MCM or 5.56% per year. Irrigation posted an average abstraction of 1,542.55 MCM.

The only recorded decrease in abstraction was in 2017 at 1,678.85 MCM, from 1,792.69 MCM in the previous year.

Electricity Generation

There were only three instances that abstraction for the purpose of Electricity Generation increased. These instances were recorded in 2009, 2012, and 2013. From 190.96 MCM in 2008, it went up by 1.8 MCM to 192.76 MCM in 2009, and from 192.76 MCM in 2011 to 193.33 MCM in 2012 to 193.63 MCM in 2013, a total increase of 0.87 MCM.

Abstractions remained constant at 193.63 MCM from 2013 to 2018.

Aquaculture

Abstraction for Aquaculture remained the same all throughout the whole accounting at 24.56 MCM.

Livestock and Poultry

From the start to the end of accounting, the lowest abstraction for livestock and poultry was recorded in 2010 at 3.70 MCM, followed by 2009 at 3.86 MCM. The highest abstraction was recorded in 2018 at 3.98 MCM. The abstraction for Livestock and Poultry averaged 3.90 MCM.

Livestock and Poultry abstractions displayed an overall increasing trend, from 3.87 MCM in 2008 to 3.98 MCM in 2018. This reflects an average increase of 0.01 MCM or an average of 0.3% annualy.

Mining and Quarrying

Generally, abstractions for mining and quarrying displayed a decreasing trend. From 3.85 MCM at the start, it decreased to 2.41 MCM at the end of the accounting, equivalent to an average decrease of 35.16 MCM per year or 2.8%.

The lowest abstraction was recorded in 2013 at 0.40 MCM while the highest was in 2012 at 6.51 MCM.

It is worth mentioning that abstraction for mining and quarrying has a direct relation with production. If the production increases, the abstraction of water also increases and vice versa.

Industrial

Abstractions for Industrial purposes from 2011 to 2014 posted at 1.17 MCM were the highest during the accounting period. On the other hand, abstractions were lowest in 2016 to 2018 with 0.68 MCM.

From 0.8982 MCM abstraction in 2008, it decreased to 0.6778 MCM in 2018. This reflected an average decrease of 0.02 MCM per year or an average annual reduction of 1.9%.

From the Economy back to the Environment

Returns from Irrigation had the highest return with 58% share to the total returns equal to 308.51 MCM. Returns from Electricity Generation followed with 37% at an average return of 193.12 MCM. Aquaculture and Mine Wastewater came next with an average return of 25.56 MCM and 2.85 MCM, respectively, equal to 4% and 1% contribution to the total returns.

Household and Industrial yielded minimal returns.

Returns from Irrigation

The lowest return from Irrigation was recorded at the start of the accounting at 208.86 MCM while the highest was recorded in 2016 posted at 358.54 MCM.

Returns from irrigation exhibited the same trend with abstractions for irrigation – an increasing trend. From 208.86 MCM in 2008 to 348.66 MCM in 2018 equal to an annual increase of 13.98 MCM or 5.6% addition per year.

Returns from Electricity Generation

An increase of 1.8 MCM in 2009 was recorded, from 190.96 MCM returns in 2008 to 192.76 MCM. From 2009 to 2011, returns from Electricity Generation remained unchanged. Another increase was recorded in 2012 with 0.57 MCM and in 2013 at 0.3 MCM. Returns remained the same from 2013 to 2018 at 193.63 MCM.

Returns from Household

From a return of 2.47 MCM from households at the start of the accounting it went down to 1.56 MCM at the end of the accounting. A decreasing trend can be observed with an annual decrease of 3.8% or an average reduction of 0.09 MCM per year.

The highest return from Household was recorded in 2010 at 2.93 MCM, while the lowest recorded return was in 2017 at 1.50 MCM.

Returns from Household have a direct relationship with the number of houses connected to the city's sewerage system. This means that as the number of houses increases, returns also increase. With this, the trend should display an upward trend, but in this case, what had transpired was the reverse. It was later explained by CEPMO that lesser house was connected to the city's sewerage system. More houses built their own septic tank as a basic water treatment.

Returns from Mining and Quarrying

Returns from Mining and Quarrying exhibited a decline, the same trend that abstractions for mining and quarrying displayed since the volume of water for returns is equivalent to the volume of abstractions. From 3.85 MCM in 2008, it declined to 2.41 MCM in 2018. This means an average decrease of 0.14 MCM annually or an average reduction of 35.2% per year.

The highest return was recorded in 2012 at 6.51 MCM and the lowest was recorded in 2013 at 0.40 MCM.

Returns from Industries

The lowest volume of water that returned to the environment was recorded in 2014 at 0.36 MCM, while the highest return was in 2017 at 0.61 MCM.

Returns from industries showed an overall increasing trend, from 0.40 MCM at the start of the accounting to 0.57 MCM, equal to an average increase of 0.02 MCM per year or an annual average increase of 4.5%.

Introduction

Background

The Cordillera Administrative Region (CAR) is the watershed cradle of the north hosting 13 principal rivers systems (see Table 1) with an estimated drainage area of 18,293 square kilometers (about 6.0 percent of the total land area of the Philippines), making the region a major contributor to the Luzon Power Grid.

The river systems are crucial sources of water for irrigation not only for the region but also for other regions such as Regions I, II, and III. Since the benefits and the costs of utilizing this resource are yet to be firmly established, there are difficulties in identifying and grasping its scarcity.

Table 1. Watershed Areas (in square kilometers), CAR: 2010

Watershed	Area (km^2)
Abra	4,415.02
Silag	122.44
Amburayan	608.48
Naguilian	259.39
Aringay	194.55
Bued	184.74
Agno	1,287.25
Magat	2,324.46
Chico	4,056.71
Siffu-Mallig	1,502.58
Apayao-Abulug	2,650.95
Zimigui-Ziwanan	551.47
Cabicungan	58.88

Source: Department of Environment and Natural Resources - Cordillera Administrative Region

In 1976, the National Water Resources Council (NWRC) (now the National Water Resources Board (NWRB)) conducted a study on the water resources of the Philippines. The study entitled "1976 First National Assessment", divided the country into 13 Water Resource Regions (WRR). Due to hydrological boundary considerations as defined by physiographic features and homogeneity in climate, and political subdivisions during the period of the study, the present area under CAR is shared by WRRs I, II, and III (Environmental and Natural Resource Accounting: The Cordillera Experience, 1992, chapter IV).

CAR is the water supply center to various river systems that flow outside its boundaries. The Agno and Bued rivers that flow southward to Pangasinan and empty into the Lingayen Gulf drains water from the province of Benguet. Several tributaries like Ibulao and Lamut rivers that drain water from the province of Ifugao end up in Magat river, making Ifugao the primary source of water for Magat Dam. Chico and Abulog rivers form the major drainage system of the province of Kalinga-Apayao that eventually drains water into the mighty Cagayan River. Mountain Province is the head source of the Chico River. The Siffu-Mallig river drains water from the province towards Isabela before joining the Cagayan River (Environmental and Natural Resource Accounting: The Cordillera Experience, 1992, chapter IV).

The population of CAR grew at an average of 1.4% annually from 2010 to 2045 (see table 2). This growing population can be translated into increasing demand for water.

Commercial establishments and areas like the Baguio City Economic Zone (BCEZ) draw their needed water from privately installed pumps. The mining industry uses surface water for its drilling and mining processes. The agricultural sector also utilizes surface water as its primary source of water for irrigation. According to the National Irrigation Administration – Cordillera Administrative Region (NIA–CAR), as of 2018, there are 145,132 hectares of irrigated area where, 22,319 hectares are from the National Irrigation Systems (NIS) and 122,813 hectares are from the Communal Irrigation Systems (CIS).

This study attempts to determine the available stock of water resources in the region and measure changes in these stocks – whether it be additions or reductions in stock and to see the supply and consumption patterns. The results of this study are hoped to serve as valuable indicators in the analysis and formulation of policies with regard to the management of the region's water resources.

Table 2. Average Annual Population Growth Rate by Region, Philippines: 2010-2045 (Medium Assumption)

Region	2010-2045 Population Growth Rate
Philippines	1.21
National Capital Region	0.57
Cordillera Administrative Region	1.35
I - Ilocos Region	0.74
II - Cagayan Valley	0.87
III - Central Luzon	1.00
IVA - CALABARZON	1.31
IVB - MIMAROPA	1.58
V - Bicol Region	1.65
VI - Western Visayas	1.07
VII - Central Visayas	1.20
VIII - Eastern Visayas	1.53
IX - Zamboanga Peninsula	1.37
X - Northern Mindanao	1.09
XI - Davao Region	1.41
XII - SOCCSKSARGEN	1.47
Autonomous Region in Muslim Mindanao	2.12
Caraga	1.72

Source: Philippine Statistics Authority, 2010 Census-based Population Projections in collaboration with the Inter-Agency Working Group on Population Projections

An estimate of the region's water resources is crucial to planners and policy-makers, especially to those concerned with the management of the said resources. This study would give a wider view of how much water is being utilized, where the water is sourced, and how the water is used. Furthermore, the sustainable volume of abstraction will also be determined through the indicators that will emerge from this study.

Objectives of the Study

In general, this study aims to support the institutionalization of the environmental-economic accounting by following the United Nations System of Environmental-Economic Accounting (SEEA) 2012 Central Framework, particularly in water resources accounting. This study also aims to strengthen data support on the environment and natural resource accounting.

Specifically, the study intends to:

1. Compile the Asset Accounts for water resources of CAR. Assets include but are not limited to surface water (artificial reservoirs, rainwater catchment facilities, water treatment facilities, lakes, rivers, and streams);
2. Compile the Flow Accounts for water resources of CAR; and
3. Provide recommendations for the improvement of the accounting and valuation of water resources of CAR.

Bayokbok Falls in Barangay Tuel, Tublay, Benguet

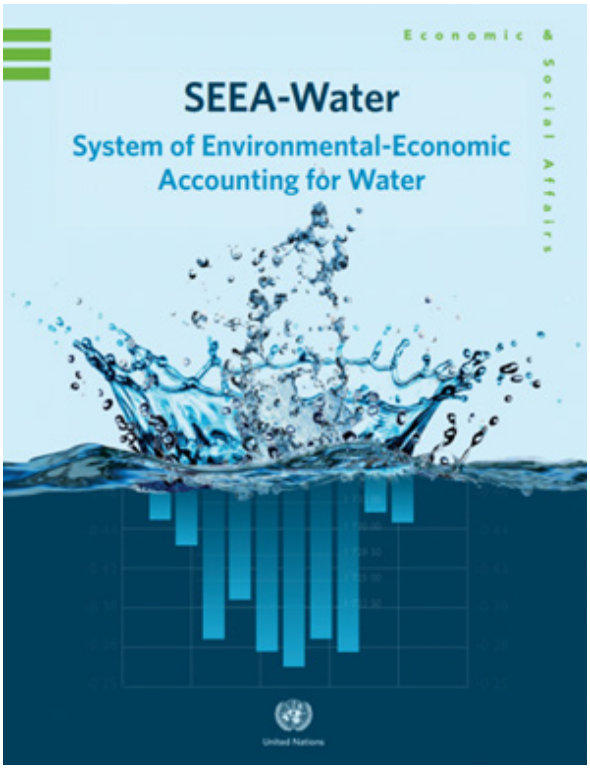
Photo by JJG Ruiz

Physical Asset Accounts for Water Resources, CAR: 2008-2018

Conceptual Framework

Scope and Coverage

The compilation of physical assets and flow accounts for water resources of the Cordillera Administrative Region (CAR) was based on the United Nations System of Environmental-Economic Accounting 2012 Central Framework (SEEA-CF). The framework integrates economic and environmental data to provide a more comprehensive view of the relationships between the economy and the environment.



There are three main accounts discussed in the SEEA-CF. These are: (1) the asset accounts, also known as the stock account that records the stocks and changes in stocks; (2) the flow accounts that measure the flow of water, energy, and material from the environment to the economy and vice versa, in both physical and monetary flow; and (3) the environmental activity accounts which focus on environmental goods and services, as well as expenditure on environmental protection and resource management. The focuses of this study are the asset and flow accounts.

Framework for the Physical Asset Accounts for Water Resources

According to the SEEA-CF, water resources are comprised of surface water, groundwater, and soil water, and consist of fresh and brackish water. Surface water covers all water that flows over or is stored on the ground's surface. This includes water in artificial reservoirs, lakes, rivers and streams, and also glaciers, snow, and ice. Groundwater refers to water that collects in porous layers of underground formations known as aquifers and yields significant quantities of water to wells and springs. Lastly, soil water consists of water suspended in the uppermost belt of soil or in the zone of aeration near the ground's surface.

The physical asset account for water resources presents information on the amount of water available at the beginning and end of an accounting period, referred to as opening and closing stocks. The accounts then record additions to stock (returns, precipitation, inflows from other territories, inflows from other inland water resources, and discoveries of water in aquifers) and reductions in stock (abstraction, evaporation and actual evapotranspiration, outflows to other territories, outflows to the sea, and outflows to other inland water resources) within the accounting period.

The entries are defined as follows:

1. Returns – the total volume of water that is returned to the environment by economic units;
2. Precipitation – the volume of atmospheric precipitation (rain, snow, hail, etc.) on the territory of reference during the accounting period. The amount of precipitation retained in the soil is to be recorded as additions to soil water while precipitation falling directly to surface water are to be recorded as additions to surface water;
3. Inflows – the amount of water that flows into water resources during the accounting period. These are disaggregated according to the origin of the water flow (inflows from other territories/countries and inflows from the other water resources within the territory);
4. Discoveries of water in new aquifers – the quantity of water in the newly discovered aquifer distinct from the overall capacity of the aquifer as initially assessed;
5. Abstraction – the amount of water removed from any source, either permanently or temporarily, during the accounting period;
6. Evaporation and actual evapotranspiration – evaporation refers to the amount of water evaporation from water bodies while actual evapotranspiration refers to the amount of water that evaporates from the land surface and is transpired by the existing vegetation; and
7. Outflows – the amount of water that flows out of water resources during the accounting period. These are disaggregated according to the destination of the water flow (other water resources within the territory, other territories/countries, the sea/ocean).

Table 3 shows the structure of the physical asset accounts for water resources. The columns present the different types of water resources while the rows enumerate the stocks and the changes in stocks over the accounting period. The values recorded in the physical asset accounts are expressed in terms of volume in million cubic meters (MCM).

Table 3. Basic Structure of Asset Accounts for Water Resources based on SEEA 2012 Central Framework

	TYPES OF WATER RESOURCES				
	SURFACE WATER				
	ARTIFICIAL RESERVOIRS	LAKES	RIVERS AND STREAMS	GROUNDWATER	SOIL WATER
OPENING STOCK FOR WATER RESOURCES					
ADDITIONS TO STOCK					
RETURNS					
PRECIPITATION					
INFLOWS					
DISCOVERIES					
TOTAL ADDITION TO STOCK					
REDUCTION IN STOCK					
ABSTRACTION					
ABSTRACTION					
EVAPORATION					
OUTFLOWS TO THE SEA					
OUTFLOWS TO OTHER INLAND WATER RESOURCES					
TOTAL REDUCTIONS IN STOCK					
CLOSING STOCK OF WATER RESOURCES					

Source: UN System of Environmental-Economic Accounting 2012 Central Framework. Table 5.25. p. 214.

Operational Framework

Scope and Coverage

The accounting covered 11 years from 2008 to 2018. The framework suggests the accounts include all water resources in the region. However, only surface water was compiled in this study.

Table 4. List of Rivers and Dams, CAR: 2015

Dams
Ambuklao
Binga

Rivers and Streams	River Length (km)
Abra	198.00
Silag	30.30
Amburayan	50.99
Naguilaina	30.60
Aringay	26.98
Bued	32.23
Agno	116.97
Magat	139.52
Chico	153.35
Siffu-Mallig	147.58
Apayao-Abulug	198.00
Zumigui-Ziwanan	34.17
Cabicungan	11.91

Source: DENR - CAR and EMB - CAR

Data sources

Opening and Closing Stocks

Data on the volume of water levels per month in dams were provided by the National Power Corporation (NPC). The volume of water levels was measured in million cubic meters (MCM).

Streamflow data that was used to compute for stocks of rivers were sourced from the Department of Environment and Natural Resources – Cordillera Administrative Region (DENR – CAR). The river profile (length) of each river and area of the watershed was also sourced from DENR-CAR.

Precipitation and Evaporation

Data on the annual amount of precipitation were provided by the Philippine Atmospheric Geophysical and Astronomical Service Administration (PAGASA). The data were disaggregated by monitoring stations all over the country and are expressed in terms of height in millimeters (mm). Similarly, evaporation data were also sourced from PAGASA and also reported by monitoring stations. Evaporation is measured in terms of volume in cubic meters.

Data on the land cover which are released every five years were provided by the National Mapping and Resource Information Authority (NAMRIA). Land cover categories include open, closed, and mangrove forests, inland water, built-up areas, cultivated areas planted with annual and perennial crops, fishponds, barren land, shrub land, grassland, and marshlands. Land cover data were expressed in the area (hectares).

Abstractions and Returns

Data on abstractions were taken from the permits applied by an individual or corporation at Natural Water Resources Board – Cordillera Administrative Region (NWRB). The permit contained the allowed daily abstraction measured in volume (cubic meters). The data also contained information on the source where the water is being abstracted (surface water or groundwater) and the primary purpose of the abstraction (livestock and poultry, electricity generation, commercial, recreation, industrial, mining and quarrying, and household).

The Bureau of Fisheries and Aquatic Resources – Cordillera Administrative Region (BFAR – CAR) reported on the volume of water used for fishpond measured in MCM.

Data on Returns came from NWRB, Philippine Economic Zone Authority (PEZA), and City Environment and Parks Management Office (CEPMO). Data on returns as recorded by NWRB were the redirected water used for electricity generation expressed in MCM. Return data from PEZA have treated wastewater from PEZA locators. Returns from CEPMO were collected wastewater from 65 barangays of Baguio City that were treated at Sanitary Camp, measured in MCM. The wastewater is released into the rivers once treated.

Another data for returns was mine wastewater from mining industries sourced from Mines and Geosciences Bureau (MGB) – CAR. The water used in mining is collected in mine tailings where the water is being impounded and treated before releasing it into bodies of water. Mine wastewater is measured in MCM.

The volume of water from fishponds was also treated as a return after fish were caught when used water is returned to rivers and streams.

Data Limitation and Measurement Issues

Stocks

According to the SEEA Central Framework, there are three main sources of stock of water resources namely: (1) surface water which consists of rivers and streams, lakes, artificial reservoirs, glaciers, snow, and ice (2) groundwater, and (3) soil water.

However, there are no conducted studies yet to measure the available volume of groundwater in the region. For soil water, the Task Force is still in the process of developing assumptions and methodologies that are applicable to the topography of the region.

In this study, the opening and closing stocks used in the accounting were data on surface water. Ideally, surface water resources should cover artificial reservoirs, lakes, rivers and streams, and glaciers, snow, and ice. However, stocks of water in lakes were not yet available thus, stocks for surface water in this accounting only included dams and rivers, and streams.

Additions to Stocks

Based on the SEEA Central Framework, there are four factors that increase the stocks of water resources, specifically: (1) Returns; (2) Precipitation; (3) Inflows; and (4) Discoveries of water in new aquifers. Ideally, all these factors should be included in the accounting. However, discoveries of water in new aquifers were not included in the accounting due to lack of available data.

Returns

There were three (3) sources for Returns as Additions to Stocks. These are Electricity Generation, Mining and Quarrying, and Aquaculture. Data for returns are only limited to the data available from NWRB (permit grants) for electricity generation. These permit grants have a declared volumes of abstraction. Thus, these abstractions were considered equivalent to returns for electricity generation. The data for Mining and Quarrying were sufficient. On the other hand, aquaculture data is limited to 2008 data only.

Precipitation

It is important to note that precipitation data for most provinces were not readily available. For CAR, the only source of data for precipitation that is within the region is from a station located in the City of Baguio. Precipitation data for other provinces of CAR was sourced from other stations located outside the region.

Inflows

Considering the topography and location of the region, CAR became one of the main sources of water for irrigation for low-lying areas, particularly Regions I, II, and III. Consequently, inflows towards the territory of the region were not considered.

Discoveries of water in new aquifers

There was no way to determine discoveries of water in new aquifers since studies to measure groundwater for the region were unavailable. In response to this, the Task Force adopted new entries as additions to stocks - Surface Runoff and Inflitration.

Surface Runoff

As defined by the National Irrigation Administration (NIA), surface runoff is the portion of precipitation that is not absorbed by the deep strata and finds its way into streams.

Retention

Denotes the portion of the precipitation that enters the soil (NIA).

Infiltration

Is the absorption of liquid water by the soil, either when it falls as rain when applied as irrigation, or from a stream flowing over the ground (NIA).

Reductions in Stocks

Reductions in stocks are from (1) Abstraction; (2) Evaporation and actual evapotranspiration; (3) Outflows; and (4) Ground Water Runoff. Most of the reductions in this study were derived by abstraction and evaporation.

Abstraction

All abstractions were dependent on permit grants given by NWRB. These data do not reflect the actual abstraction. An individual/company may go over or under the declared abstraction.

Evaporation and actual evapotranspiration

It is important to note that evaporation data for most provinces were not readily available. Evaporation data for Benguet was sourced from a station located at Benguet State University (BSU). On the other hand, evaporation data for other provinces were statistically imputed.

With respect to actual evapotranspiration, many factors needed to be considered like age of the plant, geographical location, and type of plant, among others, hence, evapotranspiration was not yet included in the compilation. The evapotranspiration coefficient of some variety of plants will be provided by NIA and would be incorporated in future updates.

Outflows

There are three types of outflows: (1) Outflows to other water resources; (2) Outflows to other territories; and (3) Outflows to the sea. Outflows to the sea were not incorporated in this compilation since the region is a landlocked area.

Ground Water Runoff

Ground Water Runoff, as defined by NIA, is the part of the runoff which has passed into the ground, becomes groundwater, and is discharged into a stream channel as spring or seepage water.

Estimation Methodology

Stocks

Stocks for water resources in the region were derived from the volume of water in dams and rivers. The total stock is presented by the formula below:

$$Total\ Stock = RiverStocks + DamStocks$$

Stocks for rivers were computed through a watershed approach, where a watershed discharges to a major river. Two parameters, discharge or streamflow, and length of river were utilized to calculate the stock of a river.

The formula below presents the computation procedure to derive the stock of water:

$$RiverStock_x = Streamflow_x \times Length\ of\ River_x$$

A river is never the same in width, depth, and streamflow all throughout its stretch. The limit of this methodology was that these parameters were considered but not yet included since river profiles were not yet completed.

Precipitation to Surface Water

The amount of precipitation as an addition to stock of surface water is estimated using the 2015 Land Cover of the region and the annual amount of precipitation by monitoring stations in the region.

Provinces with no facility to measure the amount of rain and precipitation were derived from the adjacent province with monitoring station that almost has the same characteristics (i.e., topography, temperature, weather, etc.). For the province of Abra, data on precipitation were derived from the average recorded rainfall from the monitoring stations of Laoag and Sinait. In Apayao, the data were derived from the station located in Appari. Benguet, Mountain Province, and Ifugao used the precipitation data from Baguio City monitoring station and for Kalinga, the data were derived from the station in Tuguegarao.

After deriving the amount of rainfall for each of the provinces, the precipitation to surface water was computed. The area of inland water was multiplied by the corresponding recorded precipitation data for each province.

$$Precipitation\ to\ Surface\ Water = \sum (P_x \times IWArea_x)$$

Where:

$P_x = Precipation\ of\ Province\ x$
$IWArea_x = Inland\ Water\ Area\ of\ Province\ x$

Total precipitation to inland water is the summation of the products of precipitation and inland water area of each province. Inland water is composed of lakes, rivers and streams, and dams.

Evaporation

The only monitoring station that records evaporation in the region was at Benguet State University (BSU) in Benguet. To derive evaporation, the ratio of evaporation and precipitation of a province, in this case Benguet, were utilized.

$$Ratio_{EP} = \frac{E_B}{P_B}$$

Where:

The computed *ratio* was then used together with the province's respective *Inland Water Area* to estimate the evaporation per province.

$$Evaporation = \sum (Ratio_{EP} \times IWArea_x)$$

Where:

$Ratio_{EP} = Ratio\ of\ Evaporation\ to\ Precipitation$

$IWArea_x = Inland\ Water\ Area\ of\ Province\ x$

Evaporation of the region is the summation of computed evaporation of each province.

Total Abstraction

Total Abstraction is the summation of all abstractions namely, Abstractions for Irrigation, Abstractions for Aquaculture, Abstractions for Livestock and Poultry, Abstractions for Mining and Quarrying, Abstractions for Electricity Generation, and Abstractions for Other use.

$$Total\ Abs_y = \sum (AbsIrr_y , AbsA_y, AbsL\&P_y, AbsM\&Q_y, AbsEG_y, AbsO_y)$$

Where:

$Total\ Abs_y = Total\ Abstraction\ in\ year\ y$

$AbsIrr_y = Abstractions\ for\ Irrigation\ in\ year\ y$

$AbsA_y = Abstractions\ for\ Aquaculture\ in\ year\ y$

$AbsL\&P_y = Abstractions\ for\ \ Livestock\ and\ Poultry\ in\ y$

$AbsM\&Q_y = Abstractions\ for\ Mining\ and\ Quarrying\ in\ year\ y$

$AbsEG_y = Abstractions\ for\ Electricity\ Generation\ in\ year\ y$

$AbsO_y = Abstractions\ for\ Other\ Use\ in\ year\ y$

Surface Runoff

Table 5 shows the adapted assumptions derived from the workshops conducted by the Task Force (TF). These assumptions were observed by DENR – CAR, and discussed and polished by the TF.

Table 5. Percentage of Surface Runoff according to slope, CAR: 2008-2018

Slope	Water Retention	Surface Runoff	Land Area (ha)
0-8 degrees	100% water retained	0% runoff	144,068
9-18 degress	90% water retained	10% runoff	111,235
19-30 degrees	10% water retained	90% runoff	150,290
31 degrees and above	5% water retained	95% runoff	1,459,741

Note: Derived from conducted workshops conducted with the Task Force

$$Surface\ Runoff = P_x\ (LArea_x \times SRCoefficient_x)$$

Where:

$P_x = Precipitation\ of\ Province\ x$

$LArea_x = Land\ Area\ of\ Province\ x$

$SRCoefficient = Surface\ Runoff\ Coefficient\ in\ Province\ x$

Returns

Sectors that generate returns to the environment other than sewerages and spills during delivery of water were electricity generation, fishponds, and mining and quarrying. These sectors abstract water, utilize it and then return the water back to the environment. The volume of water that goes back to the environment is the same volume that was abstracted.

Outflows

The Task Force from workshops and meetings conducted, agreed to assume that Outflow is 98% of the Surface Runoff. The remaining 2% is retained at flat areas where water is stagnant.

Ground Water Runoff

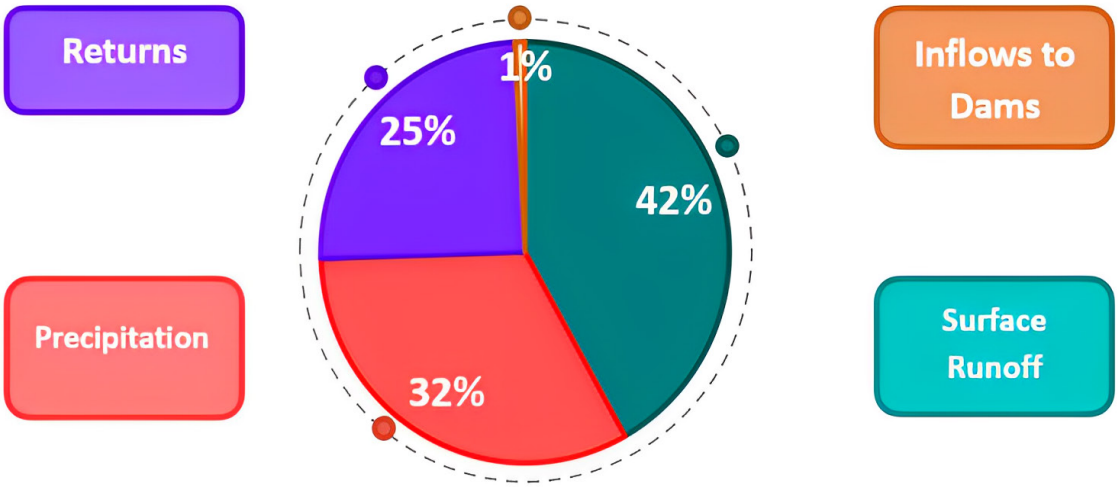
As defined by NIA, is the part of the runoff which has passed into the ground, becomes groundwater, and is discharged into a stream channel as spring or seepage water. Ground Water Runoff was adopted by the Task Force as a reduction in stock.

Results and Discussions

Additions to Stocks

As observed in Figure 1, the main driving force in the increase in stocks for surface water was Surface Runoff contributing an annual average of 42% or 902.60 MCM, after deducting outflow which is 98% of the surface runoff. Precipitation contributed a yearly average of 32% or 703.40 MCM, followed by returns and inflows to dams with 25% and 1% equal to 531.61 MCM and 17.69 MCM increase per year.

Figure 1. Average Percent Distribution of Inflows, Runoff, Precipitation, Returns as Additions to Stocks, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Table 6. Summary Table of Additions to Stocks for Surface Water in MCM, CAR: 2008-2018

Additions to Stock					
Year	Precipitation	Returns	Surface Runoff	Inflow to Dams	Total
2008	840.43	431.10	54,062.11	15.27	55,348.92
2009	980.90	488.00	63,143.67	11.41	64,623.98
2010	638.07	491.01	40,111.21	47.15	41,287.44
2011	731.46	500.47	46,775.46	7.39	48,014.78
2012	785.98	540.41	50,525.55	3.16	51,855.10
2013	583.19	545.99	37,149.25	2.78	38,281.20
2014	503.83	566.61	32,244.33	53.16	33,367.93
2015	732.82	574.34	47,881.53	8.53	49,197.22
2016	597.44	580.90	37,828.53	7.72	39,014.58
2017	532.76	557.51	34,226.05	28.44	35,344.75
2018	810.47	571.39	52,483.20	9.57	53,874.63

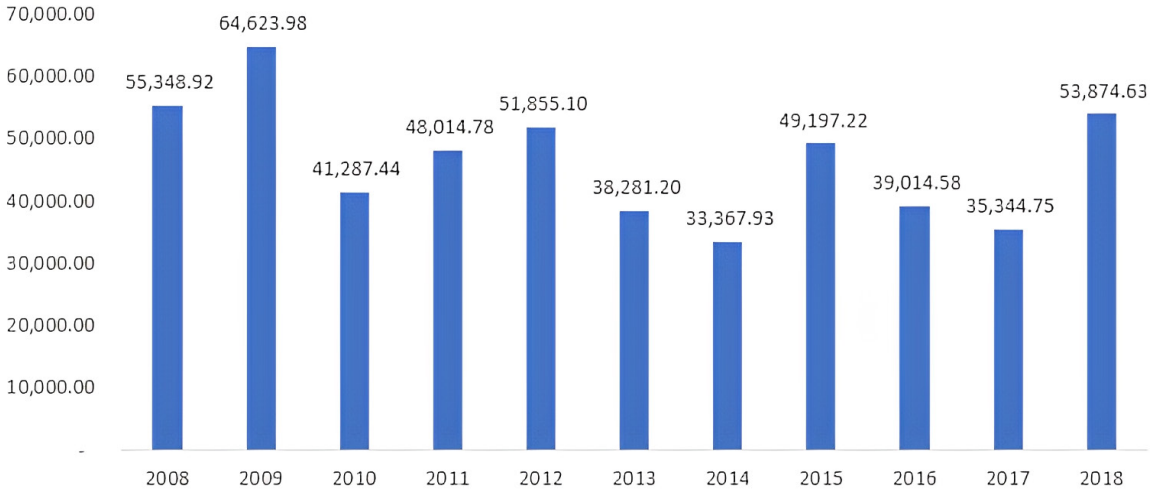
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

The highest increase in the stock was recorded in 2009 at 64,623.98 MCM. This was followed by 55,348.92 MCM and 53,874.63 MCM in 2008 and 2018, respectively. The lowest recorded addition to stock was in 2014 at 33,367.93 MCM.

It can be observed that there were spikes in the additions to stocks every 3 years, i.e., 2009, 2012, 2015, and 2018.

The total additions to stock follow the same trend with surface runoff since it is the main factor that affects the increases in stocks.

Figure 2. Total Additions to Stocks in MCM, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

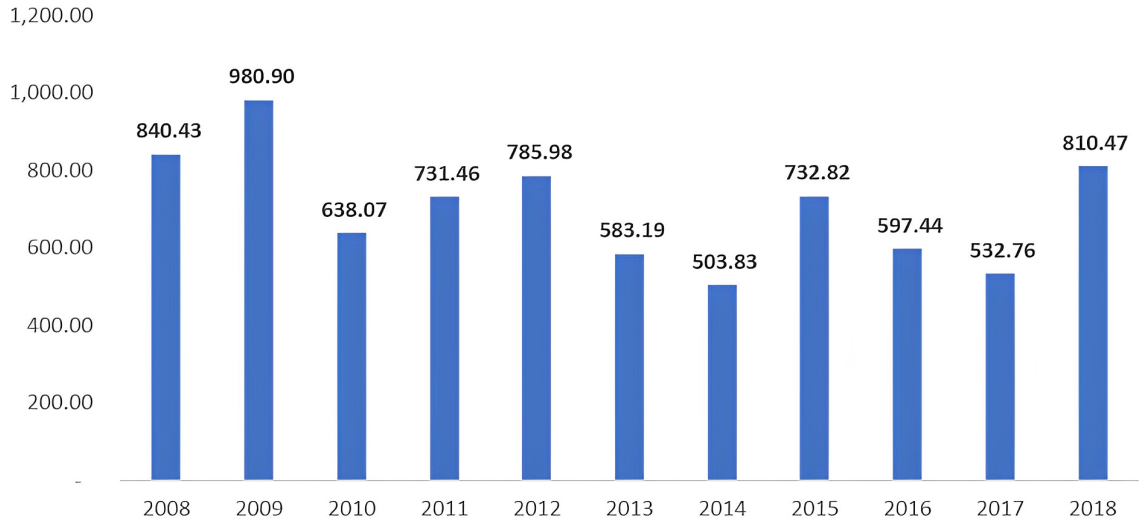
Precipitation

From 2008 to 2018, the highest annual volume of precipitation was recorded in 2009 at 980.90 MCM, followed by 840.43 MCM and 810.47 MCM in 2008 and 2018, respectively. On the other hand, the lowest volume of precipitation was recorded in 2014 at 503.83 MCM.

In general, precipitation in the region showed a decreasing trend. From 840.43 MCM at the beginning of the accounting to 810.47 MCM at the end. This reflects an annual average reduction of 3.00 MCM or an average of 3.27% decrease yearly.

It is important to note that in the years 2009, 2012, 2015, and 2018, precipitation was at its highest, a pattern observed that every three years there was an increase in precipitation – a phenomenon known as La Niña.

Figure 3. Annual Precipitation in MCM, CAR: 2008-2018



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration

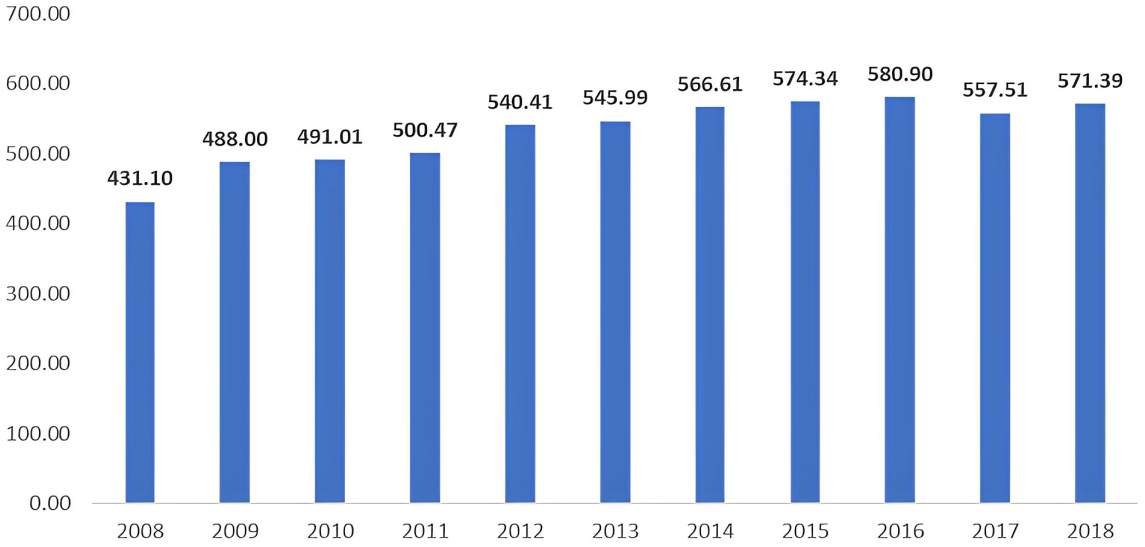
Returns

Returns displayed an increasing trend, from 431.10 MCM in 2008 to 571.39 MCM in 2018, this means an annual average increase of 0.14% annually or 0.27 MCM average increase per year.

The highest recorded return was in 2016 at 580.90 MCM while, the lowest was recorded in 2008 at 431.10 MCM.

There was only one instance when the return declined which was recorded in 2017 at 557.51 MCM from 580.90, equal to a decrease of 23.39 MCM.

Figure 4. Annual Return in MCM, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

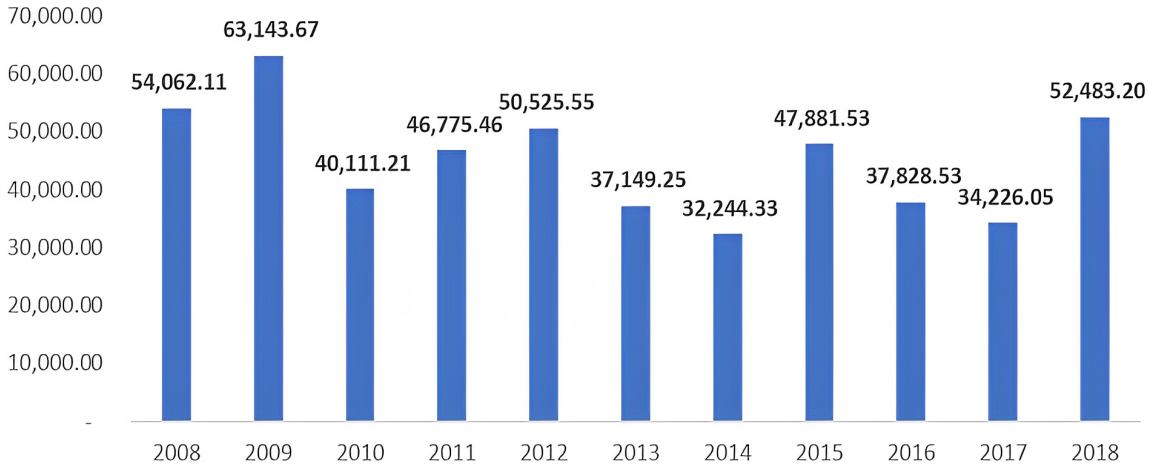
Surface Runoff

From the start to the end of the accounting period, the highest amount of surface runoff was recorded in 2009 at 62.494.34 MCM, followed by 53,500.69 MCM and 51,949.21 MCM in 2008 and 2018, respectively. The year 2014 was the lowest recorded surface runoff which posted at 31,905.85 MCM.

Although the figures for Surface Runoff were high, 98% of it goes out of the river systems immediately, and only 2% of the runoff remains in the rivers and streams. The main driver for additions to stocks was precipitation.

Surface Runoff has the same trend with respect to Precipitation since it utilized precipitation for its estimation.

Figure 5. Annual Surface Runoff in MCM, CAR: 2008-2018



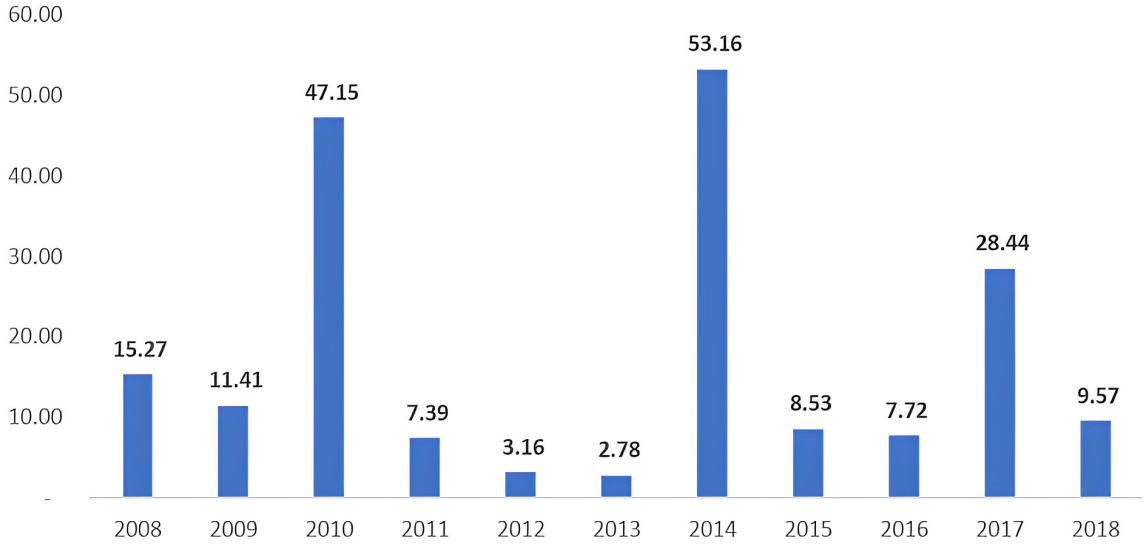
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Inflows to Dams

The highest inflow to dams was 53.16 MCM recorded in the year 2014, followed by 47.15 MCM in 2010. On the other hand, the lowest inflow was recorded in 2013 and 2014 at 2.78 MCM and 3.16 MCM, respectively.

Inflows displayed an overall decreasing trend, from 15.27 MCM at the start of the accounting to 9.57 MCM at the end. This means an average decrease of 0.57 MCM per year or an average of 205.5% decrease annually.

Figure 6. Annual Surface Runoff in MCM, CAR: 2008-2018

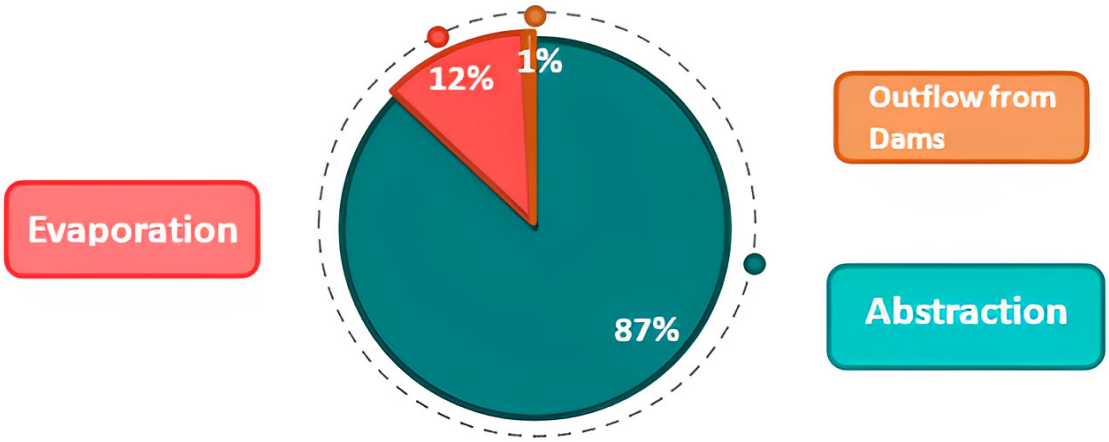


Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Reductions in Stock

Most of the reductions in stocks were attributed to abstraction amounting to an annual average of 87% amounting to an average of 1,768.45 MCM increase per year. Evaporation followed with an annual average of 12%, equal to a yearly increase of 246.77 MCM. Lastly, Outflow from Dams contributed minimal with an annual average of 1% or 14.68 MCM increase per year.

Figure 7. Average Percent Distribution of Abstraction, Evaporation, Outflows to other Territories, and Outflows from Dams as Reductions in Stocks, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

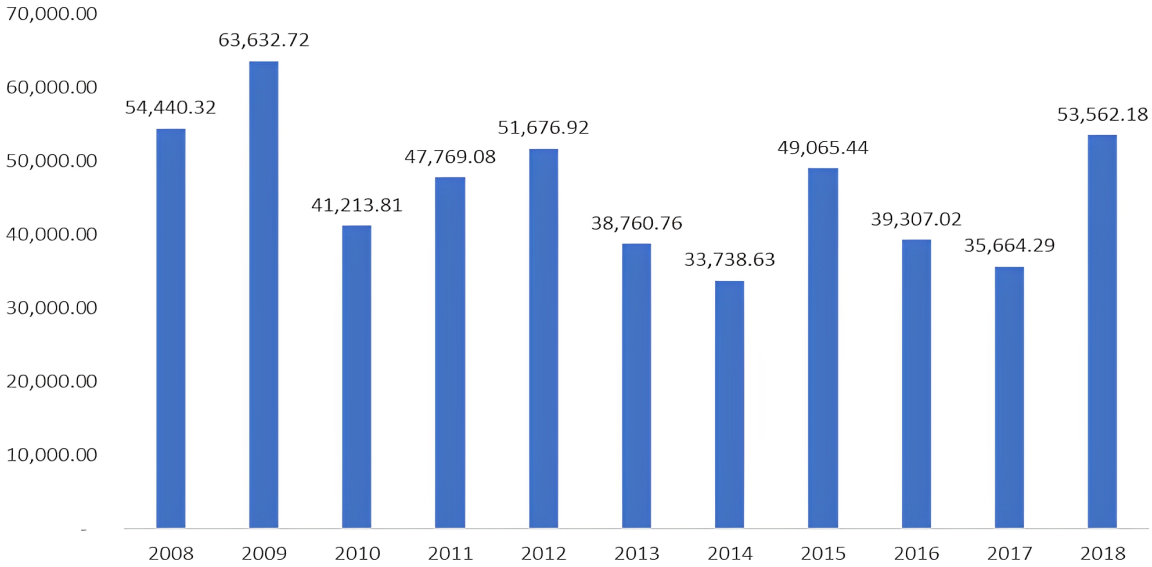
Table 7. Summary Table of Reductions of Stocks for Surface Water in MCM, CAR: 2008-2018

Reductions in Stocks					
Year	Abstractions	Evaporation	Outflow	Outflow from Dams	Total
2008	1,268.96	185.75	52,980.87	4.74	54,440.32
2009	1,543.49	188.26	61,880.79	20.18	63,632.72
2010	1,560.08	336.57	39,308.99	8.17	41,213.81
2011	1,609.02	308.75	45,839.95	11.36	47,769.08
2012	1,797.04	339.07	49,515.04	25.77	51,676.92
2013	1,850.25	476.84	36,406.26	27.41	38,760.76
2014	1,948.59	186.33	31,599.44	4.27	33,738.63
2015	1,985.13	151.76	46,923.90	4.65	49,065.44
2016	2,017.75	179.78	37,071.96	37.53	39,307.02
2017	1,903.55	212.68	33,541.53	6.53	35,664.29
2018	1,969.07	148.66	51,433.54	10.91	53,562.18

Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

The largest reduction in stock was recorded in 2009 with a value of 62,996.37 MCM, followed by 53,890.13 MCM and 53,038.87 MCM in 2008 and 2018, respectively. Conversely, the least reduction recorded in stock was in 2014 at 33,406.92 MCM.

Figure 8. Total Reductions in Stocks for Surface Water in MCM, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

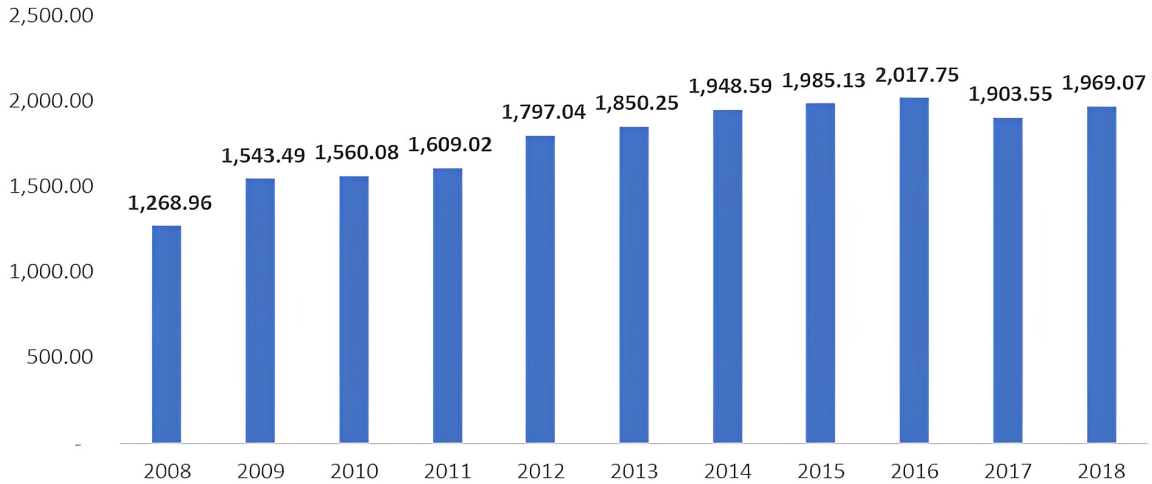
Abstractions

Abstractions such as reductions in stocks displayed an increasing trend. From 1,268.96 MCM in 2008, it increased to 1,969.70 MCM in 2018. This is equivalent to an increase of 700.11 MCM or an annual average growth rate of 4.7% or 70.01 MCM average growth per year.

There was only one instance when abstraction decreased which occured in the year 2017, from 2,017.75 MCM in 2016, it decreased by 114.2 MCM to 1,903.55 MCM the following year.

The highest recorded abstraction for the entire series was in 2016 at 2,017.75 MCM while the lowest abstraction was in 2008 at 1,268.96 MCM.

Figure 9. Annual Abstractions in MCM, CAR: 2008-2018



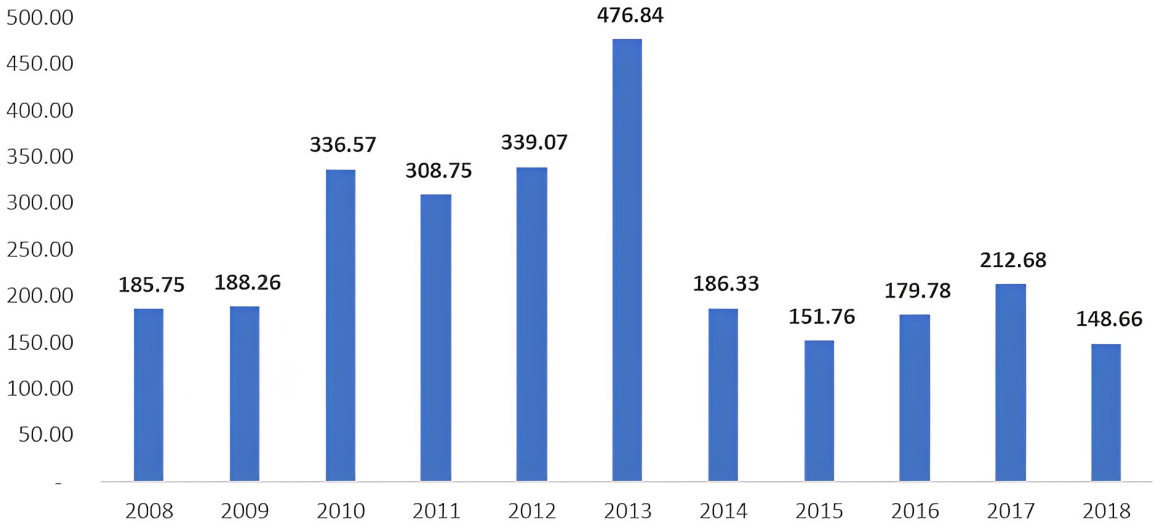
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Evaporation

In 2013, the highest evaporation was recorded at 476.84 MCM, followed by 336.57 MCM and 338.07 MCM in 2010 and 2012, respectively. Meanwhile, the least evaporation was recorded in 2018 at 148.66 MCM. The average evaporation throughout the whole accounting period amounted to 246.77 MCM.

In general, evaporation displayed a decreasing trend from annual evaporation of 185.75 MCM in 2018, it decreased to 148.66 MCM in 2018. This is translated to an annual average decrease of 3.71 MCM or an average of 5.0% yearly.

Figure 10. Annual Evaporation in MCM, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

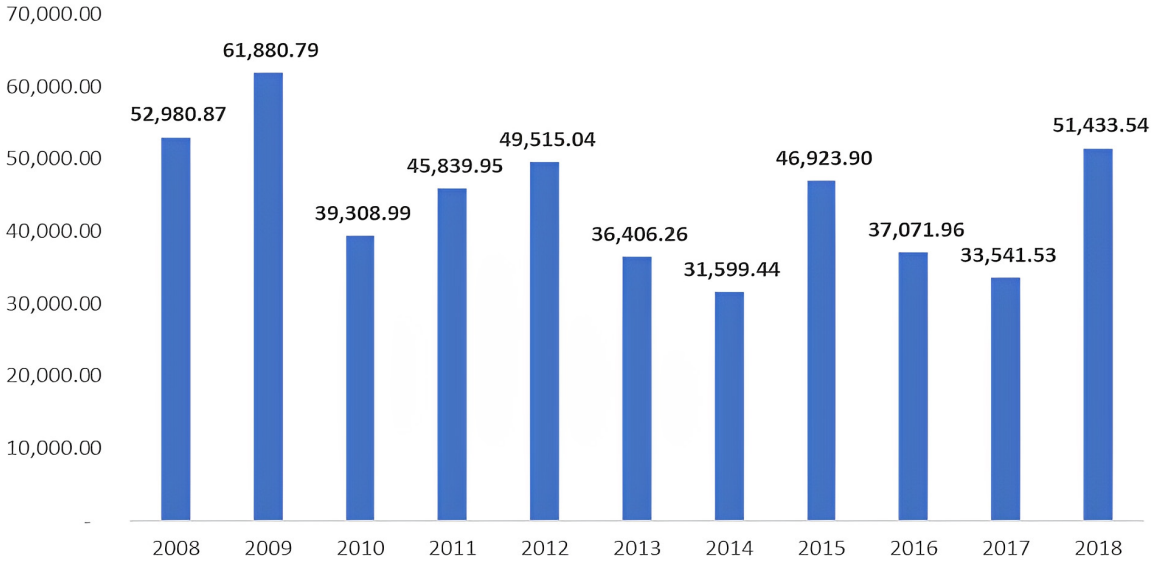
Outflow

Outflow displayed the same trend as Surface Runoff, this is because outflow is just part of the runoff that passed through the river system.

It is notable that outflow had the highest contribution to the total reductions to stock, but outflow is not the main driver since it only passed through the river and was cancelled out by Surface Runoff.

Throughout the whole accounting, the highest outflow amounting to 61,880.79 MCM was recorded in 2009, followed by 52,980.87 MCM and 51,433.54 MCM in 2008 and 2018, respectively. On the other hand, the lowest recorded outflow was in 2014 at 31,599.44 MCM followed by 36,406.26 MCM and 37,071.96 MCM in 2013 and 2017, respectively.

Figure 11. Annual Outflow in MCM, CAR: 2008-2018



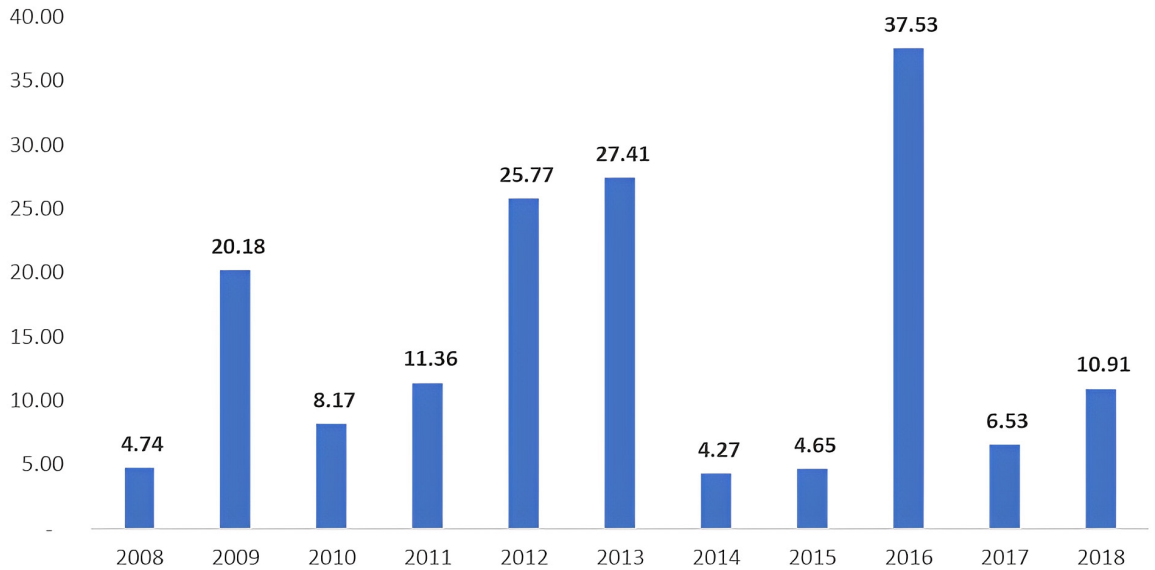
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Outflows from Dams

Generally, outflows from dams displayed an increasing trend from 4.74 MCM in 2008, it increased to 10.91 MCM in 2018, which means an average increase of 105.45 MCM per year or an average of 0.6% increment annually.

From 2008 to 2018, the highest outflow was recorded in year 2016 at 37.53 MCM, followed by 27.41 MCM and 25.77 MCM in 2013 and 2012, respectively. Conversely, the lowest outflow was recorded in 2014 at 4.27 MCM, followed by 4.65 MCM and 4.74 MCM in 2015 and 2008, respectively.

Figure 12. Outflows from Dams in MCM, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

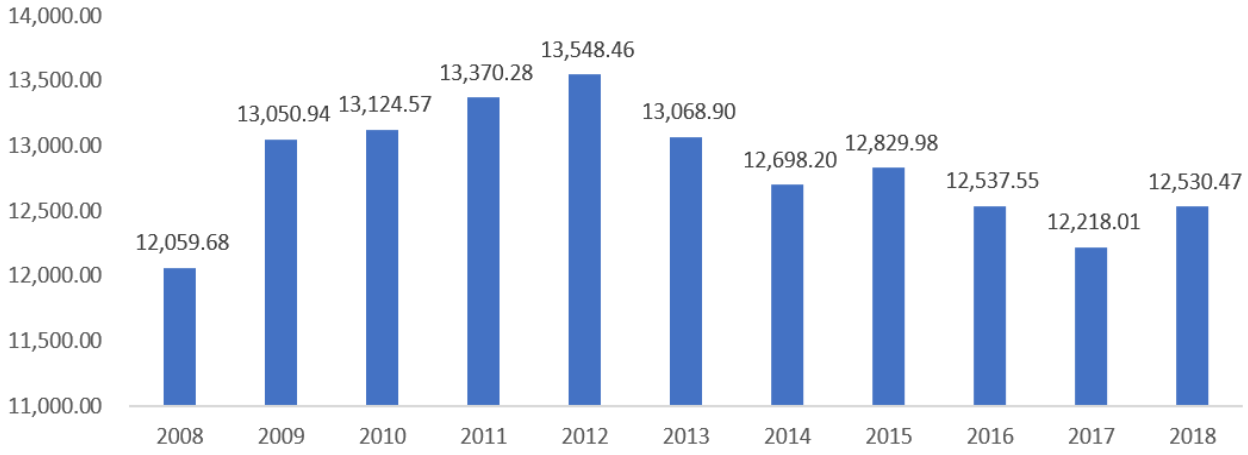
Closing Stocks of Surface Water

The figure shows an increasing trend from the start of the accounting to 2012 from 12,059.68 MCM in 2008 to 13,548.46 MCM in 2012, equivalent to an annual average increase of 372.20MCM or an average of 3.1% increase per year. From 2012 towards the end of the accounting, the figure displayed a change of trend from increasing to decreasing. From 13,548.46 MCM in 2012, it decreased to 12,530.47 MCM in 2018. This is translated to an annual average decrease of 169.66 MCM or an average of 1.3% decrease per year.

The highest level of stock for surface water was recorded in 2012 at 13,548.46 MCM while the lowest stock was recorded in 2008 at 12,059.68 MCM.

The increase in stocks generally followed the trend of Precipitation while the decrease in stocks reflected the trend of Abstractions. In general, precipitation and abstraction dictated the changes of stocks.

Figure 13. Closing Stocks of Surface Water in MCM, CAR: 2008-2018



Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Lussok River, Barangay Dagupan,
Luna, Apayao

Photo by JJG Ruiz

Physical Flow Accounts for Water Resources, CAR: 2008-2018

Conceptual Framework

Scope and Coverage

The SEEA – Central Framework enumerated seven disaggregation for data entries on the water flow based on how and where water is used.

Table 8. SEEA-Water Data items

Data Items
Agriculture, Forestry, and Fishing
Mining and quarrying, Manufacturing, Construction
Electricity, Gas, Steam, and Air conditioning supply
Water Collection, Treatment, and Supply
Sewerage
Other Industries
Households

Framework for the Physical Flow Accounts for Water Resources

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 on the flows of water between the environment and the economy. The five sections are defined as follows:

1. 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;

2. 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;

3. 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);

4. 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; and
5. 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 into the atmosphere. The amount of water incorporated into products is shown supplied by the relevant industry i.e., water is used in the manufacture of beverages.

In addition, the flow accounts are also divided into two parts: the supply and 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 their 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 the environment. The two tables must satisfy the supply and use identity – the total supply must be equal to the total use.

The supply and use table have virtually the same structure, containing the aforementioned five sections in the rows and the different economic units in the columns. Similar to the physical asset accounts, the physical flow accounts are measured in terms of volume in million cubic meters. Table 2 shows the structure of the supply table of the flow accounts while Table 3 presents the use table. Gray cells are null by definition.

Table 9. Basic Structure of the Supply Table of the Physical Flow Accounts for Water Resources

	Agriculture, Forestry and Fishing	Mining and Quarrying, Manufacturing, 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									

Source: UN System of Environmental-Economic Accounting 2012 Central Framework. Table 5.25. p. 214.

Table 10. Basic Structure of the Use Table of the Physical Flow Accounts for Water Resources

	Agriculture, Forestry and Fishing	Mining and quarrying, Manufacturing, 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 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										

Source: UN System of Environmental-Economic Accounting 2012 Central Framework. Table 5.25. p. 214.

Operational Framework

Scope and Coverage

The study derived eleven categories where the flow of water goes – from the source to the intended destination. These categories are based on how the water was intended to be utilized. These records were disaggregated as follows:

Table 11. Regional Data Items

Data Items Available in CAR
Irrigation
Aquaculture
Livestock and Poultry
Mining and Quarrying
Electricity Generation
Commercial
Industrial
Municipal
Recreation
Household
Water Collection, Treatment and Supply

Sources of Data

There are several data sources for the different elements of the physical flow accounts for water resources. This section enumerates the different components of the accounts, the data source agencies, as well as descriptions of the basic data provided. Conversion and estimation procedures are covered in the next section.

Irrigation

Data on the volume of water used for irrigation were sourced from NWRB-CAR and NIA-CAR. Water used for the communal irrigation system (CIS) was sourced from NWRB-CAR given by the permit grants on the average abstraction per day. On the other hand, water used for the national irrigation system (NIS) was provided by NIA-CAR which was further divided into three cropping seasons namely, wet crop, dry crop, and 3R crop or Quick Time Around crop.

Aquaculture

The Bureau of Fisheries and Aquatic Resources – Cordillera Administrative Region (BFAR – CAR) provided the volume of water for fish production in million cubic meters (MCM).

Livestock and Poultry

The per capita daily water requirements of major species were sourced from the Department of Science and Technology – Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD). Species and the number of heads per species were from PSA.

Mining and Quarrying

Mines and Geosciences Bureau (MGB) – CAR provided the abstracted and returned volume of water for mining. The water used for mining is collected in mine tailings where the water is being impounded and treated before releasing it into bodies of water. Mine wastewater is measured in MCM.

Electricity Generation, Commercial, Industrial, Municipal, and Recreation

NWRB – CAR provided volume of abstractions for electricity generation, commercial, industrial, municipal, and recreation through permit grants or allowed abstractions per day in MCM.

Household

For household use, abstractions were estimated from projected population from PSA and per capita daily consumption were obtained from a study of the Philippine Institute for Development Studies in 1999 entitled "Determination of Basic Household Water Requirements".

Treated Water

The volume of treated water from households was provided by the City Environment and Parks Management Office – LGU Baguio and treated water from industries was provided by the Philippine Economic Zone Authority – CAR.

Data Limitation

Physical flow accounting focuses on the amount of abstracted water from the environment, how the water was utilized in the economy, and the amount of water that returned to the environment from the economy.

Abstractions, as recorded by NWRB–CAR, applied by an individual or corporation should be limited to the allowable abstraction set by the agency. However, since there is no actual way to monitor these abstractions, it was assumed that abstractions can go under and beyond the allowable abstraction. Therefore, abstractions in this study were limited to the registered individual or corporation with their granted volume of abstraction.

Household

The data captured on abstractions for household use are limited between the projected population of the region and the estimated per capita water requirement which is equivalent to 54 liters per day. Information on other abstractions for household use was not captured like water deliveries, abstraction from rivers and streams, rainwater collection, and many more. Given this, there is a possibility of underestimation.

It should be noted that there was no disaggregation of abstraction between surface water and groundwater. However, the majority of abstractions for household use were from groundwater. Thus, abstraction was classified as groundwater.

Livestock and Poultry

Abstracted water for livestock and poultry was limited to water consumption, i.e., water used for cleaning, taking baths, brushing, and the like.

Mining and Quarrying

The volume of water for mining and quarrying was limited to registered companies. Abstractions from small-scale miners that are not registered legally were not captured in this study.

Electricity Generation, Commercial, Industrial, Municipal, Recreation

Volume of water for electricity generation, commercial, industrial, municipal, and recreation were limited to allowable abstractions from permit grants. However, the amount of abstraction per day indicated in the grant does not necessarily reflect the real amount of abstraction made by the applicant.

Estimation Methodology

Irrigation

Allowed abstractions from permit grants were utilized to compute the volume of water for irrigation.

$$Abstraction\ for\ Irr_y = \sum_{i=1}^{n}(Abstraction\ per\ Day_x \times 365)$$

Where:

$$Abstraction\ for\ Irr_y = Abstraction\ for\ Irrigation\ in\ year\ y$$

$$Abstraction\ per\ Day_x = Abstraction\ per\ Day\ of\ Person/Company\ x$$

Livestock and Poultry

Water consumption of CAR for livestock and poultry was computed from the per capita daily consumption of each species in the region.

$$Abstraction\ for\ L\&P = \sum_{i=1}^{n}(No.\ Heads_i\ x\ PCDR_i \times 365)$$

Where:

$$No.Heads_i = number\ of\ heads\ of\ the\ ith\ specie$$

$$PCDR_i = Per\ Capita\ Daily\ Requirement\ of\ the\ ith\ specie$$

Table 12. Per Capita Daily Requirement of Species in Liters, CAR: 2008-2018

Specie	Per Capita Daily Requirement (liters)
Carabao	60
Cattle	45
Goat	4.5
Swine	4
Broiler	140 per 100 heads
Layer	140 per 100 heads
Native	98 per 100 heads
Ducks	0.83

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

Mining and Quarrying

Water for mining and quarrying is the summation of all abstractions from registered mining companies. Return is equivalent to abstraction.

$$Abstraction\ for\ M\&Q_y = \sum_{i=1}^{n}(Abs\ per\ Year_x)$$

Where:

$Water\ for\ M\&Q_y = Volume\ of\ water\ for\ Mining\ and\ Quarryung\ in\ Year\ y$

$Abs\ per\ Year = Volume\ of\ Abstraction\ of\ Company\ i$

Electricity Generation, Commercial, Industrial, Municipal, and Recreation

$$Abstraction\ for\ EG_y = \sum_{i=1}^{n}(Abstraction\ per\ Day_x \times 365)$$

Where:

$Water\ for\ EG_y = Volume\ of\ water\ for\ Electricity\ Generation\ in\ Year\ y$

$Abstraction\ per\ Day_x = Abstraction\ per\ Day\ of\ Person/Company\ x$

Commercial

$$Abstraction\ for\ C_y = \sum_{i=1}^{n}(Abstraction\ per\ Day_x \times 365)$$

Where:

$Water\ for\ C_y = Volume\ of\ water\ for\ Commercial\ in\ Year\ y$

$Abstraction\ per\ Day_x = Abstraction\ per\ Day\ of\ Person/Company\ x$

Industrial

$$Abstraction\ for\ I_y = \sum_{i=1}^{n}(Abstraction\ per\ Day_x \times 365)$$

Where:

$Water\ for\ I_y = Volume\ of\ water\ for\ Industrial\ in\ Year\ y$

$Abstraction\ per\ Day_x = Abstraction\ per\ Day\ of\ Person/Company\ x$

Municipal

$$Water\ for\ M_y = \sum_{i=1}^{n} (Abstraction\ per\ Day_x \times 365)$$

Where:

$Water\ for\ M_y = Volume\ of\ water\ for\ Municipal\ in\ Year\ y$

$Abstraction\ per\ Day_x = Abstraction\ per\ Day\ of\ Person/Company\ x$

Recreation

$$Abstraction\ for\ R_y = \sum_{i=1}^{n} (Abstraction\ per\ Day_x \times 365)$$

Where:

$Water\ for\ R_y = Volume\ of\ water\ for\ Recreation\ in\ Year\ y$

$Abstraction\ per\ Day_x = Abstraction\ per\ Day\ of\ Person/Company\ x$

Household

The projected population used was from 2010 to 2020. Statistical imputation was done to complete the time series of the accounting (2008-2018). Water consumption of CAR for household is dependent to the population of the region per year with respect to the minimum requirement an individual needs/uses on a daily basis.

$$Abstraction\ for\ Household_y = PP_y \times IWR$$

Where:

$PP_y = Projected\ population\ in\ Year\ y$

$IWR = Individual\ Water\ Requirement, 54\ liters\ per\ capita$

Table 13. Projected Population in CAR: 2008-2018

Year	Projected Population
2008	1,569,100
2009	1,599,000
2010	1,629,300
2011	1,659,700
2012	1,690,100
2013	1,721,000
2014	1,752,100
2015	1,792,500
2016	1,815,300
2017	1,847,400
2018	1,879,700

Source: Philippine Statistics Authority, CPH 2010

Returns

Sectors that generate returns to the environment other than sewerages and spills during delivery of water were from electricity generation, aquaculture, and mining and quarrying. The said sectors abstract water then utilize it and then return it back to the environment. The volume of water that goes back to the environment is the same amount that was abstracted.

Mining and Quarrying

Volume of water as return from mining and quarrying is equivalent to the abstracted water since the abstracted water just passed through during the whole process. It is worthy to note that volume of abstraction and production have a direct relation, more or less production means more or less usage of water.

Irrigation Return

Estimation of return from irrigation are based on the following assumptions drawn from the conducted workshops by the Task Force.

Table 14. Assumptions for Irrigation, CAR: 2008-2018

Assumptions	
Retention	40%
Infiltration	40%
Return	20%

Note: Derived from conducted workshops with the Task Force

Returns from irrigation is the 20% of the volume of water that has entered in the rice fields that overflowed.

Results and Discussion

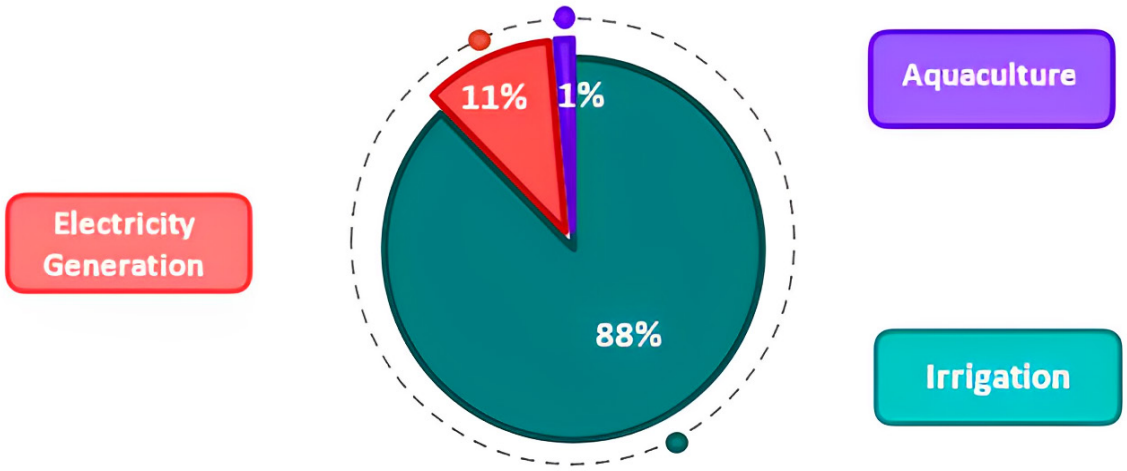
The SEEA Central Framework describes three types of flows. These are: flows from the environment to the economy; flows within the economy; and flows from the economy to the environment. With the available data, flows from the environment to the economy were broadly covered in this study, illustrating the sectors and industries utilizing the abstracted water from the environment.

Flows from the environment to the economy covers five major sector/industry/district according to the usage of abstracted water, namely: Agriculture, Forestry, and Fishing (sub divided into Irrigation, Fishing, and Livestock), Mining and Quarrying, Electricity Generation, Others (subdivided into Commercial, Industrial, Municipal, and Recreation), and Water Supply.

From the Environment to the Economy

As seen in figure x, Irrigation posted the highest abstraction from surface water with an average of 88%. Electricity generation followed with 11% and Aquaculture with 1%. The remaining industries had minimal abstractions.

Figure 14. Average Percent Distribution of Abstractions from Surface Water, CAR: 2008 – 2018



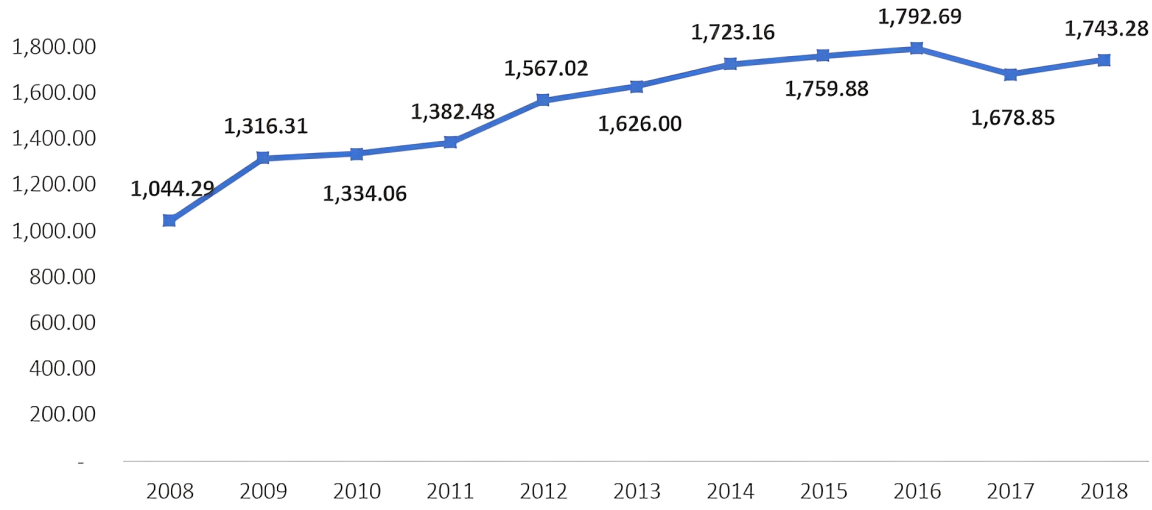
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Irrigation

Irrigation displayed an increasing trend, from an abstraction of 1,044.29 MCM at the beginning of the accounting to 1,743.28 MCM at the end. This reflected an annual average increase of 1,542.55 MCM or 5.6% addition per year. Irrigation posted an average abstraction of 1,542.55 MCM.

The only recorded decrease in the abstraction was in 2017 at 1,678.85 MCM from 1,792.69 MCM in the previous year.

Figure 15. Abstractions for Irrigation from Surface Water in MCM, CAR: 2008 – 2018



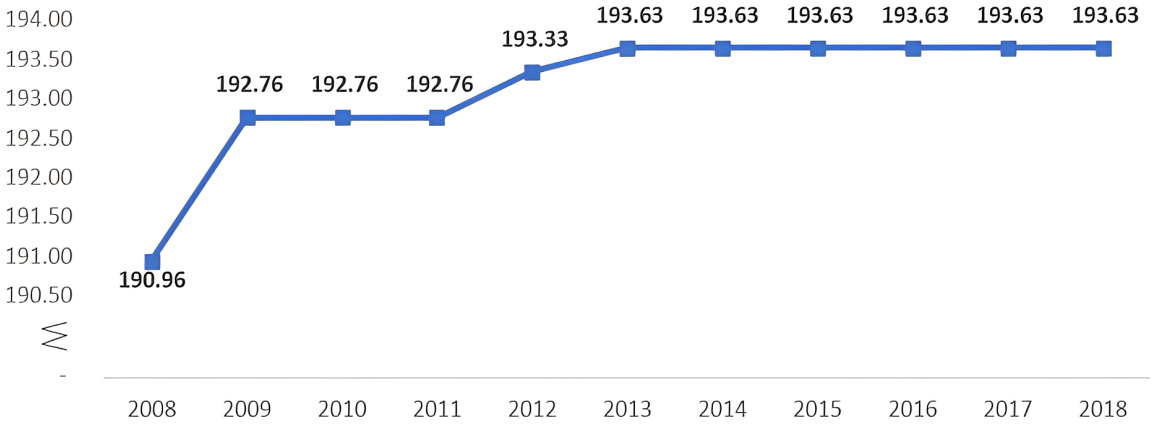
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Electricity Generation

There are only three instances that abstraction for the purpose of Electricity Generation increased. These instances were recorded in 2009, 2012, and 2013. From 190.96 MCM in 2008 it went up by 1.8 MCM to 192.76 MCM in 2009. And from 192.76 MCM in 2011 to 193.33 MCM in 2012 to 193.63 MCM, a total increase of 0.87 MCM.

Abstractions remained constant at 193.63 MCM from 2013 to 2018.

Figure 16. Abstractions for Electricity Generation from Surface Water in MCM, CAR: 2008 – 2018

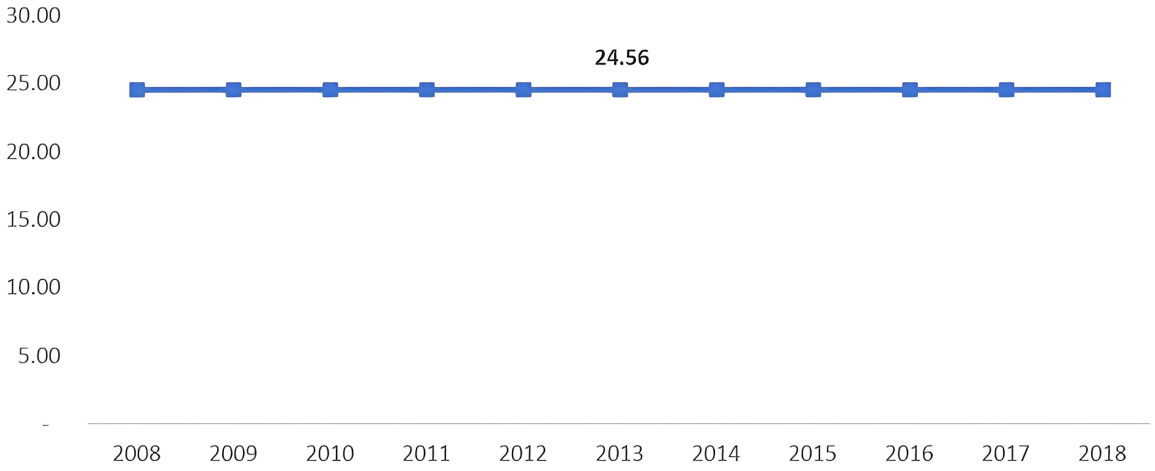


Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Aquaculture

Abstraction for Aquaculture remained the same all throughout the whole accounting at 24.56 MCM.

Figure 17. Abstractions for Aquaculture from Surface Water in MCM, CAR: 2008 – 2018



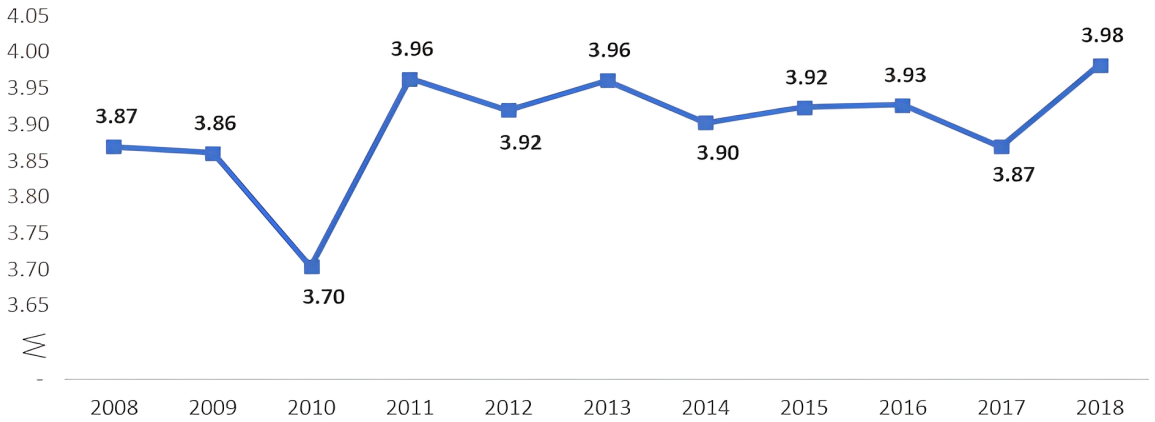
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Livestock and Poultry

From the start to the end of the accounting, the lowest abstraction for livestock and poultry was recorded in 2010 at 3.70 MCM, followed by 3.86 MCM in 2009. The highest abstraction was recorded in 2018 at 3.98 MCM. Abstraction for Livestock and Poultry averaged 3.90 MCM.

Livestock and Poultry abstractions displayed an overall increasing trend, from 3.87 MCM in 2008 to 3.98 MCM in 2018. This reflects an average increase of 0.01 MCM annually or an average of 0.3%.

Figure 18. Abstractions for Livestock and Poultry from Surface Water in MCM, CAR: 2008 – 2018



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

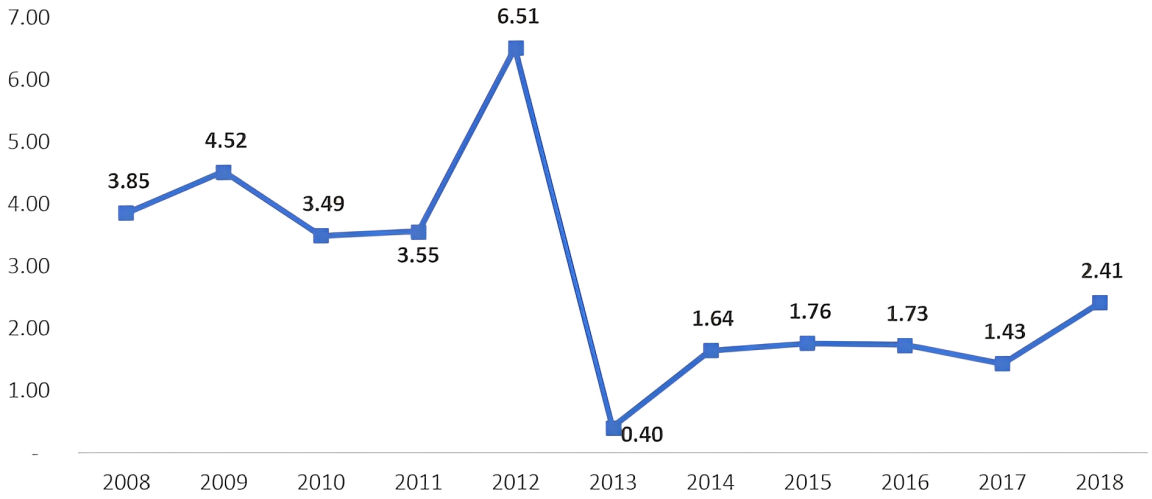
Mining and Quarrying

Generally, abstractions for mining and quarrying displayed a decreasing trend from 3.85 MCM at the start of accounting, it decreased to 2.41 MCM at the end of the accounting. This means an average decrease of 35.16 MCM per year or 2.9%.

The lowest abstraction was recorded in 2013 at 0.40 MCM while the highest was in 2012 at 6.51 MCM.

Abstraction for mining and quarrying has a direct relation with production whereas if the production increases, abstraction of water also increases and vice versa.

Figure 19. Abstractions for Mining and Quarrying from Surface Water in MCM, CAR: 2008 – 2018



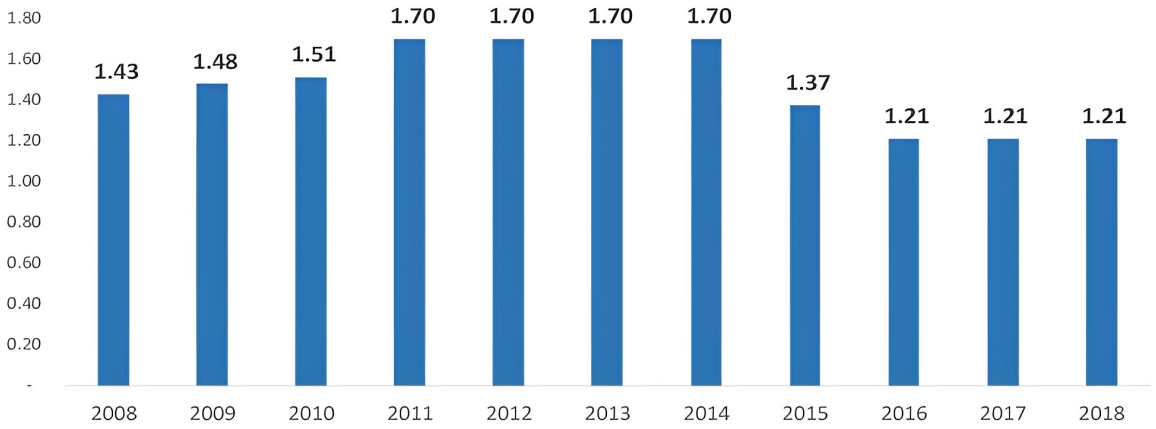
Source: Mines and Geosciences Bureau – Cordillera Administrative Region

Others

Abstractions for Others (Commercial, Recreation, Industrial) from 2011 to 2014 posted at 1.70 MCM were the highest during the accounting period. On the other hand, abstractions for Others were lowest in 2016 to 2018 with 1.21 MCM.

From 1.43 MCM abstraction in 2008, it decreased to 1.21 MCM in 2018. This reflected an average decrease of 0.02 MCM per year or an average annual reduction of 1.9%.

Figure 20. Abstraction for Others (Commercial, Recreation, Industrial) in MCM, CAR: 2008 – 2018



Source: National Water Regulatory Board – Cordillera Administrative Region

Table 15. Summary Table of All Abstractions from Surface Water in MCM, CAR: 2008 – 2018

Abstractions from Surface Water in MCM									
	Agriculture, Forestry, and Fishing			Electricity Generation	Mining and Quarrying	Others			
Year	Irrigation	Aquaculture	Livesock and Poultry			Commercial	Industrial	Recreation	Total
2008	1,044.29	24.56	3.87	190.96	3.85	0.53	0.8982	0.0026	**1,268.96**
2009	1,316.31	24.56	3.86	192.76	4.52	0.53	0.9479	0.0026	**1,543.49**
2010	1,334.06	24.56	3.70	192.76	3.49	0.53	0.9802	0.0026	**1,560.08**
2011	1,382.48	24.56	3.96	192.76	3.55	0.53	1.1702	0.0026	**1,609.02**
2012	1,567.02	24.56	3.92	193.33	6.51	0.53	1.1702	0.0026	**1,797.04**
2013	1,626.00	24.56	3.96	193.63	0.40	0.53	1.1702	0.0026	**1,850.25**
2014	1,723.16	24.56	3.90	193.63	1.64	0.53	1.1702	0.0026	**1,948.59**
2015	1,759.88	24.56	3.92	193.63	1.76	0.53	0.8421	0.0026	**1,985.13**
2016	1,792.69	24.56	3.93	193.63	1.73	0.53	0.6778	0.0026	**2,017.75**
2017	1,678.85	24.56	3.87	193.63	1.43	0.53	0.6778	0.0026	**1,903.55**
2018	1,743.28	24.56	3.98	193.63	2.41	0.53	0.6778	0.0026	**1,969.07**
Ave	**1,542.55**	**24.56**	**3.90**	**193.12**	**2.85**	**0.53**	**0.9439**	**0.0026**	

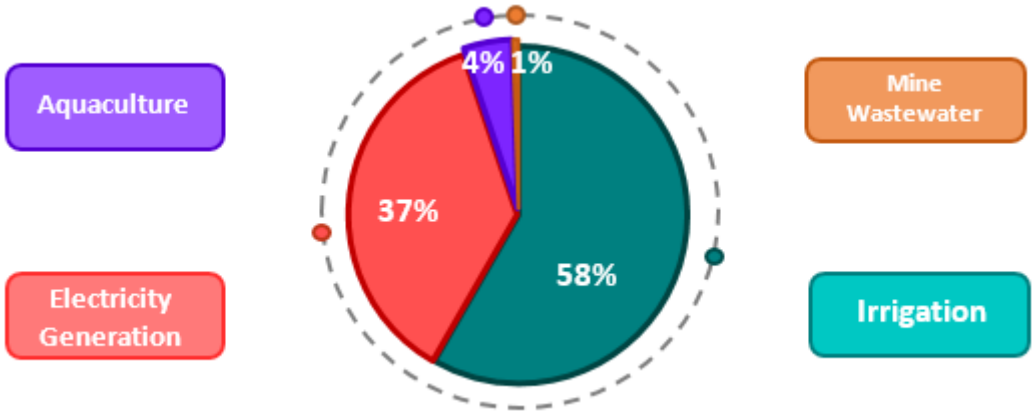
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

From the Economy back to the Environment

Figure 21 shows the average percent distribution of returns to surface water. Returns from Irrigation had the highest return with 58% share to the total returns, equal to 308.51 MCM. Returns from Electricity Generation followed with 37% at an average return of 193.12 MCM. Aquaculture and Mine Wastewater came next with an average return of 25.56 MCM and 2.85 MCM, respectively, equal to 4% and 1% contribution to the total returns.

Household and Industrial yielded minimal returns.

Figure 21. Average Percent Distribution of Returns to Surface Water, CAR: 2008 – 2018



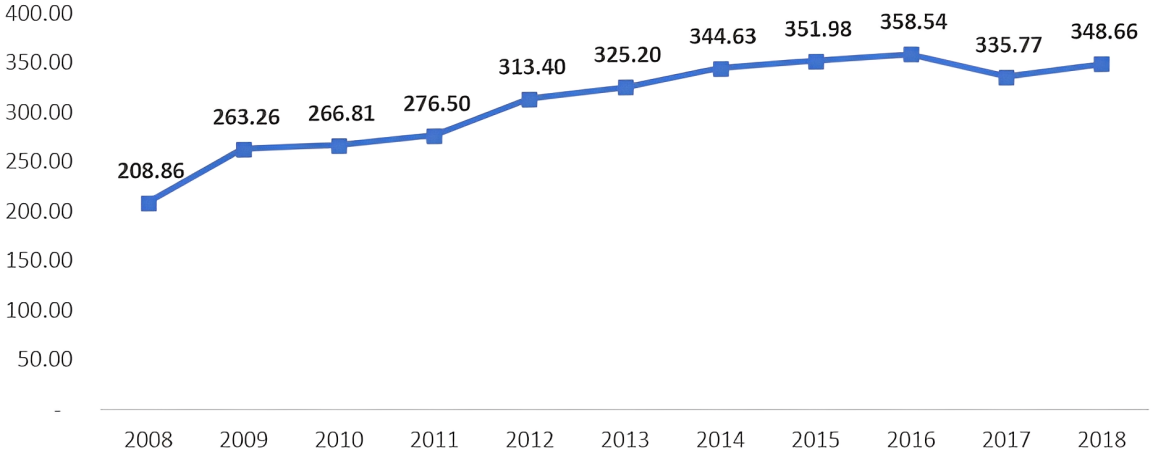
Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Returns from Irrigation

The lowest return from Irrigation was recorded at the start of the accounting at 208.86 MCM while the highest was recorded in 2016 posted at 358.54 MCM.

Returns from irrigation exhibited the same trend with abstractions for irrigation – an increasing trend. From 208.86 MCM in 2008 to 348.66 MCM in 2018, equal to an annual increase of 13.98 MCM or 5.6% addition per year.

Figure 22. Returns from Irrigation in MCM, CAR: 2008 – 2018

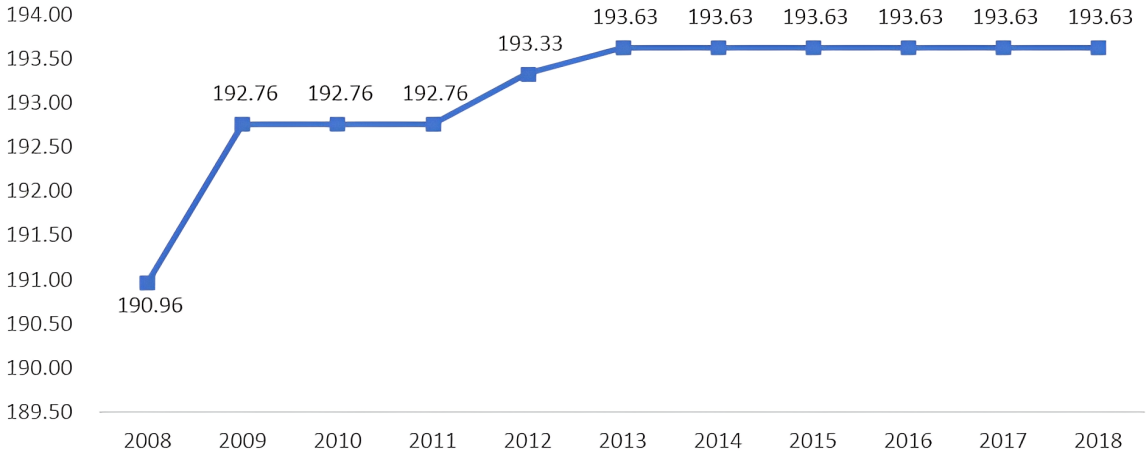


Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Returns from Electricity Generation

An increase of 1.8 MCM returns in 2009 was recorded from 190.96 MCM returns in 2008 to 192.76 MCM. From 2009 to 2011, returns from Electricity Generation remained unchanged. Another increase was recorded in 2012 with 0.57 MCM and in 2013 with 0.3 MCM. Returns remained the same from 2013 to 2018 at 193.63 MCM.

Figure 23. Returns from Electricity Generation in MCM, CAR: 2008 – 2018



Source: National Water Regulatory Board – Cordillera Administrative Region

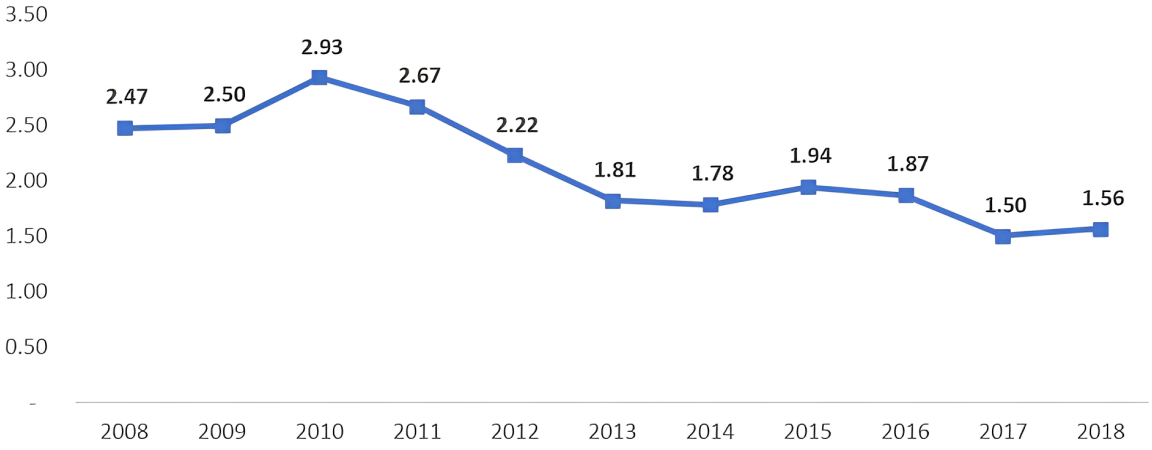
Returns from Household

From a return of 2.47 MCM from households at the start of the accounting, it went down to 1.56 MCM at the end of the accounting. A decreasing trend can be observed with an annual decrease of 3.8% or an average reduction of 0.09 MCM per year.

The highest return from household was recorded in 2010 at 2.93 MCM while the lowest recorded return was in 2017 at 1.50 MCM.

Returns from Household have a direct relationship with number of houses connected to the city's sewerage system. This means that as the number of houses increases, returns also increase. With this, the trend should display an upward trend, but in this case, what had transpired was the reverse. It was later explained by CEPMO that less houses was connected to the city's sewerage system. More houses built their own septic tank as a basic water treatment.

Figure 24. Returns from Household in MCM, CAR: 2008 – 2018



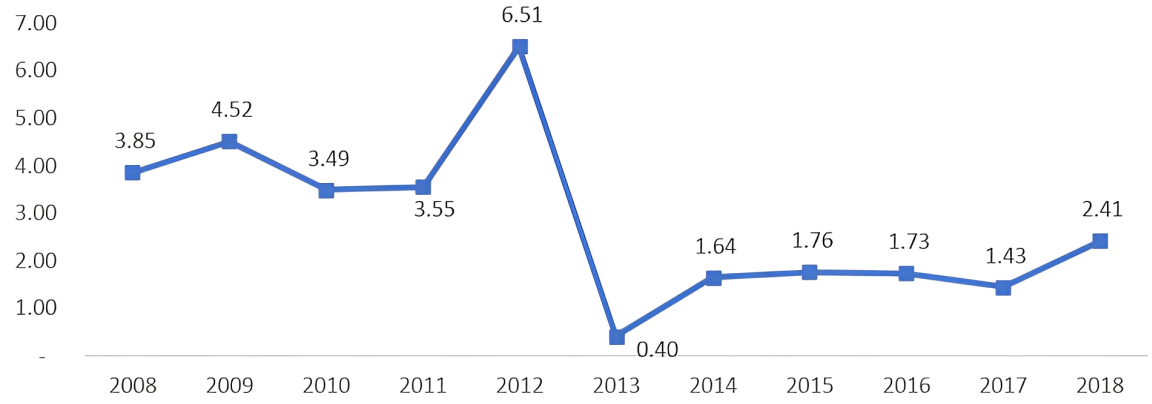
Source: City Environment and Parks Management Office – Baguio City

Returns from Mining and Quarrying

Returns from Mining and Quarrying exhibited a decline, the same trend that abstractions for mining and quarrying displayed since volume of water for returns is equivalent to the volume of abstractions. From 3.85 MCM in 2008, it declined to 2.41 MCM in 2018. This means an average decrease of 0.14 MCM annually or an average reduction of 35.2% per year.

The highest return was recorded in 2012 at 6.51 MCM and the lowest was recorded in 2013 at 0.40 MCM.

Figure 25. Returns from Mine Wastewater in MCM, CAR: 2008 – 2018



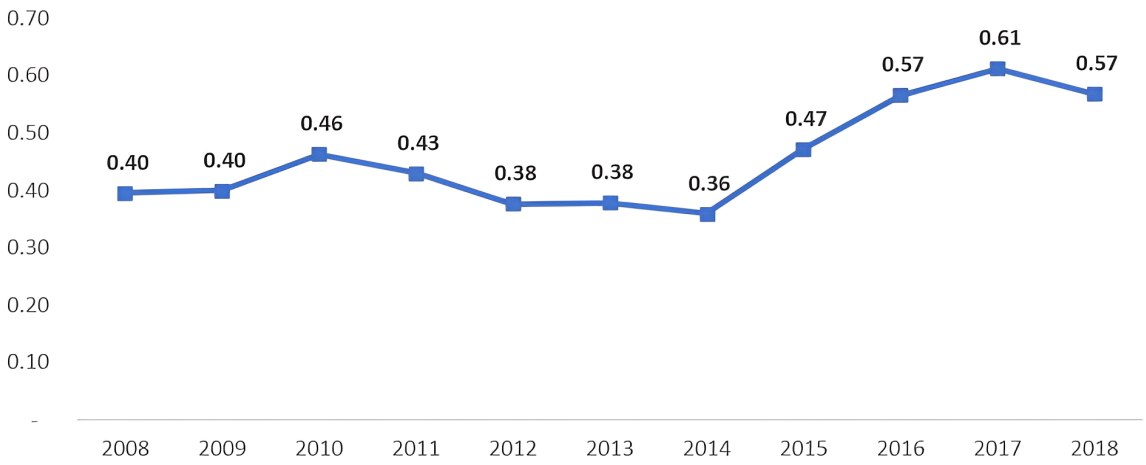
Source: Mines and Geosciences Bureau – Cordillera Administrative Region

Returns from Industries

The lowest volume of water that returned to the environment was recorded in 2014 at 0.36 MCM while the highest return was in 2017 at 0.61 MCM.

Returns from industries showed an overall increasing trend, from 0.40 MCM at the start of the accounting to 0.57 MCM. This translates to an average increase of 0.02 MCM per year or an annual average increase of 4.5%.

Figure 26. Returns from Industries in MCM, CAR: 2008 – 2018



Source: Philippine Economic Zone Authority Baguio Ecozone

Table 16. Summary Table of Returns from the Economy to the Environment in MCM, CAR: 2008 – 2018

Returns to Surface Water in MCM							
Year	Electricity Generation	Aquaculture	Mine Wastewater	Household	Industrial	Irrigation	Total
2008	190.96	24.56	3.85	2.47	0.40	208.86	**431.10**
2009	192.76	24.56	4.52	2.50	0.40	263.26	**488.00**
2010	192.76	24.56	3.49	2.93	0.46	266.81	**491.01**
2011	192.76	24.56	3.55	2.67	0.43	276.50	**500.47**
2012	193.33	24.56	6.51	2.22	0.38	313.40	**540.41**
2013	193.63	24.56	0.40	1.81	0.38	325.20	**545.99**
2014	193.63	24.56	1.64	1.78	0.36	344.63	**566.61**
2015	193.63	24.56	1.76	1.94	0.47	351.98	**574.34**
2016	193.63	24.56	1.73	1.87	0.57	358.54	**580.90**
2017	193.63	24.56	1.43	1.50	0.61	335.77	**557.51**
2018	193.63	24.56	2.41	1.56	0.57	348.66	**571.39**
Ave	**193.12**	**24.56**	**2.85**	**2.11**	**0.46**	**308.51**	

Source: Philippine Statistics Authority – Regional Statistical Services Office Cordillera Administrative Region

Conclusions and Recommendations

The following conclusions were drawn based on the results of this study:

A. Asset Accounts for Water Resources of CAR

At the end of the accounting period, the region was left with a stock of water amounting to 12,426.71 million cubic meters. All of which attributed to surface waters in the region namely rivers and streams and dams.

B. Physical Flow Accounts for Water Resources of CAR

From the Environment to the Economy

Total abstraction at the end of the accounting period amounted to 1.969.07 million cubic meters. These abstractions that went to different sectors in the economy, are as follows:

1. For Irrigation – Abstracted water from surface water amounted to 1.743.28 million cubic meters;
2. For Aquaculture – Aquaculture abstracted from surface water amounting to 24.56 million cubic meters;
3. For Livestock and Poultry – In 2018, abstractions from surface water for livestock and poultry recorded at 3.98 million cubic meters;
4. For Mining and Quarrying – Mining and quarrying sector abstracted an amount of 2.41 million cubic meters from surface water in 2018;
5. For Electric Generation – Abstracted water for electric generation from surface water posted 193.63 million cubic meters; and
6. For Others – In 2018, abstractions for others amounted to 1.21 million cubic meters.

From the Economy back to the Environment

Total returns at the end of the accounting period posted 571.39 million cubic meters that went to the surface water. These returns were attributed from the following:

1. From Industries – Wastewater from industries amounted to 0.57 million cubic meters;
2. From Households – Returns from households through sewerages posted 1.56 million cubic meters;
3. From Electricity Generation – Electricity generation sector returned 193.63 million cubic meters;
4. From Aquaculture – In 2018, returns from fishing posted 24.56 million cubic meters; and
5. From Mining and Quarrying – Returns from mining and quarrying through mine tailings posted 2.41 million cubic meters.

Based on the stated conclusions above, the following are therefore recommended:

1. Stocks for water resources in the region may be underestimated since groundwater was not included yet in the study. A study to measure groundwater is recommended.
2. Standardization of the methodology used, including definitions and terms.
3. Updating on the data pool, both for PSA and the sources of data.

Appendices

Appendix Table 1. Physical Asset Accounts for Water Resources, CAR: 2008

Physical Asset Accounts	2008		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	95.72	11,055.36	11,151.08
Additions to Stock			
Return		431.10	
Precipitation		840.43	
Inflow	15.27		
Surface Run-off		54,062.11	
Total Additions to Stock		55,348.92	
Reductions in Stock			
Abstraction		1,268.96	
Evaporation		185.75	
Outflow	4.74	52,980.87	
Total Reductions in Stock		54,440.32	
Closing Stock	**106.25**	**11,953.43**	**12,059.68**

Source: PSA - RSSO CAR

Appendix Table 2. Physical Asset Accounts for Water Resources, CAR: 2009

Physical Asset Accounts	2009		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	106.25	11,953.43	12,059.68
Additions to Stock			
Return		488.00	
Precipitation		980.90	
Inflow	11.41		
Surface Run-off		63,143.67	
Total Additions to Stock		64,623.98	
Reductions in Stock			
Abstraction		1,543.49	
Evaporation		188.26	
Outflow	20.18	61,880.79	
Total Reductions in Stock		63,632.72	
Closing Stock	**97.48**	**12,953.46**	**13,050.94**

Source: PSA - RSSO CAR

Appendix Table 3. Physical Asset Accounts for Water Resources, CAR: 2010

Physical Asset Accounts	2010		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	97.48	12,953.46	13,050.94
Additions to Stock			
Return		491.01	
Precipitation		638.07	
Inflow	47.15		
Surface Run-off		40,111.21	
Total Additions to Stock		41,287.44	
Reductions in Stock			
Abstraction		1,560.08	
Evaporation		336.57	
Outflow	8.17	39,308.99	
Total Reductions in Stock		41,213.81	
Closing Stock	**136.46**	**12,988.11**	**13,124.57**

Source: PSA - RSSO CAR

Appendix Table 4. Physical Asset Accounts for Water Resources, CAR: 2011

Physical Asset Accounts	2011		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	136.46	12,988.11	13,124.57
Additions to Stock			
Return		500.47	
Precipitation		731.46	
Inflow	7.39		
Surface Run-off		46,775.46	
Total Additions to Stock		48,014.78	
Reductions in Stock			
Abstraction		1,609.02	
Evaporation		308.75	
Outflow	11.36	45,839.95	
Total Reductions in Stock		47,769.07	
Closing Stock	**132.49**	**13,237.79**	**13,370.28**

Source: PSA - RSSO CAR

Appendix Table 5. Physical Asset Accounts for Water Resources, CAR: 2012

Physical Asset Accounts	2012		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	132.49	13,237.79	13,370.28
Additions to Stock			
Return		540.41	
Precipitation		785.98	
Inflow	3.16		
Surface Run-off		50,525.55	
Total Additions to Stock		51,855.10	
Reductions in Stock			
Abstraction		1,797.04	
Evaporation		339.07	
Outflow	25.77	49,515.04	
Total Reductions in Stock		51,676.92	
Closing Stock	**109.88**	**13,438.58**	**13,548.46**

Source: PSA - RSSO CAR

Appendix Table 6. Physical Asset Accounts for Water Resources, CAR: 2013

Physical Asset Accounts	2013		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	109.88	13,438.58	13,548.46
Additions to Stock			
Return		545.99	
Precipitation		583.19	
Inflow	2.78		
Surface Run-off		37,149.25	
Total Additions to Stock		38,281.20	
Reductions in Stock			
Abstraction		1,850.25	
Evaporation		476.84	
Outflow	27.41	36,406.26	
Total Reductions in Stock		38,760.77	
Closing Stock	**85.25**	**12,983.65**	**13,068.90**

Source: PSA - RSSO CAR

Appendix Table 7. Physical Asset Accounts for Water Resources, CAR: 2014

Physical Asset Accounts	2014		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	85.25	12,983.65	13,068.90
Additions to Stock			
Return		566.61	
Precipitation		503.83	
Inflow	53.16		
Surface Run-off		32,244.33	
Total Additions to Stock		33,367.93	
Reductions in Stock			
Abstraction		1,948.59	
Evaporation		186.33	
Outflow	4.27	31,599.44	
Total Reductions in Stock		33,738.63	
Closing Stock	**134.14**	**12,564.06**	**12,698.20**

Source: PSA - RSSO CAR

Appendix Table 8. Physical Asset Accounts for Water Resources, CAR: 2015

Physical Asset Accounts	2015		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	134.14	12,564.06	12,698.20
Additions to Stock			
Return		574.34	
Precipitation		732.82	
Inflow	8.53		
Surface Run-off		47,881.53	
Total Additions to Stock		49,197.22	
Reductions in Stock			
Abstraction		1,985.13	
Evaporation		151.76	
Outflow	4.65	46,923.90	
Total Reductions in Stock		49,065.44	
Closing Stock	**138.02**	**12,691.96**	**12,829.98**

Source: PSA - RSSO CAR

Appendix Table 9. Physical Asset Accounts for Water Resources, CAR: 2016

Physical Asset Accounts	2016		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	138.02	12,691.96	12,829.98
Additions to Stock			
Return		580.90	
Precipitation		597.44	
Inflow	7.72		
Surface Run-off		37,828.53	
Total Additions to Stock		39,014.58	
Reductions in Stock			
Abstraction		2,017.75	
Evaporation		179.78	
Outflow	37.53	37,071.96	
Total Reductions in Stock		39,307.01	
Closing Stock	**108.21**	**12,429.34**	**12,537.55**

Source: PSA - RSSO CAR

Appendix Table 10. Physical Asset Accounts for Water Resources, CAR: 2017

Physical Asset Accounts	2017		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	108.21	12,429.34	12,537.55
Additions to Stock			
Return		557.51	
Precipitation		532.76	
Inflow	28.44		
Surface Run-off		34,226.05	
Total Additions to Stock		35,344.75	
Reductions in Stock			
Abstraction		1,903.55	
Evaporation		212.68	
Outflow	6.53	33,541.53	
Total Reductions in Stock		35,664.29	
Closing Stock	**130.12**	**12,087.89**	**12,218.01**

Source: PSA - RSSO CAR

Appendix Table 11. Physical Asset Accounts for Water Resources, CAR: 2018

Physical Asset Accounts	2018		
	Types of Water Resources		
	Surface Water		Total Surface Water
	Dams	Rivers and Streams	
Opening Stocks	130.12	12,087.89	12,218.01
Additions to Stock			
Return		571.39	
Precipitation		810.47	
Inflow	9.57		
Surface Run-off		52,483.20	
Total Additions to Stock		53,874.63	
Reductions in Stock			
Abstraction		1,969.07	
Evaporation		148.66	
Outflow	10.91	51,433.54	
Total Reductions in Stock		53,562.18	
Closing Stock	**128.78**	**12,401.69**	**12,530.47**

Source: PSA - RSSO CAR

Appendix Table 12. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2008

2008													
	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,268.96	1,268.96
Ground water												30.93	30.93
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,299.89
II) Abstracted water													
For distribution									30.93				30.93
For own-use	1044.29	24.56	3.87	3.85	190.96	0.53	0.00	0.90					1,268.96
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										2.47			2.47
Own treatment				3.85							0.40		4.25
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													6.72
IV) Return flows of water													
To inland water resources													
Surface water	208.86	24.56			190.96								424.38
Ground water													-
Soil water													-
Total													424.38
To other sources													
Total return flows													424.38
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													1,730.99

Source: PSA - RSSO CAR

Appendix Table 13. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2009

2009													
	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,543.49	1,543.49
Ground water												31.52	31.52
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,575.00
II) Abstracted water													
For distribution									31.52				31.52
For own-use	1316.31	24.56	3.86	4.52	192.76	0.53	0.00	0.95					1,543.49
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										2.50			2.50
Own treatment				4.52							0.40		4.92
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													7.41
IV) Return flows of water													
To inland water resources													
Surface water	263.26	24.56			192.76								480.59
Ground water													-
Soil water													-
Total													480.59
To other sources													
Total return flows													480.59
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													2,063.00

Source: PSA - RSSO CAR

Appendix Table 14. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2010

2010													
	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,560.08	1,560.08
Ground water												32.11	32.11
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,592.20
II) Abstracted water													
For distribution									32.11				32.11
For own-use	1,334.06	24.56	3.70	3.49	192.76	0.53	0.00	0.98					1,560.08
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										2.93			2.93
Own treatment				3.49							0.46		3.95
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													6.88
IV) Return flows of water													
To inland water resources													
Surface water	266.81	24.56			192.76								484.14
Ground water													-
Soil water													-
Total													484.14
To other sources													
Total return flows													484.14
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													2,083.21

Source: PSA - RSSO CAR

Appendix Table 15. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2011

2011													
	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,609.02	1,609.02
Ground water												32.71	32.71
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,641.73
II) Abstracted water													
For distribution									32.71				32.71
For own-use	1,382.48	24.56	3.96	3.55	192.76	0.53	0.00	1.17					1,609.02
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										2.67			2.67
Own treatment				3.55							0.43		3.98
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													6.65
IV) Return flows of water													
To inland water resources													
Surface water	276.50	24.56			192.76								493.82
Ground water													-
Soil water													-
Total													493.82
To other sources													
Total return flows													493.82
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													2,142.20

Source: PSA - RSSO CAR

Appendix Table 16. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2012

2012	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,797.04	1,797.04
Ground water												33.31	33.31
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,830.35
II) Abstracted water													
For distribution									33.31				33.31
For own-use	1,567.02	24.56	3.92	6.51	193.33	0.53	0.00	1.17					1,797.04
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										2.22			2.22
Own treatment				6.51							0.38		6.89
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													9.11
IV) Return flows of water													
To inland water resources													
Surface water	313.40	24.56			193.33								531.30
Ground water													-
Soil water													-
Total													531.30
To other sources													
Total return flows													531.30
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													2,370.77

Source: PSA - RSSO CAR

Appendix Table 17. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2013

2013	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,850.25	1,850.25
Ground water												33.92	33.92
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,884.17
II) Abstracted water													
For distribution									33.92				33.92
For own-use	1,626.00	24.56	3.96	0.40	193.63	0.53	0.00	1.17					1,850.25
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										1.81			1.81
Own treatment				0.40							0.38		0.78
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													2.59
IV) Return flows of water													
To inland water resources													
Surface water	325.20	24.56			193.63								543.39
Ground water													-
Soil water													-
Total													543.39
To other sources													
Total return flows													543.39
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													2,430.16

Source: PSA - RSSO CAR

Appendix Table 18. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2014

2014	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,948.59	1,948.59
Ground water												34.53	34.53
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,983.13
II) Abstracted water													
For distribution									34.53				34.53
For own-use	1,723.16	24.56	3.90	1.64	193.63	0.53	0.00	1.17					1,948.59
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										1.78			1.78
Own treatment				1.64							0.36		2.00
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													3.78
IV) Return flows of water													
To inland water resources													
Surface water	344.63	24.56			193.63								562.83
Ground water													-
Soil water													-
Total													562.83
To other sources													
Total return flows													562.83
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													2,549.73

Source: PSA - RSSO CAR

Appendix Table 19. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2015

2015	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,985.13	1,985.13
Ground water												35.33	35.33
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													2,020.46
II) Abstracted water													
For distribution									35.33				35.33
For own-use	1,759.88	24.56	3.92	1.76	193.63	0.53	0.00	0.84					1,985.13
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										1.94			1.94
Own treatment				1.76							0.47		2.23
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													4.17
IV) Return flows of water													
To inland water resources													
Surface water	351.98	24.56			193.63								570.17
Ground water													-
Soil water													-
Total													570.17
To other sources													
Total return flows													570.17
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													**2,594.80**

Source: PSA - RSSO CAR

Appendix Table 20. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2016

2016	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												2,017.75	2,017.75
Ground water												35.78	35.78
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													2,053.53
II) Abstracted water													
For distribution									35.78				35.78
For own-use	1792.69	24.56	3.93	173	193.63	0.53	0.00	0.68					2,017.75
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										1.87			1.87
Own treatment				173							0.57		2.30
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													4.16
IV) Return flows of water													
To inland water resources													
Surface water	358.54	24.56			193.63								576.73
Ground water													-
Soil water													-
Total													576.73
To other sources													
Total return flows													576.73
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													**2,634.42**

Source: PSA - RSSO CAR

Appendix Table 21. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2017

2017	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,903.55	1,903.55
Ground water												36.41	36.41
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													1,939.96
II) Abstracted water													
For distribution									36.41				36.41
For own-use	1678.85	24.56	3.87	143	193.63	0.53	0.00	0.68					1,903.55
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										1.50			1.50
Own treatment				143							0.61		2.05
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													3.54
IV) Return flows of water													
To inland water resources													
Surface water	335.77	24.56			193.63								553.96
Ground water													-
Soil water													-
Total													553.96
To other sources													
Total return flows													553.96
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													2,497.47

Source: PSA - RSSO CAR

Appendix Table 22. Supply Table, Physical Flow Accounts for Water Resources, CAR: 2018

2018	Agriculture, Forestry and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows from the environment	Total Supply
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I) Sources of Abstracted Water													
Inland water resources													
Surface water												1,969.07	1,969.07
Ground water												37.05	37.05
Other water resources													
Precipitation													-
Sea water													-
Total supply abstracted water													**2,006.12**
II) Abstracted water													
For distribution									37.05				37.05
For own-use	1743.28	24.56	3.98	2.41	193.63	0.53	0.00	0.68					1,969.07
III) Wastewater and reused water													
Wastewater													
Wastewater to treatment										1.56			1.56
Own treatment				2.41							0.57		2.98
Reused water produced													
For distribution													-
For own-use													-
Total supply wastewater and reused water													**4.54**
IV) Return flows of water													
To inland water resources													
Surface water	348.66	24.56			193.63								566.85
Ground water													-
Soil water													-
Total													566.85
To other sources													
Total return flows													**566.85**
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													**2,577.51**

Source: PSA - RSSO CAR

Appendix Table 23. Use Table, Physical Flow Accounts for Water Resources, CAR: 2008

2008	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,044.29	24.56	3.87	3.85	190.96	0.53	0.00	0.90					1,268.96
Ground water									30.93				30.93
Soil water													-
Total	1,044.29	24.56	3.87	3.85	190.96	0.53	0.00	0.90	30.93	-	-		1,299.89
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,299.89**
II Abstracted water													
Distributed water									30.93				30.93
Own-use	1,044.29	24.56	3.87	3.85	190.96	0.53	0.00	0.8982					1,268.96
III Wastewater and reused water													
Wastewater													
wastewater received from other units										2.47			2.47
Own treatment				3.85							0.40		4.25
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**6.72**
IV Return flows of water													
To inland water resources												424.38	424.38
To other sources													-
Total return flows													**424.38**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**1,730.99**

Source: PSA - RSSO CAR

Appendix Table 24. Use Table, Physical Flow Accounts for Water Resources, CAR: 2009

2009													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,316.31	24.56	3.86	4.52	192.76	0.53	0.00	0.95					1,543.49
Ground water									31.52				31.52
Soil water													-
Total	1,316.31	24.56	3.86	4.52	192.76	0.53	0.00	0.95	31.52	-	-		1,575.00
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,575.00**
II Abstracted water													
Distributed water									31.52				31.52
Own-use	1,316.31	24.56	3.86	4.52	192.76	0.53	0.00	0.9479					1,543.49
III Wastewater and reused water													
Wastewater													
wastewater received from other units										2.50			2.50
Own treatment				4.52							0.40		4.92
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**7.41**
IV Return flows of water													
To inland water resources												480.59	480.59
To other sources													-
Total return flows													**480.59**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,063.00**

Source: PSA - RSSO CAR

Appendix Table 25. Use Table, Physical Flow Accounts for Water Resources, CAR: 2010

2010													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,334.06	24.56	3.70	3.49	192.76	0.53	0.00	0.98					1,560.08
Ground water									32.11				32.11
Soil water													-
Total	1,334.06	24.56	3.70	3.49	192.76	0.53	0.00	0.98	32.11	-	-		1,592.20
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,592.20**
II Abstracted water													
Distributed water									32.11				32.11
Own-use	1,334.06	24.56	3.70	3.49	192.76	0.53	0.00	0.9802					1,560.08
III Wastewater and reused water													
Wastewater													
wastewater received from other units										2.93			2.93
Own treatment				3.49							0.46		3.95
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**6.88**
IV Return flows of water													
To inland water resources												484.14	484.14
To other sources													-
Total return flows													**484.14**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,083.21**

Source: PSA - RSSO CAR

Appendix Table 26. Use Table, Physical Flow Accounts for Water Resources, CAR: 2011

2011													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,382.48	24.56	3.96	3.55	192.76	0.53	0.00	1.17					1,609.02
Ground water									32.71				32.71
Soil water													-
Total	1,382.48	24.56	3.96	3.55	192.76	0.53	0.00	1.17	32.71	-	-		1,641.73
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,641.73**
II Abstracted water													
Distributed water									32.71				32.71
Own-use	1,382.48	24.56	3.96	3.55	192.76	0.53	0.00	1.1702					1,609.02
III Wastewater and reused water													
Wastewater													
wastewater received from other units										2.67			2.67
Own treatment				3.55							0.43		3.98
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**6.65**
IV Return flows of water													
To inland water resources												493.82	493.82
To other sources													-
Total return flows													**493.82**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,142.20**

Source: PSA - RSSO CAR

Appendix Table 27. Use Table, Physical Flow Accounts for Water Resources, CAR: 2012

2012													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,567.02	24.56	3.92	6.51	193.33	0.53	0.00	1.17					1,797.04
Ground water									33.31				33.31
Soil water													-
Total	1,567.02	24.56	3.92	6.51	193.33	0.53	0.00	1.17	33.31	-	-		1,830.35
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,830.35**
II Abstracted water													
Distributed water									33.31				33.31
Own-use	1,567.02	24.56	3.92	6.51	193.33	0.53	0.00	1.1702					1,797.04
III Wastewater and reused water													
Wastewater													
wastewater received from other units										2.22			2.22
Own treatment				6.51							0.38		6.89
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**9.11**
IV Return flows of water													
To inland water resources												531.30	531.30
To other sources													-
Total return flows													**531.30**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,370.77**

Source: PSA - RSSO CAR

Appendix Table 28.Use Table, Physical Flow Accounts for Water Resources, CAR: 2013

2013													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,626.00	24.56	3.96	0.40	193.63	0.53	0.00	1.17					1,850.25
Ground water									33.92				33.92
Soil water													-
Total	1,626.00	24.56	3.96	0.40	193.63	0.53	0.00	1.17	33.92	-	-		1,884.17
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,884.17**
II Abstracted water													
Distributed water									33.92				33.92
Own-use	1,626.00	24.56	3.96	0.40	193.63	0.53	0.00	1.1702					1,850.25
III Wastewater and reused water													
Wastewater													
wastewater received from other units										1.81			1.81
Own treatment				0.40							0.38		0.78
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**2.59**
IV Return flows of water													
To inland water resources												543.39	543.39
To other sources													-
Total return flows													**543.39**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,430.16**

Source: PSA - RSSO CAR

Appendix Table 29. Use Table, Physical Flow Accounts for Water Resources, CAR: 2014

2014													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,723.16	24.56	3.90	1.64	193.63	0.53	0.00	1.17					1,948.59
Ground water									34.53				34.53
Soil water													-
Total	1,723.16	24.56	3.90	1.64	193.63	0.53	0.00	1.17	34.53	-	-		1,983.13
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,983.13**
II Abstracted water													
Distributed water									34.53				34.53
Own-use	1,723.16	24.56	3.90	1.64	193.63	0.53	0.00	1.1702					1,948.59
III Wastewater and reused water													
Wastewater													
wastewater received from other units										1.78			1.78
Own treatment				1.64							0.36		2.00
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**3.78**
IV Return flows of water													
To inland water resources												562.83	562.83
To other sources													-
Total return flows													**562.83**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,549.73**

Source: PSA - RSSO CAR

Appendix Table 30. Use Table, Physical Flow Accounts for Water Resources, CAR: 2015

2015	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,759.88	24.56	3.92	1.76	193.63	0.53	0.00	0.84					1,985.13
Ground water									35.33				35.33
Soil water													-
Total	1,759.88	24.56	3.92	1.76	193.63	0.53	0.00	0.84	35.33	-	-		2,020.46
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**2,020.46**
II Abstracted water													
Distributed water									35.33				35.33
Own-use	1,759.88	24.56	3.92	1.76	193.63	0.53	0.00	0.8421					1,985.13
III Wastewater and reused water													
Wastewater													
wastewater received from other units										1.94			1.94
Own treatment				1.76							0.47		2.23
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**4.17**
IV Return flows of water													
To inland water resources												570.17	570.17
To other sources													-
Total return flows													**570.17**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,594.80**

Source: PSA - RSSO CAR

Appendix Table 31. Use Table, Physical Flow Accounts for Water Resources, CAR: 2016

2016	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,792.69	24.56	3.93	1.73	193.63	0.53	0.00	0.68					2,017.75
Ground water									35.78				35.78
Soil water													-
Total	1,792.69	24.56	3.93	1.73	193.63	0.53	0.00	0.68	35.78	-	-		2,053.53
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**2,053.53**
II Abstracted water													
Distributed water									35.78				35.78
Own-use	1,792.69	24.56	3.93	1.73	193.63	0.53	0.00	0.6778					2,017.75
III Wastewater and reused water													
Wastewater													
wastewater received from other units										1.87			1.87
Own treatment				1.73							0.57		2.30
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**4.16**
IV Return flows of water													
To inland water resources												576.73	576.73
To other sources													-
Total return flows													**576.73**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,634.42**

Source: PSA - RSSO CAR

Appendix Table 32. Use Table, Physical Flow Accounts for Water Resources, CAR: 2017

2017													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,678.85	24.56	3.87	1.43	193.63	0.53	0.00	0.68					1,903.55
Ground water									36.41				36.41
Soil water													-
Total	1,678.85	24.56	3.87	1.43	193.63	0.53	0.00	0.68	36.41	-	-		1,939.96
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**1,939.96**
II Abstracted water													
Distributed water									36.41				36.41
Own-use	1,678.85	24.56	3.87	1.43	193.63	0.53	0.00	0.6778					1,903.55
III Wastewater and reused water													
Wastewater													
wastewater received from other units										1.50			1.50
Own treatment				1.43							0.61		2.05
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**3.54**
IV Return flows of water													
To inland water resources												553.96	553.96
To other sources													-
Total return flows													**553.96**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,497.47**

Source: PSA - RSSO CAR

Appendix Table 33. Use Table, Physical Flow Accounts for Water Resources, CAR: 2018

2018													
	Agriculture, Forestry, and Fishing			Mining and Quarrying	Electricity Generation	Others			Water Supply	Sewerage	Other Industries	Flows to the environment	Total Use
	Irrigation	Aquaculture	Livestock and Poultry			Commercial	Industrial	Recreation					
I Sources of Abstracted Water													
Inland water resources													
Surface water	1,743.28	24.56	3.98	2.41	193.63	0.53	0.00	0.68					1,969.07
Ground water									37.05				37.05
Soil water													-
Total	1,743.28	24.56	3.98	2.41	193.63	0.53	0.00	0.68	37.05	-	-		2,006.12
Other water resources													
Precipitation													
Sea water													
Total													
Total use abstracted water													**2,006.12**
II Abstracted water													
Distributed water									37.05				37.05
Own-use	1,743.28	24.56	3.98	2.41	193.63	0.53	0.00	0.6778					1,969.07
III Wastewater and reused water													
Wastewater													
wastewater received from other units										1.56			1.56
Own treatment				2.41							0.57		2.98
Reused water produced													
Distributed reuse													-
Own-use													-
Total supply wastewater and reused water													**4.54**
IV Return flows of water													
To inland water resources												566.85	566.85
To other sources													-
Total return flows													**566.85**
V Evaporation of abstracted water, transpiration and water incorporated into products													
Evaporation of abstracted water													-
Transpiration													-
Water incorporated into products													
TOTAL USE													**2,577.51**

Source: PSA - RSSO CAR

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