NATURAL CAPITAL 4

Sub-national Water Resource Accounts, 2015 to 2021

Forestry, Fisheries and the Environment
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South African National Biodiversity Institute

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PREFACE

Natural Capital Accounting (NCA) is a growing field of work globally, in which South Africa is an acknowledged leader. NCA includes accounting for environmental assets such as land, water, minerals and energy, and also for ecosystem assets and ecosystem services, with an international standard, the System of Environmental-Economic Accounting (SEEA), in place for these accounts. This report is part of Statistics South Africa's (Stats SA) *Natural Capital* series and presents sub-national water resource accounts at catchment level.

Stats SA is proud to have been involved in applying the SEEA towards developing natural capital accounts for over two decades, starting with the National Water Accounts in 2000 (Stats SA, 2000). The reliable supply of water is vital for the well-being of people and growth of South Africa's economy. Ensuring water security, now and into the future, requires standardised statistics and information to support planning, decision-making and evaluation of policy and implementation. In the words of Jackson Mthembu, "The future of policymaking and implementation is upon us and experience has taught us that without measurement, our boat will not sail far" (Stats SA Strategic Plan). Stats SA, as a custodian and coordinator of national statistics, is embracing working in partnership with other organs of state to produce the statistics needed to make decisions for sustainable national development, including through NCA.

Stats SA has partnered with relevant organs of state to develop natural capital accounts in the form of environmental economic accounts, which included water, fisheries, mineral and energy accounts, since the early 2000s. Stats SA's partnership with the Department of Water and Sanitation (DWS) and the Water Research Commission (WRC) has spanned several decades. The accounts presented in this discussion document build on investments made by these partners in data sources and in methodologies to compile catchment-level accounts (WRC has funded two projects in relation to the latter). Since 2018, Stats SA has collaborated with the Department of Forestry, Fisheries and the Environment (DFFE) and the South African National Biodiversity Institute (SANBI) in developing ecosystem accounts and related thematic accounts in line with SEEA Ecosystem Accounting (adopted by the UN in March 2021).

The *Sub-national Water Resource Accounts, 2015 to 2021* brings together elements of water accounts and ecosystem accounts, acknowledging connections between the landscapes and ecosystems upon which precipitation occurs and the resulting flows and stores of water that are important for supply to and use by the economy. In essence, this acknowledges the connections between built water infrastructure and ecological infrastructure, as indicated in South Africa's National Infrastructure Plan 2050 (released in March 2022).

Statistics that come from accounts such as in this publication, add to the richness of evidence available to decision and policymakers. Using the best available data in South Africa and applying robust, globally endorsed methodologies, NCA can help public and private sector actors to understand more about the interactions between the economy, society and the environment. Information from NCA can be used to monitor and report on progress against achieving the goals of the National Development Plan and the global Sustainable Development Goals.

This report is published as a discussion document in the *Natural Capital* series. The purpose of a discussion document is to present experimental accounts that are not official statistics. Rather, the aim of this document is to invite comment regarding the accounts. The process of developing the water resources accounts involved providing stakeholders and NCA practitioners opportunities to engage with and comment on the draft results. This includes the development of indicators that could provide information relevant to catchment management and reporting. The release of the discussion document supports ongoing comment by stakeholders. It contributes to the implementation of South Africa's National NCA Strategy, which was published by Stats SA in June 2021. This discussion document also contributes to advancing knowledge on NCA and its application in the context of a developing country.

ACKNOWLEDGEMENTS

This discussion document was produced as part of the project “Unlocking Biodiversity Benefits through Development Finance in Critical Catchments” (also known as the *Ecological Infrastructure for Water Security (EI4WS)* project) which is funded by the Global Environment Facility (GEF), implemented by the Development Bank of Southern Africa (DBSA), supported by the Department of Forestry, Fisheries and the Environment (DFFE), and executed by the South African National Biodiversity Institute (SANBI) in partnership with the Department of Water and Sanitation (DWS) and the Water Research Commission (WRC) along with other organisations and institutions. Statistics South Africa (Stats SA) is a member of the EI4WS Project Steering Committee and is acknowledged as a partner in the EI4WS project related to the development of natural capital accounts for water-related ecological infrastructure.

Contents of this report are the sole responsibility of Stats SA and do not necessarily reflect views of GEF or DBSA.

Aimee Ginsburg (SANBI) and Riaan Grobler (Stats SA) are acknowledged as NCA leads in their institutions. Jenifer Zungu is acknowledged as the project leader of the EI4WS project. David Clark with the Centre for Water Resources Research (CWRR) at the University of KwaZulu-Natal (UKZN) is acknowledged as the technical lead in undertaking the modelling and compiling of these accounts. CWRR is further acknowledged for provision of administrative support and guidance by CWRR members. Specific acknowledgements are given to Aimee Ginsburg (SANBI) and Amanda Driver (previously with SANBI) for strategic leadership from inception to completion of the accounts. Nokuthula Mahlangu, Mookho Makanyane and Ziyanda Dyasi (SANBI) are acknowledged for their technical assistance with making maps. This report was written through the collaborative effort of David Clark and Aimee Ginsburg, with support from Nokuthula Mahlangu and Mookho Makanyane. Robert Parry, Marinda Snyman and Riaan Grobler (Stats SA) are acknowledged for their editorial support and guidance. The following persons are acknowledged for their assistance in arranging validation workshops and accessing data in the sub-accounting areas (in alphabetical order): Elkerine Rossouw (Breede Olifants Catchment Management Agency), Helen Nonyane (previously SANBI), Louise Dobinson (Zutari), Luvuyo Kani (previously SANBI), Nomalungelo Ndlovu (SANBI), Nontutuzelo Gola (SANBI), Roderick Juba (WRC) and Samantha Braid (previously SANBI). Members of the CWRR are acknowledged for their technical advice, especially Prof. Graham Jewitt, Prof. Jeff Smithers and Prof. Roland Schulze. Nancy Job (SANBI) and Patrick O’Farrell (independent consultant) are acknowledged for their technical inputs.

The following institutions are acknowledged for data provided: DFFE for providing the 2018 version of their national land cover dataset (NLC 2018); DWS for providing catchment boundary, rainfall, flow and dam data; Umgeni Water for providing flow data for the uMngeni Catchment; South African Sugarcane Research Institute for providing rainfall data; Mondi Group for providing rainfall data; CWRR for providing air temperature, vegetation parameter and soil property datasets; SANBI for providing the National Vegetation Map and National Biodiversity Assessment (NBA) 2018 artificial wetlands dataset; and South African National Space Agency for providing the Mzansi Amanzi dams dataset.

Stakeholders who participated in a validation workshop provided valuable feedback and input that influenced additional analysis and contextual information that has been included in this report.

The photograph on the front cover taken along the uMngeni River in KwaZulu-Natal was provided courtesy of Sam Ayres.

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ABBREVIATIONS

AIP	Alien Invasive Plant
ARC	Agricultural Research Council
BSU	Basic Spatial Unit
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CWRR	Centre for Water Resources Research
DEM	Digital Elevation Models
DFFE	Department of Forestry, Fisheries and the Environment
DSf GW	Change in groundwater store
DSf SoilM	Change in soil moisture store
DSf SW	Change in surface water store
DSO	Dam Safety Office
DWS	Department of Water and Sanitation
EI4WS	Ecological Infrastructure for Water Security
ET	Evaporation
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FEPA	Freshwater Ecosystem Priority Areas
GTI	GeoTerraImage
GW	Groundwater
IWMI	International Water Management Institute
mm	Millimetres
Mm3	Million cubic metres
NBA	National Biodiversity Assessment
NCA	Natural Capital Accounting
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act (Act No. 36 of 1998)
NWRS	National Water Resources Strategy
Qin GW	Groundwater inflow
Qin SW	Surface water inflow
Qin Transfers	Inflow as inter-catchment transfers
Qout GW	Groundwater outflow
Qout SW	Surface water outflow
Qout Transfers	Outflow as inter-catchment transfers
SANBI	South African National Biodiversity Institute
SANLC	South African National Land Cover
SANSA	South African National Space Agency
SAWS	South African Weather Service

SEEA	System of Environmental-Economic Accounting
Stats SA	Statistics South Africa
SWSA	Strategic Water Source Area
UKZN	University of KwaZulu-Natal
UN	United Nations
WA+	Water Accounting Plus
WARMS	Water use Authorization and Registration Management System
WMA	Water Management Area
WRC	Water Research Commission

1 INTRODUCTION

This report presents the results of sub-national accounts on water resources in selected catchments in two provinces in South Africa. This section provides background on Natural Capital Accounting (NCA), water resources, and accounts, including the scope of the accounts, their purpose and key indicators that can be drawn from the accounts.

1.1 What is Natural Capital Accounting?

NCA refers to the use of an accounting framework to provide a systematic way to measure and report on stocks and flows of natural capital, analogous to accounts for other forms of capital. It is a broad term that includes accounting for individual environmental assets or resources, both biotic and abiotic (such as water, minerals, energy, timber, fish), as well as accounting for ecosystem assets and ecosystem services. NCA provides a common framework for measuring and tracking over time the contribution of ecosystems and natural resources to social and economic goals, such as water security, food security and job creation, and provides a wealth of information that can improve planning and decision-making related to the management of natural resources.

Using an accounting framework provides well-accepted, broadly based and globally consistent information on the nature of humanity's connection to the environment and how this is changing over time. Regular production of natural capital accounts can therefore provide standardised statistical information (comparable between countries, or between administrative units within a country, and over time) for tracking and reporting on progress towards sustainable development, including goals and targets set out in policies, frameworks and plans at international, continental, national, provincial or local levels. NCA can provide information to inform economic policy and decision-making for sustainable development.

To this end, the System of Environmental-Economic Accounting (SEEA) has been developed by the United Nations (UN) to organise and present statistics on the environment and its relationship with the economy. It is a statistical system that brings together economic and environmental information into a common framework. SEEA contains an internationally agreed set of standard concepts, definitions, classifications, accounting rules and tables to produce internationally comparable statistics and indicators for policy-making, analysis and research. SEEA Central Framework[1] describes methods to account for changes in land cover, pollution and waste, as well as to account for stocks and use of natural resources (water, minerals, energy, timber, fish, soil) (UN, 2014). To complement this, SEEA Ecosystem Accounting[2] describes methods to account for ecosystems and their services, using a spatial approach (UN, 2021). SEEA also provides specific guidance related to water accounting, with which the accounts presented in this report are aligned. The water resource accounts presented here extend beyond SEEA-Water accounts in several ways described in Section 1.3 following a brief overview of the water resource environment in South Africa.

1.2 Water resource environment in South Africa

Water is a scarce and limiting resource in South Africa in terms of economic and social development. South Africa has an average annual rainfall of 464 mm, approximately half the global average (DWS, 2018a). The total annual runoff is approximately 49 000 million m³/a (DWS, 2018a), with approximately half of the country's runoff contributed by just 8,2% of South Africa's mainland (Nel et al., 2017; Le Maitre et al., 2018; Stats SA, 2023). Rainfall and runoff also have a high temporal variability, both intra- and inter- annually, and it is anticipated that climate change may also have a significant impact on rainfall and temperature in some parts of the country. As is the case globally, human activity has resulted in the degradation of land and ecosystems, which further impacts the quantity and quality

[1] SEEA Central Framework is available at https://seea.un.org/content/seea-central-framework.

[2] SEEA Ecosystem Accounting is available at https://seea.un.org/ecosystem-accounting.

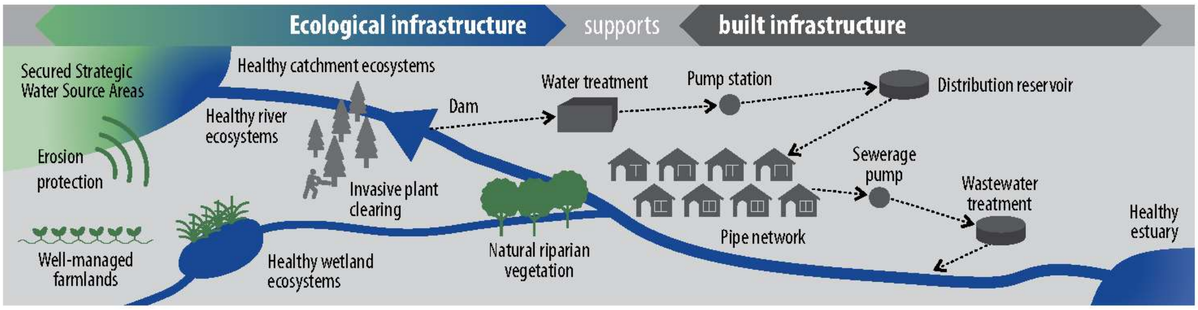
of water resources. South Africa shares rivers and catchments, and thus water resources with six neighbouring countries (Botswana, Eswatini, Lesotho, Mozambique, Namibia and Zimbabwe).

South Africa has a long history of water monitoring and national water resource assessment studies (Bailey and Pitman, 2016). Water storage infrastructure in South Africa is highly developed to assist in managing variability in rainfall and runoff, including many large dams and also several large-scale inter-catchment transfers to augment water resources in high demand areas. However, options for further infrastructure development are becoming less physically and economically feasible, requiring better management of water resources and the existing built infrastructure. There is also growing recognition of the role of ecological infrastructure in supplementing or even serving in place of built infrastructure in catchment water resource management plans (see Figure 1).

Ecological infrastructure refers to naturally functioning ecosystems that provide valuable services to people and the economy, such as fresh water, climate regulation, soil formation and disaster risk reduction. It is the nature-based equivalent of built or hard infrastructure and is just as important for providing services and underpinning socio-economic development. Ecological infrastructure includes, for instance, healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitat, which together form a network of interconnected structural elements in the landscape. Healthy ecological infrastructure can "directly support water security by increasing runoff and water storage in soils, preventing or delaying the build-up of sediment in dams, improving water quality and reducing flood damage by storing and slowly releasing flood waters" (SANBI, 2022). Loss or degradation of the ecological infrastructure will diminish or alter the flow of ecosystem services. As with built infrastructure, it is important to manage and maintain ecological infrastructure to prevent it from becoming degraded. Ecological infrastructure assets for water security include rivers, wetlands, riparian areas, local recharge areas and Strategic Water Source Areas (SWSAs). These are assets of policy relevance as South Africa grapples with water insecurity and climate change, making investing in this ecological infrastructure even more crucial. Investing in ecological infrastructure also creates jobs and strengthens local economies.

The National Water Act (Act No. 36 of 1998) (NWA) recognises "the need for the integrated management of all aspects of water resources". An integrated approach recognises that there are hydrological, engineering, ecological, economic, political, social and institutional aspects to water resources management, which need to be considered to ensure sustainable and equitable use. The NWA provides for the establishment of Catchment Management Agencies (CMAs) and gives them authority to manage water resources at a catchment level and coordinate functions of other water management institutions in Water Management Areas (WMAs) throughout South Africa. The NWA also calls for the development of the National Water Resources Strategy (NWRS) as the framework for protection, use, development, conservation, management and control of water resources nationally, and the framework within which water will be managed at catchment level, in defined WMAs. Both the NWRS and CMAs require catchment-level and spatially explicit information to support water resource management at a decentralised level. Such information could provide inputs into Catchment Management Strategies (CMSs) and/or support tracking progress of the National Water and Sanitation Master Plan or CMSs.

Figure 1 – The relationship between water and ecological infrastructure



Source: SANBI, 2022

1.3 Accounts related to water and water-related ecological infrastructure in South Africa

Given the water resource constraints in South Africa, accounting for water stocks and flows as well as water-related ecological infrastructure and ecosystem services is of interest and has been given particular attention in recent years.

A range of accounts related to water (in line with SEEA Central Framework) and water-related ecological infrastructure and ecosystem services (in line with SEEA Ecosystem Accounting) have been produced over the past two decades, including National Water Accounts (Stats SA, 2000, 2004, 2005, 2006, 2009, 2010), detailed catchment-scale water resource accounts (Clark, 2015; Clark, 2019), National River Ecosystem Accounts (Nel and Driver, 2015), Accounts for Strategic Water Source Areas (Stats SA, 2023) and experimental ecosystem service accounts for one province that included water supply (Turpie et al., 2021).

These accounts are intended to provide a range of statistics, indicators, and improved information to facilitate better understanding and decision-making with respect to water as a scarce resource and the ecosystems, catchments and landscapes that are important for the quantity and quality of water supply. As such, the interlinkages between different types of accounts are important. This section therefore provides a brief overview of these to clarify commonalities, differences and interlinkages between these accounts.

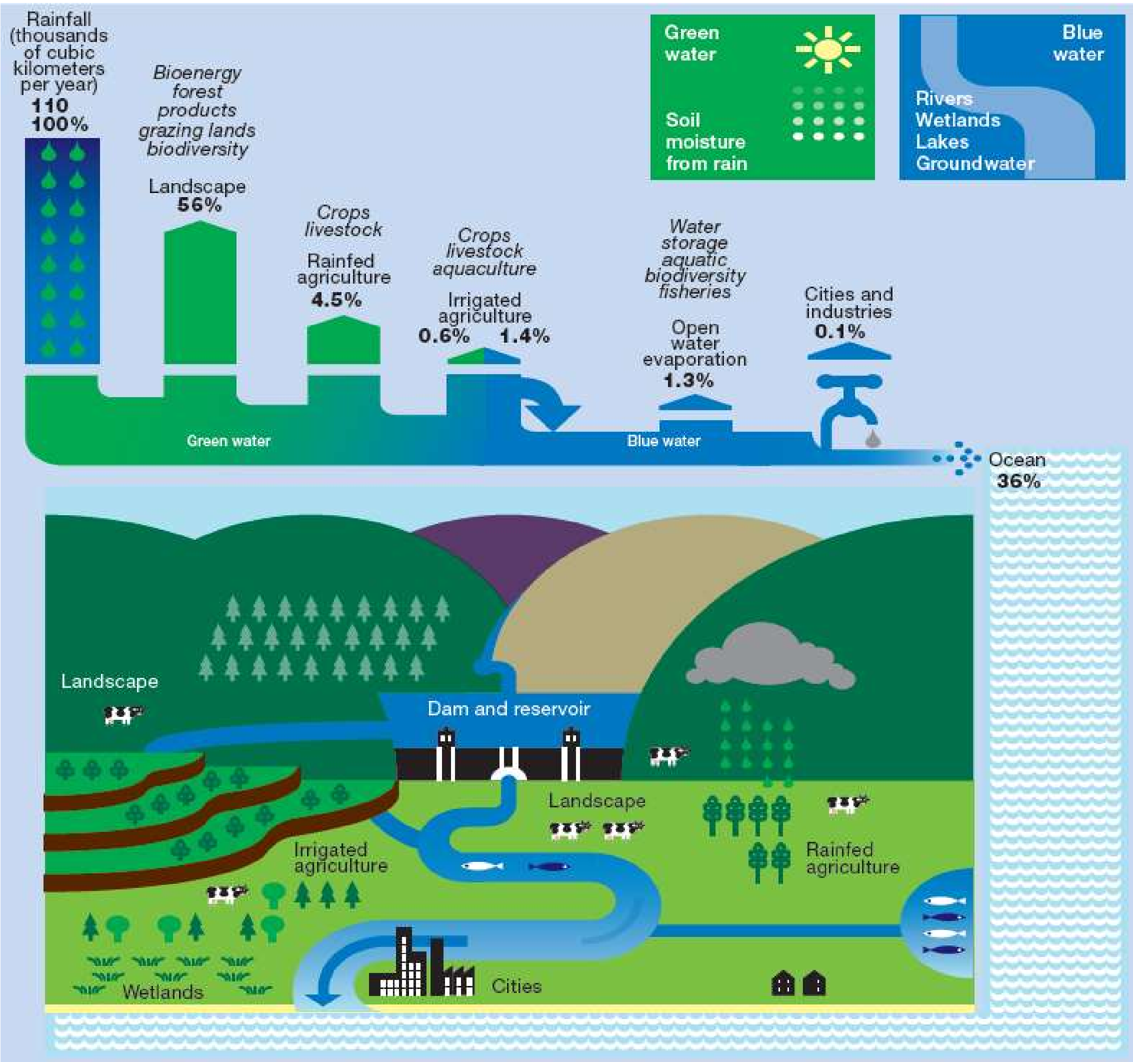
1.3.1 Water accounts (in line with SEEA Central Framework)

Water accounts provide a standardised conceptual framework for organising water-related information in a coherent and consistent manner. Water accounting helps to address the need to quantify, describe, understand, compare, and communicate the status of water resource systems (Clark, 2019). The development of water accounting frameworks has been driven by the need for better management of stressed water resource systems and the recognition of the need for integrated assessment (Clark, 2019).

An illustration of the broad concept of water accounting is provided in Figure 2, using a simplified global water balance (or water account). Water enters the terrestrial water system as rainfall, some of this rainfall may infiltrate into the soil profile (possibly a portion even recharging the groundwater store) and some may run off into the river flow network. Some of this water is consumed by the natural processes of evaporation and transpiration from natural vegetation, forest plantations, agricultural crops and open water surfaces. Engineered flows of water for irrigation and urban water use results in further water consumption. Unconsumed water may accumulate in the soil profile, in the groundwater store or in dams, with the remainder flowing out to seas and oceans.

Quantification and understanding of the system of water inflows, outflows and storage is useful for water management. The standardised quantification of water related information in water accounts is therefore intended to enable water resource managers and policymakers to clearly view the options available to them together with the required scientific information, and to make decisions based on knowledge of actual water availability, actual water use and an understanding of the potential impacts on all water users (UN, 2012; IWMI, 2013).

Figure 2 – The concept of water accounting using a simple global water balance



Source: Molden, 2007

National Water Accounts (Stats SA, 2002, 2004, 2005, 2006, 2009, 2010), have been compiled by Statistics South Africa (Stats SA) using the System of Environmental-Economic Accounting for Water (SEEA-Water) framework (UN, 2012). The SEEA-Water framework is a UN standard for compiling national water accounts and has a strong economics emphasis. It aims to measure the use of water resources by the economy and the impact of the economy on water resources. National Water Accounts include estimates of water use and related economic productivity at national level and the level of WMAs by different economic sectors (including agriculture, mining, electricity, commercial and industrial, and domestic). More recently, national water accounts were developed by Maila et al. (2018) through a project funded by the Water Research Commission (WRC) of South Africa. Stats SA intends to publish further National Water Accounts and is working with the Department of Water and Sanitation (DWS) to compile updated national water accounts on a more regular basis, at a national and WMA scale.

SEEA-Water recognises the catchment level water cycle and associated hydrological processes, which it refers to as the "inland water resource system". However, many landscape-level water flows within catchments do not fit neatly with the economic sectors that underpin the SEEA framework for economic accounting. In addition, SEEA-Water accounts, with their intentional link between physical measures of water stocks and flows and economic measures relating to water, are typically compiled for administrative accounting areas, which are not often well aligned spatially with natural accounting areas such as catchments. Lastly, economic sector level data are also not typically available at a sufficient level of spatial detail that can easily be applied to catchment accounting areas, which are relevant for catchment management authorities and other stakeholders.

There was a need, expressed by stakeholders[3], for water-related information at more relevant scales to support catchment-level water management. In response to this, a review of water accounting frameworks by Clark (2015) proposed the application of the Water Accounting Plus (WA+) framework based on the International Water Management Institute (IWMI) Water Accounting system (Karimi et al., 2013). The WA+ framework was proposed as a standardised method that was complementary to the SEEA-Water[4] framework (and therefore to national water accounts), but with a catchment-scale land and water management focus. The method was also well suited to meeting stakeholder needs of also providing spatially explicit information on water depletion and withdrawal processes in complex river basins. These finer-scale accounts would be beneficial to understanding the implications of land management on water resources.

The development of an integrated water resources accounting methodology for South Africa was supported by the WRC and is described in Clark (2015) and Clark (2019). These accounts are referred to as "**water resource accounts**" to differentiate them from the National Water Accounts, based on SEEA-Water framework.

The water resource accounts aim to provide modelled estimates of a complete catchment water balance, with strong emphasis on land cover and land use, at a range of catchment scales. The water resource accounts are intended, primarily, to support catchment level water management decisions. A methodology has been developed for producing these water resource accounts using national datasets that are readily available in South Africa. Due to the high level of temporal variability in climate and related variability in catchment water resources, water asset accounts are of limited use and thus the water resource accounts are primarily intended to be flow accounts. In addition, large stocks such as groundwater stores and even soil water stores are difficult to quantify, thus the water resource accounts show changes in stocks, but not the start and end stock for an accounting period.

The following definition of the water resource accounts is suggested: "*Water resource accounts describe the water resources within a specified spatial and temporal water accounting domain, including changes in water storage, the source and quantity of water inflows, water use by different sectors within the domain, and the destination and quantity of water outflows.*"

It is anticipated that at the catchment scale, strong land cover/use focus and full hydrological water balance will facilitate the investigation and understanding of linkages between land cover, land use, ecological infrastructure, and catchment water resources.

1.3.2 Accounts of water-related ecological infrastructure and ecosystem services (in line with SEEA Ecosystem Accounting)

Water resource accounts explicitly seek to take land cover/use into account, recognising the connection between the extent and condition of natural or semi-natural, or intensively modified land cover classes and how water infiltrates, runs off, evaporates, or transpires. These natural or semi-natural and intensively modified land cover classes can also be seen as natural or semi-natural and intensively modified ecosystem types, as illustrated in the *Land and Terrestrial Ecosystem Accounts, 1990 to 2014*, connecting and recognising the interactions between accounting domains in the SEEA Central Framework and SEEA Ecosystem Accounting. Natural systems are complex and complicated, thus an integrated set of accounts recognising the interactions between accounting domains (e.g., land, ecosystems, water) is required and the idea behind the SEEA-Water is a point of commonality cutting

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[3] Stakeholders engaged during workshop on the water resource accounts, included stakeholders from DWS, CMAs, DFFE, municipalities, irrigation boards, Umgeni Water, provincial government and conservation authorities.

[4] The water resource accounts could potentially provide information on physical stocks and flows of water supplied from the environment to support the application of the SEEA-Water framework. If compiled for suitably fine scale accounting areas, SEEA-Water physical accounts could potentially provide estimates of water use for application in the water resource accounts. Detailed information on water demand, supply, consumption and return flows by the economic sector is required for both the National Water Accounts and the water resource accounts.

across many accounting domains. This section briefly describes accounts of water-related ecological infrastructure and ecosystem services compiled in South Africa.

Water-related ecological infrastructure includes rivers, wetlands, riparian areas, and SWSAs. Ecosystem accounts, following SEEA Ecosystem Accounting, have been developed at a national level for rivers and SWSAs in South Africa. National River Ecosystem Accounts were compiled for all rivers and their tributaries on South Africa's mainland, using data from DWS and accounting for the extent of different river ecosystem types and condition of rivers. This was based on four indicators of the condition of rivers and assessed relative to a reference condition of natural (Nel and Driver, 2015).

SWSAs are "*natural source areas for water that supply disproportionately large volumes of water per unit area and that are considered of strategic significance …"* and as such, they are *"national ecological infrastructure assets that are essential for water security, which in turn underpins national development goals*" (Stats SA, 2023). In the *Accounts for SWSAs, 1990 to 2020* (Stats SA, 2023), SWSAs are used as accounting areas for which land accounts and accounts for protected areas in SWSAs are compiled and reported for all SWSAs combined and per SWSA. These accounts provide information on land cover and land use (an indicator of socio-economic activity) within the SWSAs, which can impact the ecological condition of water-related ecosystems, thus their ability to provide water, both within and beyond their boundaries. The land accounts for SWSAs are methodologically in line with the *Land and Terrestrial Ecosystem Accounts, 1990 to 2014* (Stats SA, 2020). The accounts of protected areas in SWSAs are methodologically in line with the *Accounts for Protected Areas, 1990 to 2020* (Stats SA, 2021).

Lastly, experimental ecosystem service accounts following SEEA Ecosystem Accounting, quantify and value the supply of ecosystem services provided by various terrestrial and aquatic ecosystem assets in the province of KwaZulu-Natal in South Africa (Turpie et al., 2021). The ecosystem related services evaluated included selected provisioning, cultural and regulating services. The water regulating services evaluated included flow regulation, flood attenuation and water quality amelioration. These accounts, compiled in physical and monetary terms, based on SEEA Ecosystem Accounting, have methodological linkages to the *Land and Terrestrial Ecosystem Accounts, 1990 to 2014* (Stats SA, 2020) and the *Accounts for Protected Areas, 1900 to 2020* (Stats SA, 2021).

1.4 Purpose of the water resource accounts

This discussion document focuses on water resource accounts. Water resource accounts in South Africa are physical accounts at the catchment scale, quantifying changes in stocks, flows and consumption of water within a defined spatial and temporal domain.

The **purpose of water resource accounts** is to provide annual, standardised water resources estimates (statistics and indicators) at a range of catchment scales, in a manner that is spatially explicit (maps at quaternary catchment scale) to support a holistic landscape or system view of water resources. Based on hydrological modelling, the approach also aims to fill gaps between sparse point measurements and improve understanding of the impacts and influence of upstream land use and management of water.

The **purpose of presenting sub-national accounts** in a discussion document is to support the evolution of a methodology and output that links to priority national level accounts listed in the National NCA Strategy and could be applied nationally in the future. Specifically, the development of water resource accounts is listed in the National NCA Strategy as an activity supporting the overall *Output 3.1.1 Accounts related to surface and groundwater*.

1.5 Scope of the water resource accounts

This discussion document presents a set of sub-national water resource accounts developed for selected catchments in two WMAs, namely the Breede-Olifants WMA that lies largely in the Western Cape province and the Pongola-Mtamvuna WMA that lies largely in the KwaZulu-Natal province. Figure

3 shows the spatial domain for the water resource accounts, in relation to the provinces and the WMAs within South Africa. The WMAs shown are the revised WMAs as given in the NWRS-3 by DWS (2023).

Figure 3 – Water resource accounts were compiled for three sub-accounting areas in two water management areas in South Africa

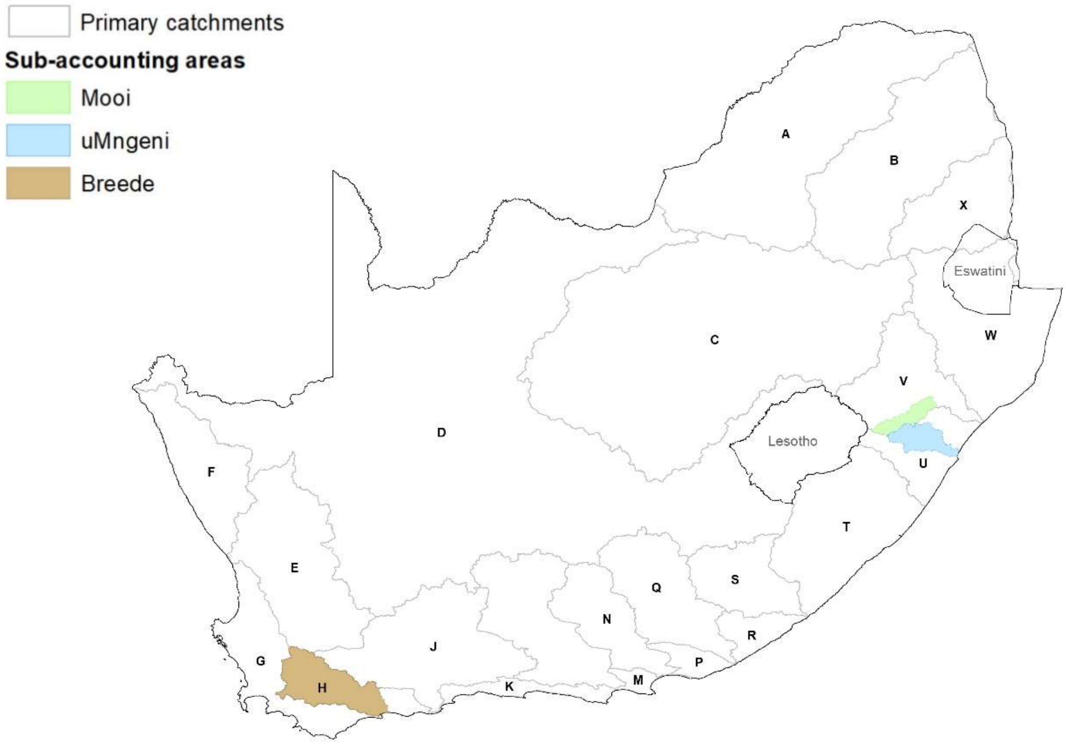
Source: Adapted from DWS (2023).

1.5.1 Spatial domain for water resource accounts

The sub-national water resource accounts are compiled for three sub-accounting areas that are delineated by the boundaries of quaternary catchments that fall within three primary catchments.

South Africa consists of 22 primary catchments, defined by the DWS, forming the first level of a 4-level nested system of hydrological catchments: primary, secondary, tertiary and quaternary catchments. There are almost 2 000 quaternary catchments, which nest hierarchically within 278 tertiary catchments, 148 secondary catchments and 22 primary catchments. A unique identifying code was devised to individually identify each of the layers of nested catchments. Primary catchments are denoted by a letter of the alphabet A-X. Secondary catchments within a primary catchment are given a number 1-9 (e.g. A1 or U7), and tertiary catchments within these are also given a number 1-9 that is added to the secondary catchments' identifying code (e.g. A11 or U72). Quaternary catchments within tertiaries are allocated a letter (e.g., A11A or U72L). Figure 4 shows the sub-accounting areas in relation to the primary catchments.

Figure 4 – Water resource accounts were compiled for three sub-accounting areas in three primary catchments (named A to X) in South Africa



The three sub-accounting areas for which water resource accounts were compiled, were selected because of their importance for providing water to two major cities in South Africa. The three sub-accounting areas are as follows:

1. **Breede Catchment sub-accounting area**: Defined by selected quaternary catchments in primary catchment H, specifically for 56 quaternary catchments within secondary catchments H1, H2, H3, H4, H5, H6 and H7 shown in Figure 5. Quaternary catchments H60A, H60B and H60C were merged to form a single catchment as the Theewaterskloof Dam lies across all three.

2. **uMngeni Catchment sub-accounting area:** Defined by selected quaternary catchments in primary catchment U, specifically for 12 quaternary catchments within secondary catchment U2 shown in Figure 6.

3. **Mooi Catchment sub-accounting area**: Defined by selected quaternary catchments in primary catchment V, specifically for nine quaternary catchments within secondary catchment V2 shown in Figure 6.

The Breede Catchment feeds the Western Cape Water Supply System and is thus important for the water supply to the City of Cape Town. The Mooi Catchment is connected to the uMngeni Catchment by an inter-catchment transfer, which together provide water to parts of the uMgungundlovu District Municipality (which includes the city of Pietermaritzburg) and eThekwini Metropolitan Municipality (which includes the city of Durban).

Water resource accounts were compiled for each of the sub-accounting areas as a whole, the secondary catchments (in the Breede Catchment), and the quaternary catchments. This discussion document presents results from accounts for the sub-accounting areas and quaternary catchments. All accounts are available in the supplementary Excel workbooks that can be downloaded from the Stats SA website (http://www.statssa.gov.za/).

Figure 5 – Quaternary catchments for which water resource accounts were compiled in the Breede Catchment sub-accounting area

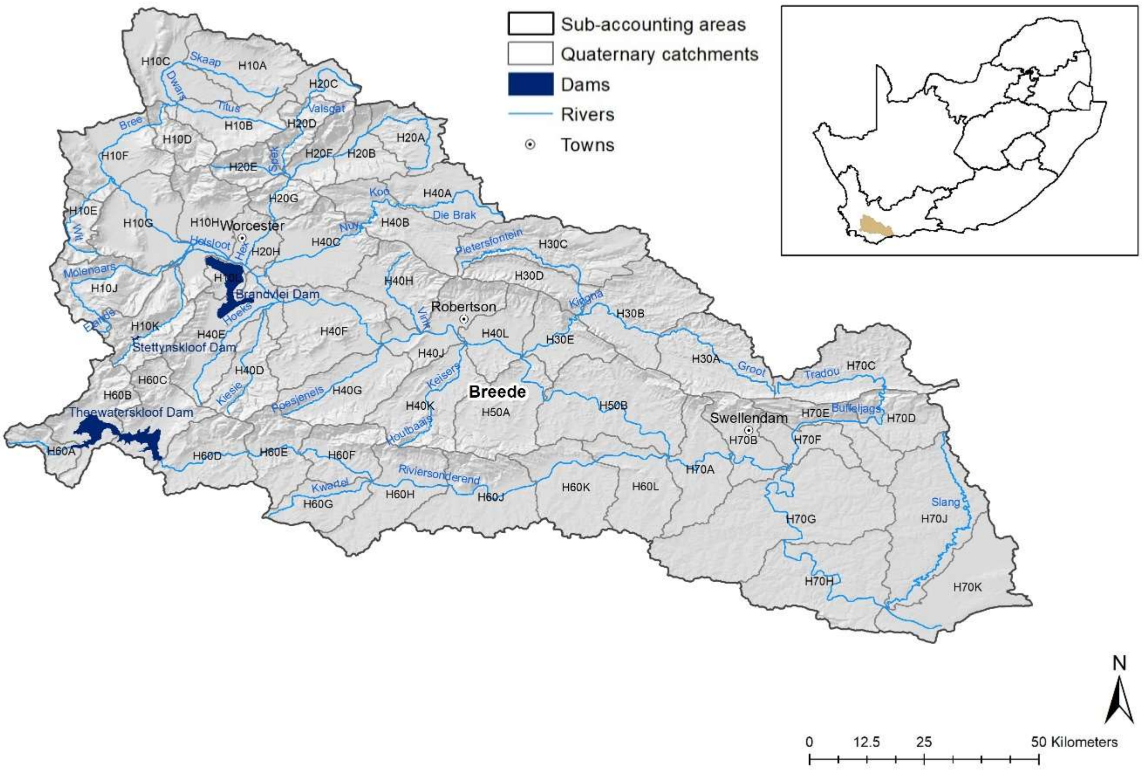
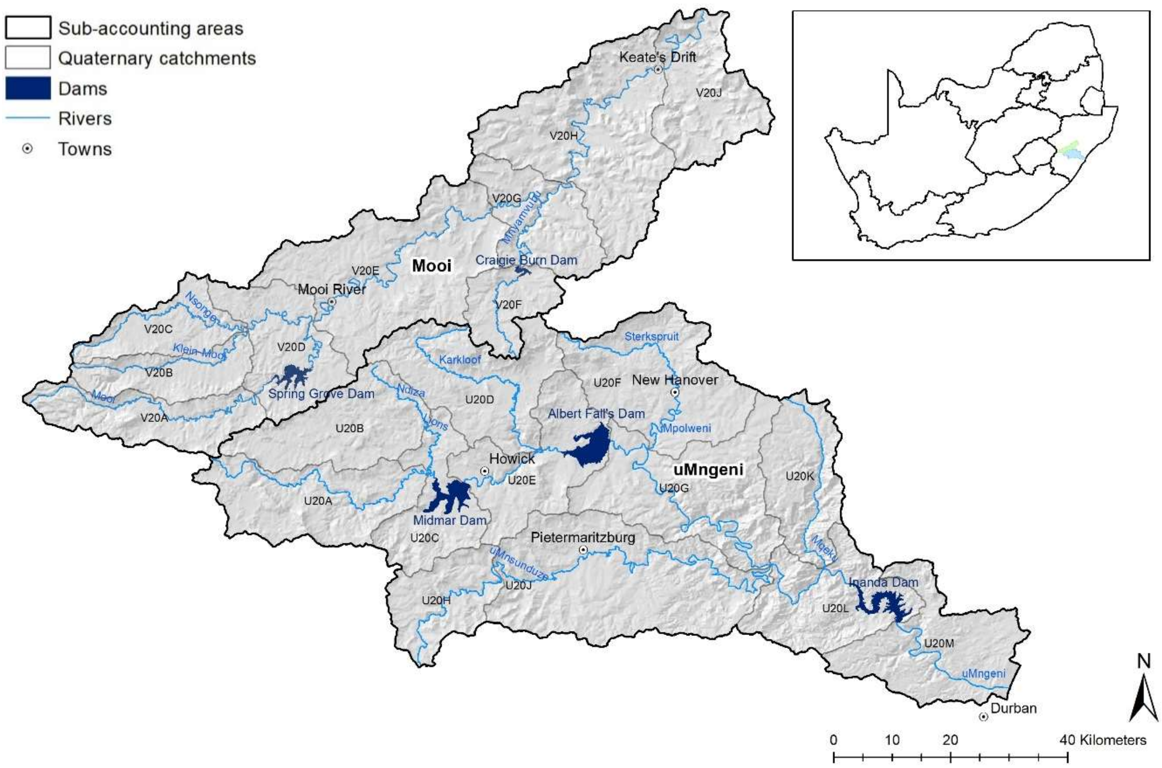


Figure 6 – Quaternary catchments for which water resource accounts were compiled in the uMngeni Catchment sub-accounting area and the Mooi Catchment sub-accounting area



1.5.2 Accounting period

The water resource accounts are presented as annual accounts, compiled for hydrological years running from October to September the following year. They include six hydrological years from 2015-2016 up to 2020-2021[5].

1.5.3 Types of account tables

The hydrological modelling for the water resource accounts provides a large amount of information, for many quaternary catchments (77 in total) within three sub-accounting areas over six accounting periods. This information is presented in four different types of account tables. These tables and their purpose are:

1. **Water resource flow accounts**: Provide a time series of summaries of catchment inflows, outflows and change in storage. This is also shown in the form of water balance graphs.

2. **Water resource flow accounts disaggregated by land cover**: Provide a disaggregation of water flow information across broad land cover classes and additional information on inter-catchment flows. This information helps to improve understanding of the impacts and influence of upstream land use and management of water.

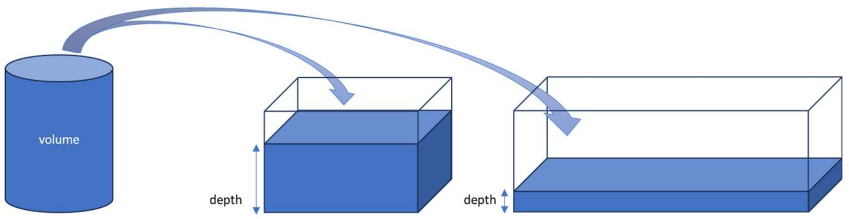
3. **Water resource flow account with reference state:** Provide a baseline against which impacts of actual land cover and water management on water resources can be further explored. These are water resource flow accounts compiled for a scenario where the sub-accounting area is fully covered by natural or semi-natural land cover and contains no built water infrastructure, such as dams or inter-catchment transfers (i.e. a reference state prior to land cover change with associated infrastructure).

4. **Water resource managed flow accounts:** Provide information on the managed water use, including information on the total water resource demand in terms of withdrawals, consumption and returns of water. These are disaggregated by the demands from cultivated and built-up areas, for each accounting period. The tables are similar to a table of physical supply and use of water in SEEA-Water.

The information provided in each of the tables is summarised in Table 1. Provides the calculations used to calculate percentages in water resource flow accounts disaggregated by land cover.

The water resource values are provided in two units of measurement namely, volume in millions of cubic metres (Mm^3) and depths in millimetres (mm). This is because they are each meaningful in different contexts of water resource management: volume (Mm^3) is generally used in relation to water supply, and depth is the typical unit of measurement for rainfall and evaporation. Depth is calculated by dividing volume by area. Two catchments may have the same water inflows (as measured by volume) but have different areal extents. The same volume of water spread across areas of different extents will result in different amounts of water measured by depth (as illustrated in Figure 7). Depth therefore provides a useful measure to compare the water balance across catchments (which have different areas).

Figure 7 – Illustration of how volume is translated into depth across areas of different extent



[5] It should be noted that the hydrological modelling is done at a daily time step (to better represent hydrological processes) and the model output is aggregated to monthly values. The monthly values could be aggregated to other accounting periods (such as calendar years).

Table 1 – Water resource information provided across water resource account tables

Water resource variables	No.	Description of water resource variables	Types of accounts: Water resource flow accounts	Water resource flow accounts disaggregated by land cover	Water resource flow account with reference state	Water resource managed flow accounts
Total In	**[1]**	Gross inflow to the catchment (= [2]+[3])	Yes	Yes	Yes	
Precipitation	[2]	Precipitation as an inflow to the catchment	Yes	Yes	Yes	
Inflows	[3]	Inflows to the catchment other than from precipitation (= [4]+[5]+[6])	Yes	Yes	Yes	
$Q_{in\ SW}$	[4]	Surface water inflow (e.g. from upstream catchment)	Yes	Yes	Yes	
$Q_{in\ GW}$*	[5]	Groundwater inflow (e.g. from neighbouring catchment)	Yes	Yes	Yes	
$Q_{in\ Transfers}$	[6]	Inflow to a catchment as inter-catchment transfers	Yes	Yes	Yes	
Total Out	**[7]**	Gross outflow from the catchment (= [8]+[15])	Yes	Yes	Yes	
Total Evaporation (ET)	[8]	Total evaporation within the catchment (= [9]+[10] = [11]+[12]+[13] +[14])	Yes	Yes	Yes	
Landscape ET	[9]	Evaporation of naturally occurring water from the landscape	Yes	Yes	Yes	
Incremental ET	[10]	Evaporation of water that would not naturally occur (e.g. irrigated water)	Yes	Yes	Yes	
Interception ET	[11]	The precipitation and irrigated water that has been intercepted by vegetation and other surfaces and has subsequently evaporated		Yes	Yes	
Transpiration ET	[12]	The water transpired by vegetation		Yes	Yes	
Soil Water ET	[13]	The water evaporated from the soil		Yes	Yes	
Open Water ET	[14]	The evaporation from open water surfaces (e.g. dams)		Yes	Yes	
Outflows	[15]	Water flowing out of a catchment	Yes	Yes	Yes	
$Q_{out\ SW}$	[16]	Surface water outflows (e.g. to a downstream catchment)	Yes	Yes	Yes	
$Q_{out\ GW}$*	[17]	Groundwater outflows (e.g. to a neighbouring catchment)	Yes	Yes	Yes	
$Q_{out\ Transfers}$	[18]	Outflow from a catchment as inter-catchment transfers	Yes	Yes	Yes	
Reserved outflows	[19]	The portion of utilisable flow that is reserved as outflow from the catchment, for example, to meet environment requirements or downstream requirements or inter-catchment transfers to other catchments (=[18]+environmental flow requirements)	Yes			
Utilisable outflows	[20]	The portion of utilisable outflow that was not utilised, but could have been utilised, and will flow out of the catchment (= [15]-[19])	Yes			
Total Change in Storage	**[21]**	Gross change in storage in the catchment calculated as Total In subtracted from Total Out (= [7]-[1] = [22]+[23]+[24])	Yes	Yes	Yes	
$DS_{f\ SW}$	[22]	Change in surface water store (e.g. in dams)	Yes	Yes	Yes	
$DS_{f\ SoilM}$	[23]	Change in soil moisture store	Yes	Yes	Yes	
$DS_{f\ GW}$	[24]	Change in groundwater store	Yes	Yes	Yes	
Internal Flows	[25]	Flows within the catchment (these are not additive)		Yes	Yes	
Interception	[26]	Interception of rainfall by vegetated and impervious surfaces		Yes	Yes	
Surface Runoff	[27]	Surface runoff		Yes	Yes	

Table 1 – Water resource information provided across water resource account tables (concluded)

Water resource variables	No.	Description of water resource variables	Types of accounts: Water resource flow accounts	Water resource flow accounts disaggregated by land cover	Water resource flow account with reference state	Water resource managed flow accounts
Infiltration	[28]	Infiltration into the topsoil layer		Yes	Yes	
Pot. GW Recharge	[29]	Water percolating down out of the subsoil layer, potential recharge		Yes	Yes	
Baseflow	[30]	Baseflow leaving the baseflow store		Yes	Yes	
Irrigation	[31]	Irrigation applied within the catchment		Yes	Yes	
Total Demand	[32]	Gross managed demand for water by users in the catchment				Yes
Total Withdrawal	[33]	Gross water actually supplied to water users in the catchment (= [34]+[35])				Yes
Cultivated	[34]	Water supplied to cultivated areas (i.e. for irrigation)				Yes
Built-up	[35]	Water supplied to built-up areas				Yes
Total Consumed	[36]	Gross water actually consumed (depleted) by water users (= [37]+[38])				Yes
Cultivated	[37]	Water consumed by cultivated area water users				Yes
Built-up	[38]	Water consumed by built-up area water users				Yes
Total Returned	[39]	Gross water returned by water users (= [40]+[41])				Yes
Cultivated	[40]	Water returned by cultivated area water users				Yes
Built-up	[41]	Water returned by built-up area water users				Yes
Deficit	[42]	Water supply deficit (= [32]-[33])				Yes

* Flows of groundwater between neighbouring catchments were not modelled.

Table 2 – Formulas used to calculate percentages in water resource flow accounts disaggregated by land cover

Catchment		Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area			(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
Water resource details Year-Year		**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	[1]	V1														
Precipitation	[2]	V2		*= V2 / V1*	Vn		*=Vn / V2*	Vc		*=Vc / V2*	Vb		*=Vb / V2*	Vw		*=Vw / V2*
Inflows	[3]	V3		*= V3 / V1*	*No values calculated because these variables do not transfer into individual land cover classes*											
$Q_{in\ SW}$	[4]	V4		*= V4 / V1*												
$Q_{in\ GW}$	[5]	*No values calculated in these accounts*			*No values calculated because these variables do not transfer into individual land cover classes.*											
$Q_{in\ Transfers}$	[6]	V6		*= V6 / V1*												
Total Out	[7]	V7														
Total Evaporation (ET)	[8]	V8		*= V8 / V7*	Vn		*=Vn / V8*	Vc		*=Vc / V8*	Vb		*=Vb / V8*	Vw		*=Vw / V8*
Landscape ET	[9]	V9		*= V9 / V8*	Vn		*=Vn / V9*	Vc		*=Vc / V9*	Vb		*=Vb / V9*	Vw		*=Vw / V9*
Incremental ET	[10]	V10		*= V10 / V8*	Vn		*=Vn / V10*	Vc		*=Vc / V10*	Vb		*=Vb / V10*	Vw		*=Vw / V10*
Interception ET	[11]	V11		*= V11 / V8*	Vn		*=Vn / V11*	Vc		*=Vc / V11*	Vb		*=Vb / V11*	Vw		*=Vw / V11*
Transpiration ET	[12]	V12		*= V12 / V8*	Vn		*=Vn / V12*	Vc		*=Vc / V12*	Vb		*=Vb / V12*	Vw		*=Vw / V12*
Soil Water ET	[13]	V13		*= V13 / V8*	Vn		*=Vn / V13*	Vc		*=Vc / V13*	Vb		*=Vb / V13*	Vw		*=Vw / V13*
Open Water ET	[14]	V14		*= V14 / V8*	Vn		*=Vn / V14*	Vc		*=Vc / V14*	Vb		*=Vb / V14*	Vw		*=Vw / V14*
Outflows	[15]	V15		*= V15 / V7*	*No values calculated because these variables do not transfer into individual land cover classes*											
$Q_{out\ SW}$	[16]	V16		*= V16 / V7*												
$Q_{out\ GW}$	[17]	*No values calculated in these accounts*			*No values calculated because these variables do not transfer into individual land cover classes.*											
$Q_{out\ Transfers}$	[18]	V18		*= V18 / V7*												
Total Change In Storage	[21]	V21			Vn		*No values*[3]	Vc		*No values*[3]	Vb		*No values*[3]	Vw		*No values*[3]
$DS_{f\ SW}$	[22]	V22			Vn			Vc			Vb			Vw		
$DS_{f\ SoilM}$	[23]	V23		*No values*[3]	Vn		*No values*[3]	Vc		*No values*[3]	Vb		*No values*[3]	Vw		*No values*[3]
$DS_{f\ GW}$	[24]	V24			Vn			Vc			Vb			Vw		
Internal Flows	[25]															
Interception	[26]	V26			Vn		*=Vn / V26*	Vc		*=Vc / V26*	Vb		*=Vb / V26*	Vw		*=Vw / V26*
Surface Runoff	[27]	V27			Vn		*=Vn / V27*	Vc		*=Vc / V27*	Vb		*=Vb / V27*	Vw		*=Vw / V27*
Infiltration	[28]	V28		*No values calculated*	Vn		*=Vn / V28*	Vc		*=Vc / V28*	Vb		*=Vb / V28*	Vw		*=Vw / V28*
Pot. GW Recharge	[29]	V29			Vn		*=Vn / V29*	Vc		*=Vc / V29*	Vb		*=Vb / V29*	*No values calculated*		
Baseflow	[30]	V30			Vn		*=Vn / V30*	Vc		*=Vc / V30*	Vb		*=Vb / V30*	Vw		*=Vx / V30*
Irrigation	[31]	V31			*No irrigation on this land cover*			Vc		*=Vc / V31*	*No values calculated*			*No irrigation on this land cover*		

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out.

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

[3] Percentages are not calculated as the change in storage values can be both negative and positive, making the percentages difficult to understand, although mathematically correct.

1.5.4 What is not included in these accounts

There are several aspects of water resource information which are not included in the water resource accounts presented in this discussion document. Water resource accounts are for water quantity only and do not include water quality.

Water resource flow accounts do not account for:

- **Groundwater flows into and out of the catchment**: These were not included due to a lack of information. The usage of groundwater within a catchment is represented in a simple manner, but natural flows of groundwater between neighbouring catchments were not modelled.
- **Commercial and industrial water consumption**: These were not included due to a lack of sufficiently spatially disaggregated information.
- **Specific cultivated crops**: These were not included due to a lack of sufficiently detailed information on specific crops in the land cover dataset; consequently, the crop water requirements of specific crops could not be modelled. Assumptions are made regarding predominant field crop types in a catchment, deciduous versus non-deciduous orchards and forest plantation types.
- **Changes in land cover**: It was assumed that there was no significant land cover change in the accounting period 2015 to 2021. The land cover represented in the National Land Cover 2018 (DEA and GTI, 2019) was used.
- **Consumption of water by invasive alien plant species**: These were not included due to a lack of information.

The datasets underlying the water resource accounts also do not adequately:

- **Include all inter-catchment transfers**: Not all inter-catchment transfers into, out of and within the sub-accounting areas are adequately represented due to a lack of information about the location, operational status and flow records. Major inter-catchment transfers were included but comprehensive datasets of all inter-catchment transfers are needed to include all transfers. This is especially true in the Breede Catchment, which has extensive irrigated agriculture fed by water infrastructure including dams, river diversions, canals and pipelines which transfer water between catchments.
- **Characterise all irrigation schemes**: Assumptions have been made regarding irrigation from sources internal to each catchment, however, the irrigation schemes are not yet adequately represented.
- **Represent urban water sources**: These are currently assumed to be from surface water and thus the sources of water for some urban areas are not yet adequately represented.

Water resource managed flow accounts are only provided for the uMngeni Catchment sub-accounting area. They are not provided for the Breede Catchment and Mooi Catchment sub-accounting areas due to a lack of information. Even in the uMngeni Catchment, the withdrawal sheet does not account for:

- ground water use as information on this is lacking (all water use is instead assumed to be from surface water sources);
- irrigation schemes; and
- water for hydropower is not modelled as none of the large dams in the catchment are used for hydropower generation.

Future directions of work to address some of these gaps are discussed in Section 5.

1.5.5 Key indicators drawn from these accounts

The structuring and formatting of account tables to present this wealth of information, in an appropriate level of detail and in a manner that is useful and easy to understand for a range of potential users of this information, was not simple. Validation workshops with potential users of the information for these accounts confirmed the need for indicators that could be represented spatially. The key indicators selected are calculated from water resource variables in the account tables and are described in Table 3. All indicators are calculated per quaternary catchment. In the future, more indicators could be added, such as indicators related to groundwater (which are not possible now due to a lack of information, see Section 5).

Table 3 – Key indicators that can be calculated from water resource accounts

Indicator	Description	Formula
Evaporation ratio	The ratio of total evaporation to precipitation, referred to as the evaporation ratio, provides an indication of the portion of precipitation within a catchment that is “lost” to evaporation and thus unavailable for other use. A higher ratio indicates lower availability of water in a catchment, and vice versa.	Evaporation / Precipitation
Surface runoff ratio	Precipitation is either intercepted by vegetation and hard surfaces (and typically lost as evaporation), infiltrated (into the soil profile where it is used by plants, evaporates or may percolate deeper into groundwater recharge) or it flows as surface runoff into rivers and dams. The ratio of surface runoff to precipitation relates to availability of water generated on a renewable basis within the catchment. Surface runoff is a component of the water balance that could be used to provide for domestic, industrial and agricultural requirements.	Surface water / precipitation
Per capita total water resources	Ratio between total water resources and population size. Total water resources are the sum of internal water resources (from surface runoff, baseflow and groundwater recharge) and external water resources (surface inflows or groundwater inflows from upstream catchments and inter-catchment transfer inflows) within each quaternary catchment. These are the water resources that would be available for use in a catchment and to provide reserved outflows to downstream catchments or ecosystems, but excludes water stored in dams in a previous accounting period (which may also be used in the catchment or to provide reserved flows).	Total water resources / population size within catchment
Per capita net water resources	Ratio between net water resources and population size. Net water resources are what remains after the reserved outflows have been subtracted from total water resources. Net water resources may be negative for a catchment when reserved outflows leaving the catchment in a year are greater than the total water resources (which excludes stored water) for the catchment that year. This is most likely to occur in catchments with large dams during years with low rainfall. Dividing this by the population size within the catchment enables comparison of net water resources per person across different areas. It is important to note that this excludes water stored in dams in a previous accounting period that could be used in the catchment.	(Total water resources – reserved outflows) / population size within catchment
Water resources dependency ratio	The reliance of a catchment on water resources contributed from outside the catchment. External water resources are the inflows from neighbouring catchments. In the context of these accounts, this is either as engineered transfers or surface water inflows from neighbouring catchments (water resource accounts groundwater inflows were not modelled). The degree to which a catchment relies on water contributed from outside the catchment indicates risk.	External water resources / total water resources
Reserved outflow ratio	Not all of the total water resources within a catchment are available for use within the catchment as some of these resources are exported for use in other catchments (downstream catchments or via engineered transfers to other neighbouring catchments) or reserved to meet environmental water requirements downstream. The “burden” of these reserved outflows is indicated by comparing these to the total water resources available in the catchment. This indicator is the fraction of total water resources that are reserved for “export” to other catchments.	Reserved outflow / total water resources
Incremental evaporation ratio	Ratio of incremental evaporation (the portion of evaporation that we have some management control over) to total evaporation within a catchment.	Incremental evaporation / Total evaporation
Exploitation index	Ratio between abstractions of managed water flows and total water resources. Managed water flows are the sum of water withdrawals by users within the catchment and reserved outflows to other catchments. This is an indicator of water stress.	(Gross withdrawals + reserved outflows) / total water resources

1.6 Structure of the discussion document

This discussion document is structured in five sections as follows:

- Section 1: Introduction (this section) – introduces NCA and the SEEA, explains the water resource environment and accounts related to water and water-related ecological infrastructure, and outlines the purpose and scope of the water resource accounts.

- Section 2: Essential foundations for water resource accounts – provides a brief summary of the hydrological modelling approach used, the data requirements and a brief description of the accounting sheets.

- Section 3: Key findings per area – presents the results of the water resource accounts per sub-accounting area.

- Section 4: Key findings across all areas – presents the results of indicators across all areas.

- Section 5: Directions for future work – makes recommendations for future work on water resource accounts.

The discussion document is accompanied by supplementary Excel workbooks containing account tables that can be downloaded from the Stats SA website (http://www.statssa.gov.za/). A sources and methods report, which provides details about the data sources used and the methodology, is available from Stats SA on request.

2 ESSENTIAL FOUNDATIONS FOR WATER RESOURCE ACCOUNTS

The purpose of this section is to provide a summary of the essential foundations for compiling water resource accounts. This includes a summary of the hydrological modelling approach used, the data requirements and a brief description of the account tables to aid the reader of this report in understanding the accounts and results. A comprehensive description of the sources and methods for these accounts is available in a separate report, accessible from Stats SA on request.

There is a focus on the components of the water accounts that are likely to be most sensitive, which are expected to be rainfall and total evaporation estimates at a catchment scale. There is also a focus on representing the impact of land cover and land use on water resources, to facilitate interlinkages with other natural capital accounts related to land use and water-related ecosystem services.

2.1 Approach to water resource accounts

In the development of an integrated water resources accounting methodology for South Africa, described in Clark (2015) and Clark (2019), it was recognised that it is not feasible to measure all the components of a catchment-level water balance at a suitable level of spatial and temporal detail. Put simply, it is not feasible to measure everything, everywhere, all the time. Many components of the hydrological cycle at catchment level are either: (i) difficult to measure, or (ii) are not measured across the whole country at a suitably detailed spatial resolution. For this reason, a hydrological modelling approach was adopted.

The ACRU[6] hydrological model (Schulze, 1995; Smithers and Schulze, 1995) was selected due to its physical conceptual nature and, being a model developed in South Africa, was supported by a range of South African derived input datasets developed by the Centre for Water Resources Research (CWRR) at the University of KwaZulu-Natal (UKZN). ACRU is a deterministic simulation type model based on physical and empirical equations and input variables. Such a model can make provision for non-stationarity (such as climate change and changes in land cover over time) and avoids the need for calibration, thus making it suitable for application in ungauged catchments (i.e. catchments with no flow gauge measurements). This modelling approach, in addition to its use in quantifying existing water resources, as reported in the accounts, enables what-if scenarios to be evaluated for use in guiding management decisions.

A daily physical conceptual model, such as ACRU, enables the natural daily fluctuations in the water balance of the climate/plant/soil continuum to be represented and ensures internal consistency through the modelled feed-forwards and feedbacks between the various components of the hydrological system. The ACRU model was used to simulate six hydrological years from 2015-2016 to 2020-2021.

The methodology has a strong land cover/use focus, and a hierarchical system of land cover/use classes (see Section 2.3) is used to accommodate land cover datasets with different levels of detail and different classification systems. This hierarchy enables sectoral water use to be reported at different levels of detail. A database of land cover/use classes (Clark, 2015; Clark, 2019) containing information describing the hydrological characteristics of these classes for use in the ACRU model was applied.

Where feasible, remotely sensed raster datasets were used as part of the methodology to improve representation of spatial variability in the configuration of the ACRU model. Examples of datasets derived from remote sensing include: Digital Elevation Models (DEM), land cover, rainfall and reference potential evaporation.

Modelled outputs are reported at quaternary catchment-scale. Many quaternary catchments are however several hundred square kilometres in size, within which topography and climate may vary

[6] The acronym ACRU is derived from the Agricultural Catchments Research Unit that used to exist within the former Department of Agricultural Engineering of the University of KwaZulu-Natal in Pietermaritzburg, although it has now become the model's generic name without reference to the former unit.

greatly. The hydrological modelling was thus done for sub-quaternary catchments, to better represent variability in climate, topography and sectoral water use within a quaternary catchment. The hydrological modelling is done at a daily time step and the modelled variables used in the water resource accounts are aggregated to monthly values. The methodology enables the aggregation of accounts up from finer to coarser spatial and temporal scales.

The water resources accounting methodology was not intended to be a prescriptive list of datasets and data processing procedures or algorithms. Rather, it sought to: (i) identify datasets that are suitable for the purpose and, for the most part, freely available, (ii) to suggest how these datasets may be applied, and (iii) demonstrate the application of a hydrological modelling approach for estimating components of water resource accounts that may not be easily measured at a suitable spatial and temporal scale. The hydrological modelling, on which the water resource accounts presented in this discussion document are based, required data related to climate, land cover/use, soil properties, dams, river networks, inter-catchment transfers, irrigation and urban water use, as summarised in Table 4. The hydrological modelling approach adopted helps to address some of the data gaps, however, the model input data requirements are also substantial. National datasets were used in the water resource accounts to support work to scale up the methodology to compile national water resource accounts in the future. Currently, urban residential water use is estimated in a simple manner based on population. Industrial water use and commercial water use are currently not included in the water use estimates as suitable national datasets on water supply and return flows have not been identified.

Table 4 – Summary of data used in the hydrological model

Types of data	Datasets used
Catchment Boundaries	Primary, Secondary, Tertiary, Quaternary: DWS (2018) updates of Weepener et al. (2011a)
	Quinary: National Freshwater Ecosystem Priority Areas (NFEPA) River Freshwater Ecosystem Priority Areas (FEPA) (Nel et al., 2011a) used as a guideline.
Rivers	NFEPA FEPA Rivers (Nel et al., 2011b)
	Flow paths from 90 m DEM (Weepener et al., 2011b)
Measured Streamflow	DWS Hydrology website (http://www.dwa.gov.za/hydrology/)
DEM	Hydrologically Corrected 90 m DEM (Weepener et al., 2011b)
Daily Rainfall	Remotely sensed rainfall: Famine Early Warning Systems RFE 2.0 (Novella and Thiaw, 2012); Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) 2.0 (Funk et al., 2014)
	Rain gauge measurements sourced from: DWS; South African Sugarcane Research Institute; National Oceanic and Atmospheric Administration
Rainfall Seasonality	South African Atlas of Climatology and Agrohydrology (Schulze et al., 2008): Rainfall seasonality (Schulze and Maharaj, 2008a)
Daily Reference Potential Evaporation	Satellite Application Facility for Land Surface Analysis (LSASAF) Meteosat Second Generation Reference Evapotranspiration (METREF) dataset (Trigo et al., 2011; De Bruin et al., 2016)
Mean Monthly Air Temperature	South African Atlas of Climatology and Agrohydrology (Schulze et al., 2008): Maximum temperature (Schulze and Maharaj, 2008b); Minimum temperature, (Schulze and Maharaj, 2008c)
Land Cover/Use	National Land Cover 2018 (DEA and GTI, 2019)
	Vegetation Types (SANBI, 2012)
	CWRR Clusters (Toucher et al., 2019)
Dams	Dam location and extent: National Biodiversity Assessment (NBA) 2018 Artificial Wetlands dataset (Van Deventer et al., 2018); Mzansi Amanzi dataset (SANSA, 2018; Thompson et al., 2018).
	Storage capacity and geometry of dams: DWS Hydrology website (http://www.dwa.gov.za/hydrology/)
	DWS Durban Regional Office
	WR2012 study (Bailey and Pitman, 2016) website (http://www.waterresourceswr2012.co.za)
	Dam Safety Office (DSO) Database of Registered Dams (DSO, 2018)
	Dam storage to initialise large dams (DWS NIWIS website: http://niwis.dws.gov.za/niwis2/SurfaceWaterStorage)
Inter-catchment Transfers	DWS Hydrology Website (http://www.dwa.gov.za/hydrology/)
Soils	South African Atlas of Climatology and Agrohydrology (Schulze et al., 2008):
	Soil properties (Schulze and Horan, 2008)
Population	2011 Census (Stats SA 2012)
Irrigation Water Source Type	DWS Water use Authorization and Registration Management System (WARMS) database (Anderson et al., 2008)

2.2 Verification of hydrological model

Any modelling approach will have uncertainties associated with the data used as input to the hydrological model and also with the representation of hydrological processes in the model. To provide some measure of confidence in the modelled information, modelled streamflow was verified against streamflow measurements, while taking into consideration that there are uncertainties associated with the accuracy of the measured streamflow. Streamflow is a useful measurement against which to verify the hydrological modelling as streamflow represents the cumulative effect of a number of hydrological processes (such as infiltration, runoff and evaporation) for a variety of land cover types in a catchment. The cumulative effect can itself also make attribution of modelling inaccuracies difficult. It is likely that inaccuracies in the catchment rainfall estimates are a key source of error.

In the Breede Catchment sub-accounting area, verifications (described in the sources and methods for these accounts) showed that streamflow was underestimated in most years at all gauges, except for 2020-2021 where flows were generally overestimated. The mean absolute percentage errors in annual streamflow at a selected gauge in each secondary catchment are: 59,6% in H10C; 33,8% in H20F; 75,1% in H30E; 32,0% in H40F; 93,5% in H50A; 33,3% in H60K; and 77,8% in H70A.

In the uMngeni Catchment sub-accounting area, verifications showed that streamflow was overestimated in most years all gauges. Verification of annual streamflow was generally better at streamflow gauges representing headwater catchments. The mean absolute percentage errors in annual streamflow at selected gauges are: 44,4% in U20A; 88,2% in U20B; 35,7% in U20D; 101,8% in U20F; 34,1% in U20H; and 28,2% in U20J. The verification at gauge U2H005 on the uMngeni River upstream of Nagle Dam showed an average overestimation of 194,0%. Verifications were especially poor immediately downstream of the large dams on the uMngeni River indicating a possible data error.

In the Mooi Catchment sub-accounting area the verifications of annual streamflow were better in the upper part of the catchment, where streamflow was overestimated in some years and underestimated in others. The mean absolute percentage errors in annual streamflow at selected gauges are: 20,4% in V20A; 38,1% in V20B; 58,0% in V20C; and 40,2% in upper V20E. Lower in the catchment, at the outlet of V20E, flows were overestimated in all years with the average error being 106,5%. Similar to uMngeni, the verification just downstream of Cragie Burn Dam in quaternary catchment V20F was poor with an error of 147,9%.

2.3 South African National Land Cover data

The land cover and use within a catchment is typically heterogeneous and can have a significant effect on the hydrology within a catchment. Water use within a catchment is closely linked to land cover and land use. Land cover data are spatial data concerning different types of physical and biological cover found on the Earth's surface. These can be natural, semi-natural or intensively modified (such as cultivation, urban settlements and mines) and are generally organised into land cover classes.

The South African National Land Cover (SANLC) dataset for 2018 (GTI, 2019) was used in the water resource accounts. The term "land cover" is used "loosely to incorporate both land-cover and land-use information" (GTI, 2015) and the term "land cover classes" is used for simplicity rather than referring each time to "land cover/land use classes". The SANLC datasets and metadata reports are freely available from the Department of Forestry, Fisheries and the Environment (DFFE).

The 2018 SANLC dataset is generated from 20-metre multi-seasonal Sentinel 2 satellite imagery and map 73 land cover classes covering a wide range of natural and human-modified landscape characteristics (and in line with the South African Land Cover Classes and Definitions in terms of section 11(2) of the Spatial Data Infrastructure Act (Act No. 54 of 2003)) (DRDLR, 2017). To simplify analysis and reporting, the SANLC classes are aggregated into groups in a hierarchical structure of increasingly aggregated levels. The South African Land Cover Classes and Definitions (DRDLR, 2017) offer a hierarchy of four levels. For natural capital accounts, a slightly different grouping of land cover classes across four hierarchical tiers is used. The grouping was done in such a way that the classes in tiers 1, 2 and 3 are aligned with the likely intensity of ecological impact and linked to socio-economic drivers of change in the landscape as far as possible. These tiers were used in the national *Land and Terrestrial*

Ecosystem Accounts, 1990 to 2014 (Stats SA, 2020) and the *Accounts for Strategic Water Source Areas, 1990 to 2020* (Stats SA, 2023).

The grouping of land cover classes in the 2018 SANLC dataset into tiers for accounting purposes is illustrated in Table 5. The water resource flow accounts are disaggregated to tier 1 of this hierarchy, referred to as broad land cover classes.

Table 5 – Grouping of South African National Land Cover 2018 detailed classes into tiers for accounting purposes

Broad land cover classes *Tier 1: 4 classes*	**Main land cover classes** *Tier 2: 8 classes*	**Detailed land cover classes** *Tier 3: 19 classes*	**2018 SANLC classes** *Tier 4: 73 classes*
Natural or semi-natural	Natural or semi-natural	Natural or semi-natural	21 land cover classes
Cultivated	Commercial field crops	Commercial field crops (dryland)	2 land cover classes
		Commercial field crops (non-pivot irrigated)	1 land cover class
		Commercial pivot crops (pivot)	1 land cover class
		Sugarcane	3 land cover classes
	Subsistence crops	Subsistence crops	1 land cover class
	Orchards and vines	Orchards	1 land cover class
		Vines	1 land cover class
	Timber plantations	Timber plantations	3 land cover classes
Built-up	Urban	Residential formal	5 land cover classes
		Residential informal	4 land cover classes
		Smallholdings	4 land cover classes
		Village	2 land cover classes
		Recreational fields	4 land cover classes
		Commercial	1 land cover class
		Industrial and transport	2 land cover classes
	Mines	Mines	5 land cover classes
Waterbodies	Waterbodies	Natural waterbodies	10 land cover classes
		Artificial waterbodies	2 land cover classes

Source: Stats SA, 2023

The reliability of the land cover change statistics is influenced by the accuracy of the input data against which change is determined. The SANLC has high levels of accuracy of land cover classes as assessed and reported for each dataset using a method described in detail in the metadata report (GTI, 2019; GTI, 2021). The overall map accuracy for the SANLC 2018 dataset is 90,1%, with a mean class accuracy of 89,6%. The accuracy for many of the intensively modified land cover classes is higher than the average map accuracy. This is important as changes in the intensively modified land cover classes have the most impact on water resources.

All natural or semi-natural land cover classes are grouped together for accounting purposes. The term “natural” is used to describe areas in which species composition, vegetation structure and ecological processes are largely intact, reflecting a more or less natural state prior to substantial human modification. The term “natural” is used with full recognition that in the current context of the Anthropocene there are no ecosystems that are untouched by human influence, so it does not imply a pristine or wilderness state and includes areas that are near-natural rather than strictly natural. The term semi-natural is used to describe areas in which species composition no longer reflects a natural state and vegetation structure has also changed, but in which ecological processes remain largely intact or have been largely restored. Examples of semi-natural areas include areas invaded by invasive alien plant species, rangelands that have been heavily grazed, and previously cultivated areas that have lain fallow for several years or more (also called secondary natural areas). Intensively modified areas include urban areas, mined areas and cultivated areas.

Natural and semi-natural areas exist on a continuum, so drawing a definitive line between natural, near natural and semi-natural is challenging. At this stage, it is not possible to reliably distinguish natural areas from semi-natural areas based on remotely sensed imagery, so these are grouped together at all tiers. The distinction between natural or semi-natural areas and intensively modified areas (such as cultivation, urban settlements and mines) is much easier to identify based on remotely sensed imagery, making it possible to delineate intensively modified areas reliably in these accounts. In future water resource accounts it would be ideal to distinguish spatially between natural areas and semi-natural areas, specifically taking invasive alien plant species into account (which impact on the water balance) (see Section 5).

The SANLC dataset includes land cover classes that relate to water surfaces, such as wetlands, seasonal waterbodies and permanent waterbodies. Although these classes have been retained in the accounting tables under the collective "waterbodies" class, they are not disaggregated in this report. Land cover data were used to estimate the full areal extent of dams in each catchment in the year 2018, combined with information from the DWS database of registered dams (DSO, 2018) and two new spatial datasets containing dams namely the NBA 2018 Artificial Wetlands dataset (Van Deventer et al. 2018) and the Mzansi Amanzi dataset (SANSA, 2018; Thompson et al. 2018).

The national Basic Spatial Unit (BSU) layer is a grid of 1-hectare (ha) (100 x 100 m) cells which provides a consistent spatial framework for integrating data from a range of sources. The 2018 SANLC dataset (with a resolution of 20 m) was resampled to the BSUs, and then applied to derive land cover based hydrological response units for use in the hydrological modelling. The application of the BSUs for the land cover promotes consistency and comparability with other natural capital accounts related to land cover extents, including the national *Land and Terrestrial Ecosystem Accounts, 1990 to 2014* (Stats SA, 2020) and the *Accounts for Strategic Water Source Areas, 1990 to 2020* (Stats SA, 2023). Information about the BSU is available in a separate BSU report, which is available from Stats SA on request.

3 KEY FINDINGS PER AREA

This section presents key findings from the water resource accounts per sub-accounting area, namely for the Breede Catchment, uMngeni Catchment and Mooi Catchment sub-accounting areas.

The accounts represent aggregated values for the whole of each sub-accounting area. More insight can be gained from understanding variability across the areas, which is provided in Section 4.

Note that in the tables, '0' signifies a zero value or a negligible value when rounded off, a blank cell indicates a case where no values could be calculated for these accounts, and a dash indicates values that could not be calculated (such as due to division by zero).

3.1 Breede Catchment sub-accounting area

The Breede Catchment sub-accounting area was 12 562 km^2. In the Breede Catchment, separate water resource flow accounts were compiled for the whole Breede Catchment sub-accounting area, the seven secondary catchments and the 56 quaternary catchments for six hydrological years from 2015-2016 to 2020-2021.

3.1.1 Water resource flow accounts

Water resource flow accounts provide flow information that is the basis for water balance graphs (showing a time series of catchment inflows and outflows). The water resource flow account as annual volumes (Mm^3) over the six hydrological years from October 2015 to September 2021 (Table 6) is shown as a time series graph of catchment total inflows (Total In) and total outflows (Total Out) for the Breede Catchment sub-accounting area in Figure 8. They are also provided as normalised depths (mm) (Table 7) and shown as a time series graph in Figure 9.

These tables and graphs describe the total inflows of water to a catchment (in the form of precipitation, surface water inflows and inflowing inter-catchment transfers), the water consumption within a catchment (in the form of evaporation and transpiration), the total outflows of water from a catchment (in the form of surface water outflows and outflowing inter-catchment transfers) and changes in water storage within the catchment (surface water stores, soil moisture stores and groundwater stores). In Figure 8 and Figure 9, the difference in height between the Total In and Total Out bars in a hydrological year represents the change in water storage. If Total In is less than Total Out, then water storage in the catchment is being drawn down. If Total In is greater than Total Out, then water storage in the catchment is being replenished. The overall water balance, as illustrated in Figure 8 and Figure 9, was the smallest in 2016-2017 and the greatest in 2020-2021.

Precipitation (as one form of water inflow) into the Breede Catchment sub-accounting area was the lowest in 2016-2017 with 233,3 mm per annum, when the region experienced a drought, but was also low in 2018-2019. Precipitation was the highest in 2020-2021 with 678,5 mm per annum. Inflows from surface water were zero at the level of the whole sub-accounting area as there are no upstream catchments and no inter-catchment transfers[7] from other catchments into the Breede Catchment sub-accounting area. Groundwater inflows were not shown due to a lack of information at this time.

Water leaves the catchment through evaporation (which includes transpiration) and outflows of surface water, groundwater and inter-catchment transfers. Total evaporation was the largest outflow. Total evaporation ranged from 222,9 mm per annum in 2016-2017 to 455,6 mm per annum in 2020-2021, matching the years of lowest precipitation and highest precipitation. While evaporation is generally high relative to precipitation, it is relatively more so in dry years. Total evaporation is broken down in Table 6 and Table 7 into evaporation of precipitated water from the landscape (Landscape ET) and

[7] Not all inter-catchment transfers into, out of and within the Breede Catchment have been adequately represented due to a lack of information about the location, operational status and flow records for these at the time the ACRU model configuration used in the generation of these results was prepared.

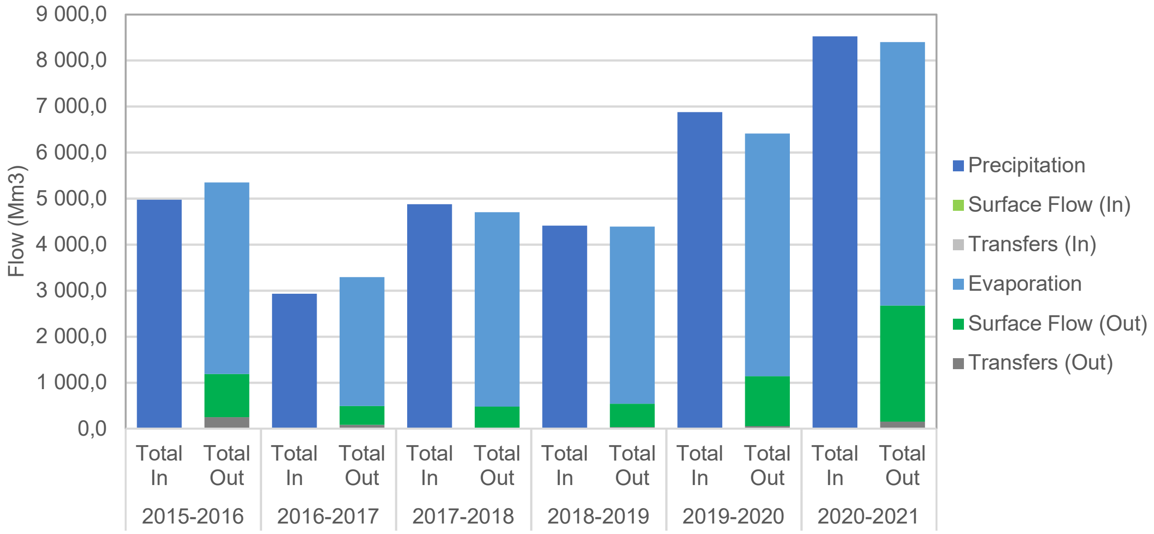
evaporation of irrigated water (Incremental ET). Incremental evaporation is a useful measure of the portion of total evaporation over which there is some management control.

Outflows are the sum of surface water outflows, groundwater outflows (which are not measured in these accounts) and inter-catchment transfer outflows. Surface water outflows were the lowest in the drier years 2016-2017, 2017-2018 and 2018-2019. Transfers[8] were higher in the driest year 2016-2017 compared with the subsequent three hydrological years. This was likely due to the water demands for the City of Cape Town during a drought in the region that saw all water supply sources drawn down. Of the exploitable water physically present in the surface water network and aquifers for potential abstraction and consumption, there are two variables that are useful to track: the portion that is reserved for outflow, and thus not available for use in the catchment (reserved outflow); and the portion that is unused flows that could be used for further development in the catchment (utilisable outflow). Reserved outflows could include inter-catchment transfers, supply to irrigation and urban users in other catchments and environmental flow requirements. The Breede Catchment does not have any downstream catchments and environmental flows are not currently represented in these accounts; thus reserved outflow only includes that which is allocated to inter-catchment transfers. In this case, utilisable outflow is the same as the surface water outflows leaving the catchment.

The total change in water storage is the subtraction of total inflows from total outflows. When this value is positive, it means that total inflows were less than total outflows, and the water storage in the catchment is being drawn down. When the value is negative, it means that inflows were greater than outflows and there is replenishment of water being stored in the catchment. Water may be stored in surface waterbodies, the soil profile or as groundwater. In the Breede Catchment, there was a drawdown on water stored in the catchment during 2015-2016 and 2016-2017 years, which was replenished in the wetter years.

These summaries provide a useful overview of the catchment water balance which can be examined in more detail for each of the 56 quaternary catchments.

Figure 8 – Time series of catchment total inflows and total outflows for the Breede Catchment, as volume in millions of cubic metres (Mm^3), 2015 to 2021



[8] The Breede Catchment has extensive irrigated agriculture fed by water infrastructure including dams, river diversions, canals and pipelines, which transfer water between catchments. Assumptions have been made regarding irrigation from sources internal to each catchment, however, the irrigation schemes are not yet adequately represented in the configuration of the ACRU model and thus not all existing transfers between catchments are represented.

Figure 9 – Time series of catchment total inflows and total outflows for the Breede Catchment, as normalised depths (mm), 2015 to 2021

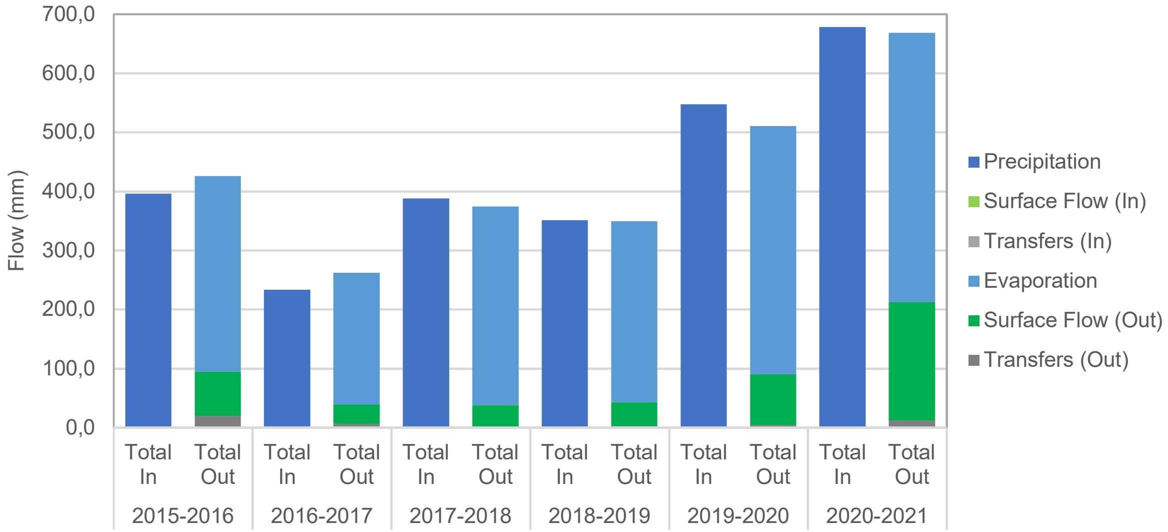


Table 6 – Water resource flow account for the Breede Catchment, 2015-2021, for six accounting periods (as volume in millions of cubic metres (Mm³))

Breede Catchment sub-accounting area (12 562,0 km²)	**2015-2016**	**2016-2017**	**2017-2018**	**2018-2019**	**2019-2020**	**2020-2021**
Total In	4974,8	2930,6	4874,7	4412,2	6880,1	8523,3
Precipitation	4974,8	2930,6	4874,7	4412,2	6880,1	8523,3
Inflows	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ GW}$						
$Q_{in\ Transfers}$	0,0	0,0	0,0	0,0	0,0	0,0
Total Out	5349,2	3294,0	4704,1	4388,5	6413,8	8396,7
Total Evaporation (ET)	4161,6	2799,6	4226,1	3849,9	5278,8	5722,8
Landscape ET	4002,5	2653,8	4152,0	3734,7	5189,4	5552,9
Incremental ET	159,1	145,8	74,1	115,2	89,4	169,8
Outflows	1187,6	494,4	478,0	538,6	1135,0	2674,0
$Q_{out\ SW}$	939,1	416,2	461,8	507,1	1081,9	2523,7
$Q_{out\ GW}$						
$Q_{out\ Transfers}$	248,5	78,2	16,2	31,5	53,1	150,3
Reserved outflows	248,5	78,2	16,2	31,5	53,1	150,3
Utilisable outflows	939,1	416,2	461,8	507,1	1081,9	2523,7
Total Change in Storage	374,4	363,3	-170,5	-23,7	-466,0	-126,9
$DS_{f\ SW}$	209,8	123,5	-65,4	21,2	-139,7	-37,3
$DS_{f\ SoilM}$	101,2	17,2	-40,8	-93,0	37,4	73,1
$DS_{f\ GW}$	63,3	222,6	-64,3	48,1	-363,7	-162,7

Table 7 – Water resource flow account for the Breede Catchment, 2015-2021, for six accounting periods (as depth in millimetres (mm))

Breede Catchment sub-accounting area (12 562,0 km^2)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total In	396,0	233,3	388,1	351,2	547,7	678,5
Precipitation	396,0	233,3	388,1	351,2	547,7	678,5
Inflows	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ GW}$						
$Q_{in\ Transfers}$	0,0	0,0	0,0	0,0	0,0	0,0
Total Out	425,8	262,2	374,5	349,3	510,6	668,4
Total Evaporation (ET)	331,3	222,9	336,4	306,5	420,2	455,6
Landscape ET	318,6	211,3	330,5	297,3	413,1	442,0
Incremental ET	12,7	11,6	5,9	9,2	7,1	13,5
Outflows	94,5	39,4	38,1	42,9	90,4	212,9
$Q_{out\ SW}$	74,8	33,1	36,8	40,4	86,1	200,9
$Q_{out\ GW}$						
$Q_{out\ Transfers}$	19,8	6,2	1,3	2,5	4,2	12,0
Reserved outflows	19,8	6,2	1,3	2,5	4,2	12,0
Utilisable outflows	74,8	33,1	36,8	40,4	86,1	200,9
Total Change in Storage	29,8	28,9	-13,6	-1,9	-37,1	-10,1
$DS_{f\ SW}$	16,7	9,8	-5,2	1,7	-11,1	-3,0
$DS_{f\ SoilM}$	8,1	1,4	-3,2	-7,4	3,0	5,8
$DS_{f\ GW}$	5,0	17,7	-5,1	3,8	-29,0	-13,0

3.1.2 Water resource flow accounts disaggregated by land cover

Changes in the extent of different land cover classes within a catchment, especially the extent of highly modified land cover, can affect both water quantity and quality. This section includes water resource flow accounts disaggregated by four broad land cover classes, namely natural or semi-natural, cultivated, built-up and waterbodies (refer to Section 2.3). Figure 10 shows the distribution of these broad land cover classes across the Breede Catchment sub-accounting area and the land cover composition per quaternary catchment is provided in Appendix 1 (Table 51). The water resource flow accounts disaggregated by land cover were compiled per accounting period from 2015-2016 to 2020-2021, as provided in Table 8 to Table 13. The tables include detail on the extent of each broad land cover class in the Breede Catchment sub-accounting area, a similar catchment water balance on the left-hand side to what is presented in Table 6 and Table 7, but provide more detail of the types of evaporation and also internal catchment flows such as surface runoff, infiltration and baseflow.

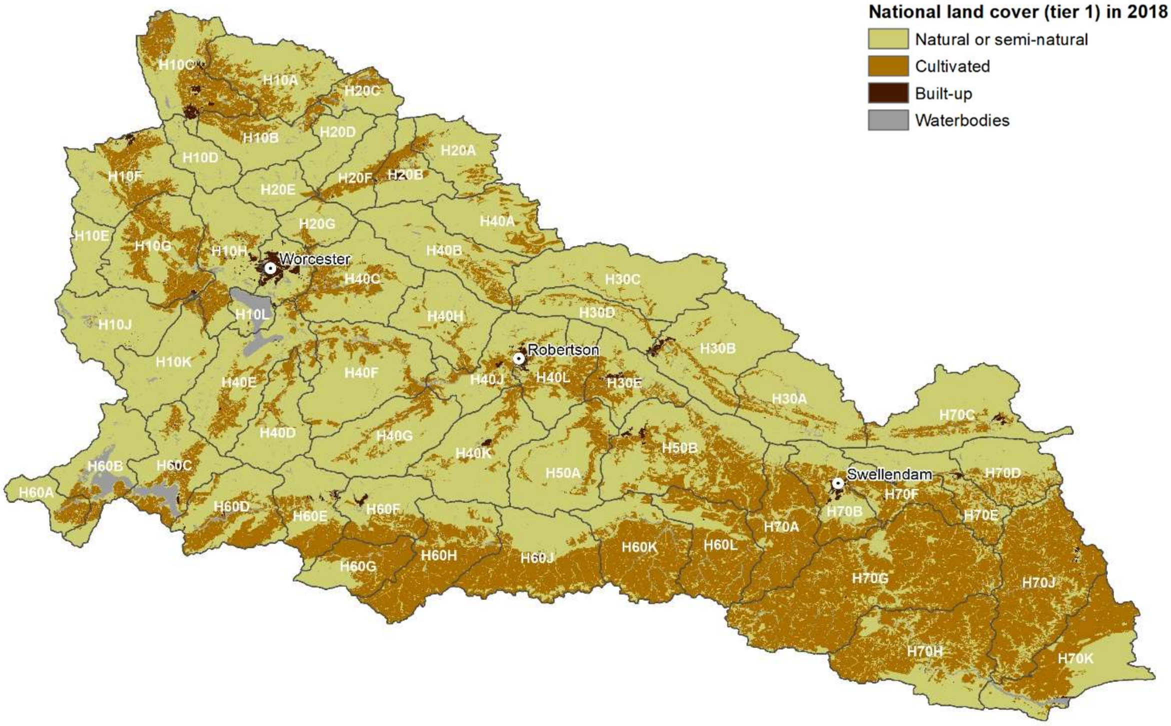
The Breede Catchment was largely natural or semi-natural (69,4%), and the remainder was largely cultivated (28,5%) with only 1,8% waterbodies (such as dams for water supply) and 0,3% built-up (urban and mines).

The proportional extent of land cover classes can be compared to the proportional attribution of each of the water resource variables. For instance, in 2015-2016, natural or semi-natural land cover made up 69,4% of the Breede Catchment, and 69,5% of precipitation fell across these areas. Precipitation was generally proportional to area in the Breede Catchment.

Evaporation, in contrast, was not proportional to area of land cover. Land cover (e.g. the types of plants, hard surfaces of built-up areas) influences evaporation. In the Breede Catchment, total evaporation was proportionally higher in cultivated land (the proportion of cultivated land was 28,5% and the proportion of total evaporation on cultivated land was between 31,3% and 34,7% in different accounting periods). Land use and land cover influence how water is made available for evaporation, and the main ways in which it is evaporated.

The water resource flow accounts disaggregated by land cover provide additional details about these different types of evaporation, to provide further insights into the relationships between water resources and land cover. Firstly, in the same manner as in the water resource flow accounts, total evaporation is partitioned into evaporation of precipitated water from the landscape (Landscape ET) and evaporation of irrigated water (Incremental ET). Landscape evaporation on natural or semi-natural land cover varies between 64,0% (2016-2017) and 67,1% (2017-2018, 2018-2019), which was proportionally lower than the area of natural or semi-natural land cover (69,4%). Landscape evaporation on cultivated land was proportionally greater than the area of cultivated land (28,5%) where it varies between 29,8% (2018-2019) and 31,9% (2020-2021), meaning water that was precipitated on cultivated land evaporates proportionally more than that which was precipitated on natural or semi-natural land. Incremental evaporation only takes place in cultivated or built-up areas, with the majority evaporated from cultivated areas (93,3% to 96,7%).

Figure 10 – Broad land cover classes in the Breede Catchment sub-accounting area



Secondly, total evaporation of water that was either precipitated and/or irrigated (regardless of where it came from) is partitioned by how the water is evaporated: water that has been intercepted by vegetation and other surfaces and then evaporated (Interception ET); water transpired by vegetation (Transpiration ET); evaporation from the soil water store (Soil Water ET); and evaporation from open water surfaces (Open Water ET). Water intercepted by vegetation in the Breede Catchment was proportionally greater in natural or semi-natural areas, varying from 77,2% (2020-2021) to 78,8% (2018-2019, 2019-2020), where there were more vegetation and vegetative material on the soil surface. Similarly, transpiration was higher, varying from 70,0% (2016-2017) to 79,2% (2018-2019), in areas with a greater proportion of well-established or mature plants. Soil water evaporation was, however, proportionally lower on natural or semi-natural areas, varying from 60,3% (2016-2017) to 63,1% (2017-2018), meaning more water was able to stay in the soil potentially moving to recharge groundwater or baseflow. Relative to the proportional extent of cultivated land cover (28,5%), soil water evaporation was high, ranging between 36,6% (2017-2018) to 39,4% (2016-2017).

This type of account table also expands on the water resource flow accounts to provide information on flows inside the catchment (internal flows), which provide more information about some of the impacts of land cover. The internal flows describe:

- **Where precipitated and irrigated water flows**, partitioning this into: water that gets intercepted on plants and hard surfaces (and thus does not move into the soil or rivers and dams, it is typically lost as evaporation) (interception); the water that infiltrates into the soil where it replenishes the water in the soil matrix (infiltration)[9]; and water that runs off the surface into rivers, wetlands and dams (surface runoff).

- **What happens to water that has infiltrated into the soil profile**: specifically, the portion of infiltrated water that percolates down the root zone where it might be available to recharge groundwater stores (potential groundwater recharge), a portion of which becomes baseflow.
- **Irrigation** is the amount of water applied as irrigation within the catchment. Just like rainfall, some of it is intercepted, infiltrates and if over-irrigating some of it might contribute to surface runoff and baseflow.

In the Breede Catchment sub-accounting area, the total surface runoff varies from 8,8 mm in the driest year (2016-2017) to 61,2 mm in the wettest year (2020-2021). Across the broad land cover types, surface runoff was proportionally higher on natural or semi-natural land cover (varying from 71,5% in 2018-2019 to 86,1% in 2016-2017) and built-up land (varying from 0,4% in 2020-2021 to 0,9% in 2017-2018). Total infiltration varies from 209,6 mm in the year with the lowest precipitation (2016-2017) to 574,0 mm in the year with the highest precipitation (2020-2021). Across the broad land cover types, infiltration was proportionally higher on cultivated land (varying from 31,0% in 2019-2020 to 36,0% in 2016-2017). Of the water that infiltrates, the amount that might recharge groundwater was proportionally higher in natural or semi-natural areas (varying from 69,4% in 2018-2019 to 77,8% in 2015-2016) than in cultivated areas (varying from 22,1% in 2015-2016 to 30,6% in 2018-2019). Of the water that becomes baseflow, natural or semi-natural areas contributed proportionally to baseflow, and cultivated areas contributed slightly more relative to their extent (varying from 25,4% in 2019-2020 to 37,1% in 2016-2017).

The amount of water irrigated in the Breede Catchment varied between 72,9 million m^3 (5,8 mm) in 2017-2018 and 151,7 million m^3 (12,1 mm) in 2020-2021.

[9] Some of this infiltrated water may be lost as evaporation from the soil surface (Soil Water ET) and through transpiration by plants (Transpiration ET).

Table 8 – Water resource flow account disaggregated by land cover for the Breede Catchment, for 2015-2016 (as volumes, depths and percentages)

Breede Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	*%[1]*		(km^2)	*%[2]*		(km^2)	*%[2]*		(km^2)	*%[2]*		(km^2)	*%[2]*
		12 562,0	*100,0*		8 721,5	*69,4*		3 577,8	*28,5*		38,2	*0,3*		224,6	*1,8*
Water resource details 2015-2016	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	4 974,8	396,0													
Precipitation	4 974,8	396,0	*100,0*	3 459,0	275,4	*69,5*	1 413,0	112,5	*28,4*	12,4	1,0	*0,2*	90,3	7,2	*1,8*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	5 349,2	425,8													
Total Evaporation (ET)	4 161,6	331,3	*77,8*	2 611,8	207,9	*62,8*	1 393,1	110,9	*33,5*	10,5	0,8	*0,3*	146,3	11,6	*3,5*
Landscape ET	4 002,5	318,6	*96,2*	2 611,8	207,9	*65,3*	1 239,6	98,7	*31,0*	5,0	0,4	*0,1*	146,3	11,6	*3,7*
Incremental ET	159,1	12,7	*3,8*	0,0	0,0	*0,0*	153,6	12,2	*96,5*	5,5	0,4	*3,5*	0,0	0,0	*0,0*
Interception ET	417,4	33,2	*10,0*	323,9	25,8	*77,6*	91,6	7,3	*21,9*	1,2	0,1	*0,3*	0,7	0,1	*0,2*
Transpiration ET	786,3	62,6	*18,9*	568,2	45,2	*72,3*	209,5	16,7	*26,6*	3,0	0,2	*0,4*	5,6	0,4	*0,7*
Soil Water ET	2 785,5	221,7	*66,9*	1 719,6	136,9	*61,7*	1 059,0	84,3	*38,0*	4,7	0,4	*0,2*	2,2	0,2	*0,1*
Open Water ET	172,4	13,7	*4,1*	0,0	0,0	*0,0*	33,1	2,6	*19,2*	1,5	0,1	*0,9*	137,8	11,0	*79,9*
Outflows	1 187,6	94,5	*22,2*												
$Q_{out\ SW}$	939,1	74,8	*17,6*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	248,5	19,8	*4,6*												
Total Change In Storage	374,4	29,8		99,1	7,9		65,8	5,2		-4,9	-0,4		214,5	17,1	
$DS_{f\ SW}$	209,8	16,7		0,7	0,1		0,1	0,0		-5,1	-0,4		214,2	17,1	
$DS_{f\ SoilM}$	101,2	8,1		65,4	5,2		35,6	2,8		0,1	0,0		0,1	0,0	
$DS_{f\ GW}$	63,3	5,0		33,1	2,6		30,0	2,4		0,0	0,0		0,2	0,0	
Internal Flows															
Interception	416,7	33,2		323,3	25,7	*77,6*	91,5	7,3	*22,0*	1,2	0,1	*0,3*	0,7	0,1	*0,2*
Surface Runoff	362,2	28,8		295,2	23,5	*81,5*	54,3	4,3	*15,0*	1,7	0,1	*0,5*	10,9	0,9	*3,0*
Infiltration	4 259,0	339,0		2 840,5	226,1	*66,7*	1 408,2	112,1	*33,1*	8,3	0,7	*0,2*	2,1	0,2	*0,0*
Pot. GW Recharge	794,1	63,2		618,0	49,2	*77,8*	175,3	14,0	*22,1*	0,8	0,1	*0,1*			
Baseflow	828,0	65,9		565,8	45,0	*68,3*	256,1	20,4	*30,9*	3,0	0,2	*0,4*	3,1	0,2	*0,4*
Irrigation	141,0	11,2		0,0	0,0	*0,0*	141,0	11,2	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 9 – Water resource flow account disaggregated by land cover for the Breede Catchment, for 2016-2017 (as volumes, depths and percentages)

Breede Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		12 562,0	*100,0*		8 721,5	*69,4*		3 577,8	*28,5*		38,2	*0,3*		224,6	*1,8*
Water resource details 2016-2017	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	2 930,6	233,3													
Precipitation	2 930,6	233,3	*100,0*	1 984,7	158,0	*67,7*	888,0	70,7	*30,3*	6,5	0,5	*0,2*	51,4	4,1	*1,8*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	3 294,0	262,2													
Total Evaporation (ET)	2 799,6	222,9	*85,0*	1 699,8	135,3	*60,7*	970,1	77,2	*34,7*	8,4	0,7	*0,3*	121,3	9,7	*4,3*
Landscape ET	2 653,8	211,3	*94,8*	1 699,8	135,3	*64,0*	829,7	66,1	*31,3*	3,0	0,2	*0,1*	121,3	9,7	*4,6*
Incremental ET	145,8	11,6	*5,2*	0,0	0,0	*0,0*	140,4	11,2	*96,3*	5,4	0,4	*3,7*	0,0	0,0	*0,0*
Interception ET	274,4	21,8	*9,8*	212,5	16,9	*77,4*	60,7	4,8	*22,1*	0,8	0,1	*0,3*	0,4	0,0	*0,2*
Transpiration ET	534,3	42,5	*19,1*	374,0	29,8	*70,0*	152,8	12,2	*28,6*	2,4	0,2	*0,4*	5,1	0,4	*1,0*
Soil Water ET	1 844,9	146,9	*65,9*	1 113,3	88,6	*60,3*	726,0	57,8	*39,4*	3,8	0,3	*0,2*	1,8	0,1	*0,1*
Open Water ET	145,9	11,6	*5,2*	0,0	0,0	*0,0*	30,6	2,4	*20,9*	1,5	0,1	*1,0*	113,9	9,1	*78,1*
Outflows	494,4	39,4	*15,0*												
$Q_{out\ SW}$	416,2	33,1	*12,6*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	78,2	6,2	*2,4*												
Total Change In Storage	363,3	28,9		177,7	14,1		60,9	4,8		-2,2	-0,2		126,9	10,1	
$DS_{f\ SW}$	123,5	9,8		0,0	0,0		0,1	0,0		-2,6	-0,2		126,0	10,0	
$DS_{f\ SoilM}$	17,2	1,4		13,2	1,0		3,5	0,3		0,1	0,0		0,4	0,0	
$DS_{f\ GW}$	222,6	17,7		164,5	13,1		57,3	4,6		0,3	0,0		0,5	0,0	
Internal Flows															
Interception	274,4	21,8		212,5	16,9	*77,4*	60,7	4,8	*22,1*	0,8	0,1	*0,3*	0,4	0,0	*0,2*
Surface Runoff	110,9	8,8		95,5	7,6	*86,1*	9,2	0,7	*8,3*	0,9	0,1	*0,8*	5,4	0,4	*4,9*
Infiltration	2 633,3	209,6		1 676,8	133,5	*63,7*	948,5	75,5	*36,0*	6,1	0,5	*0,2*	1,9	0,1	*0,1*
Pot. GW Recharge	275,9	22,0		202,7	16,1	*73,5*	73,1	5,8	*26,5*	0,1	0,0	*0,0*			
Baseflow	464,7	37,0		288,5	23,0	*62,1*	172,5	13,7	*37,1*	2,4	0,2	*0,5*	1,3	0,1	*0,3*
Irrigation	130,3	10,4		0,0	0,0	*0,0*	130,3	10,4	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 10 – Water resource flow account disaggregated by land cover for the Breede Catchment, for 2017-2018 (as volumes, depths and percentages)

Breede Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		12 562,0	*100,0*		8 721,5	*69,4*		3 577,8	*28,5*		38,2	*0,3*		224,6	*1,8*
Water resource details 2017-2018	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	4 874,7	388,1													
Precipitation	4 874,7	388,1	*100,0*	3 365,4	267,9	*69,0*	1 408,4	112,1	*28,9*	11,6	0,9	*0,2*	89,3	7,1	*1,8*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	4 704,1	374,5													
Total Evaporation (ET)	4 226,1	336,4	*89,8*	2 787,4	221,9	*66,0*	1 322,5	105,3	*31,3*	9,9	0,8	*0,2*	106,2	8,5	*2,5*
Landscape ET	4 152,0	330,5	*98,2*	2 787,4	221,9	*67,1*	1 253,5	99,8	*30,2*	4,9	0,4	*0,1*	106,2	8,5	*2,6*
Incremental ET	74,1	5,9	*1,8*	0,0	0,0	*0,0*	69,1	5,5	*93,3*	5,0	0,4	*6,7*	0,0	0,0	*0,0*
Interception ET	449,0	35,7	*10,6*	352,2	28,0	*78,4*	94,7	7,5	*21,1*	1,3	0,1	*0,3*	0,8	0,1	*0,2*
Transpiration ET	843,8	67,2	*20,0*	656,5	52,3	*77,8*	179,1	14,3	*21,2*	2,8	0,2	*0,3*	5,4	0,4	*0,6*
Soil Water ET	2 817,2	224,3	*66,7*	1 778,7	141,6	*63,1*	1 031,6	82,1	*36,6*	4,5	0,4	*0,2*	2,4	0,2	*0,1*
Open Water ET	116,1	9,2	*2,7*	0,0	0,0	*0,0*	17,1	1,4	*14,7*	1,4	0,1	*1,2*	97,6	7,8	*84,1*
Outflows	478,0	38,1	*10,2*												
$Q_{out\ SW}$	461,8	36,8	*9,8*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	16,2	1,3	*0,3*												
Total Change In Storage	-170,5	-13,6		-74,4	-5,9		-30,5	-2,4		-4,8	-0,4		-60,8	-4,8	
$DS_{f\ SW}$	-65,4	-5,2		0,0	0,0		-0,2	0,0		-4,7	-0,4		-60,4	-4,8	
$DS_{f\ SoilM}$	-40,8	-3,2		-34,2	-2,7		-6,4	-0,5		-0,1	0,0		-0,1	0,0	
$DS_{f\ GW}$	-64,3	-5,1		-40,2	-3,2		-23,8	-1,9		0,0	0,0		-0,3	0,0	
Internal Flows															
Interception	449,0	35,7		352,2	28,0	*78,4*	94,7	7,5	*21,1*	1,3	0,1	*0,3*	0,8	0,1	*0,2*
Surface Runoff	169,9	13,5		129,7	10,3	*76,3*	28,9	2,3	*17,0*	1,6	0,1	*0,9*	9,8	0,8	*5,8*
Infiltration	4 251,8	338,5		2 883,5	229,5	*67,8*	1 357,7	108,1	*31,9*	7,6	0,6	*0,2*	3,0	0,2	*0,1*
Pot. GW Recharge	554,8	44,2		414,0	33,0	*74,6*	140,6	11,2	*25,3*	0,3	0,0	*0,1*			
Baseflow	476,9	38,0		327,7	26,1	*68,7*	144,9	11,5	*30,4*	1,7	0,1	*0,4*	2,6	0,2	*0,6*
Irrigation	72,9	5,8		0,0	0,0	*0,0*	72,9	5,8	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 11 – Water resource flow account disaggregated by land cover for the Breede Catchment, for 2018-2019 (as volumes, depths and percentages)

Breede Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		12 562,0	*100,0*		8 721,5	*69,4*		3 577,8	*28,5*		38,2	*0,3*		224,6	*1,8*
Water resource details 2018-2019	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	4 412,2	351,2													
Precipitation	4 412,2	351,2	*100,0*	3 002,1	239,0	*68,0*	1 320,0	105,1	*29,9*	10,1	0,8	*0,2*	80,0	6,4	*1,8*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	4 388,5	349,3													
Total Evaporation (ET)	3 849,9	306,5	*87,7*	2 506,8	199,6	*65,1*	1 221,4	97,2	*31,7*	9,8	0,8	*0,3*	111,9	8,9	*2,9*
Landscape ET	3 734,7	297,3	*97,0*	2 506,8	199,6	*67,1*	1 111,5	88,5	*29,8*	4,5	0,4	*0,1*	111,9	8,9	*3,0*
Incremental ET	115,2	9,2	*3,0*	0,0	0,0	*0,0*	109,9	8,8	*95,5*	5,2	0,4	*4,5*	0,0	0,0	*0,0*
Interception ET	384,7	30,6	*10,0*	303,2	24,1	*78,8*	79,6	6,3	*20,7*	1,2	0,1	*0,3*	0,7	0,1	*0,2*
Transpiration ET	755,4	60,1	*19,6*	598,1	47,6	*79,2*	149,1	11,9	*19,7*	2,7	0,2	*0,4*	5,5	0,4	*0,7*
Soil Water ET	2 580,1	205,4	*67,0*	1 605,5	127,8	*62,2*	967,8	77,0	*37,5*	4,4	0,3	*0,2*	2,4	0,2	*0,1*
Open Water ET	129,6	10,3	*3,4*	0,0	0,0	*0,0*	24,9	2,0	*19,2*	1,4	0,1	*1,1*	103,3	8,2	*79,7*
Outflows	538,6	42,9	*12,3*												
$Q_{out\ SW}$	507,1	40,4	*11,6*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	31,5	2,5	*0,7*												
Total Change In Storage	-23,7	-1,9		-6,7	-0,5		-39,4	-3,1		-4,0	-0,3		26,4	2,1	
$DS_{f\ SW}$	21,2	1,7		-0,1	0,0		-0,9	-0,1		-4,1	-0,3		26,3	2,1	
$DS_{f\ SoilM}$	-93,0	-7,4		-46,0	-3,7		-47,0	-3,7		0,0	0,0		0,0	0,0	
$DS_{f\ GW}$	48,1	3,8		39,4	3,1		8,5	0,7		0,1	0,0		0,1	0,0	
Internal Flows															
Interception	384,7	30,6		303,2	24,1	*78,8*	79,6	6,3	*20,7*	1,2	0,1	*0,3*	0,7	0,1	*0,2*
Surface Runoff	184,2	14,7		131,7	10,5	*71,5*	42,6	3,4	*23,1*	1,4	0,1	*0,8*	8,5	0,7	*4,6*
Infiltration	3 880,8	308,9		2 567,1	204,4	*66,1*	1 303,9	103,8	*33,6*	7,2	0,6	*0,2*	2,6	0,2	*0,1*
Pot. GW Recharge	457,6	36,4		317,6	25,3	*69,4*	139,8	11,1	*30,6*	0,2	0,0	*0,0*			
Baseflow	484,6	38,6		308,6	24,6	*63,7*	171,8	13,7	*35,4*	1,6	0,1	*0,3*	2,6	0,2	*0,5*
Irrigation	106,0	8,4		0,0	0,0	*0,0*	106,0	8,4	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 12 – Water resource flow account disaggregated by land cover for the Breede Catchment, for 2019-2020 (as volumes, depths and percentages)

Breede Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km²)	%[1]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]
		12 562,0	*100,0*		8 721,5	*69,4*		3 577,8	*28,5*		38,2	*0,3*		224,6	*1,8*
Water resource details 2019-2020	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**
Total In	6 880,1	547,7													
Precipitation	6 880,1	547,7	*100,0*	4 808,3	382,8	*69,9*	1 927,2	153,4	*28,0*	16,7	1,3	*0,2*	127,9	10,2	*1,9*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	6 413,8	510,6													
Total Evaporation (ET)	5 278,8	420,2	*82,3*	3 454,4	275,0	*65,4*	1 699,2	135,3	*32,2*	11,2	0,9	*0,2*	114,0	9,1	*2,2*
Landscape ET	5 189,4	413,1	*98,3*	3 454,4	275,0	*66,6*	1 614,8	128,5	*31,1*	6,2	0,5	*0,1*	114,0	9,1	*2,2*
Incremental ET	89,4	7,1	*1,7*	0,0	0,0	*0,0*	84,4	6,7	*94,4*	5,0	0,4	*5,6*	0,0	0,0	*0,0*
Interception ET	543,9	43,3	*10,3*	428,6	34,1	*78,8*	112,8	9,0	*20,7*	1,6	0,1	*0,3*	0,9	0,1	*0,2*
Transpiration ET	1 011,3	80,5	*19,2*	769,4	61,3	*76,1*	233,8	18,6	*23,1*	2,9	0,2	*0,3*	5,2	0,4	*0,5*
Soil Water ET	3 596,2	286,3	*68,1*	2 256,4	179,6	*62,7*	1 332,2	106,0	*37,0*	5,3	0,4	*0,1*	2,3	0,2	*0,1*
Open Water ET	127,4	10,1	*2,4*	0,0	0,0	*0,0*	20,4	1,6	*16,0*	1,4	0,1	*1,1*	105,7	8,4	*82,9*
Outflows	1 135,0	90,4	*17,7*												
$Q_{out\ SW}$	1 081,9	86,1	*16,9*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	53,1	4,2	*0,8*												
Total Change In Storage	-466,0	-37,1		-269,1	-21,4		-61,9	-4,9		-7,5	-0,6		-127,4	-10,1	
$DS_{f\ SW}$	-139,7	-11,1		-5,4	-0,4		-0,8	-0,1		-6,9	-0,6		-126,5	-10,1	
$DS_{f\ SoilM}$	37,4	3,0		8,2	0,6		29,6	2,4		-0,2	0,0		-0,2	0,0	
$DS_{f\ GW}$	-363,7	-29,0		-271,9	-21,6		-90,7	-7,2		-0,4	0,0		-0,7	-0,1	
Internal Flows															
Interception	551,2	43,9		434,1	34,6	*78,7*	114,6	9,1	*20,8*	1,6	0,1	*0,3*	0,9	0,1	*0,2*
Surface Runoff	335,4	26,7		266,1	21,2	*79,3*	50,9	4,0	*15,2*	2,3	0,2	*0,7*	16,1	1,3	*4,8*
Infiltration	5 968,6	475,1		4 108,2	327,0	*68,8*	1 848,5	147,1	*31,0*	9,5	0,8	*0,2*	2,4	0,2	*0,0*
Pot. GW Recharge	1 403,8	111,7		1 090,5	86,8	*77,7*	312,1	24,8	*22,2*	1,2	0,1	*0,1*			
Baseflow	1 027,7	81,8		760,0	60,5	*74,0*	260,6	20,7	*25,4*	2,2	0,2	*0,2*	4,9	0,4	*0,5*
Irrigation	86,8	6,9		0,0	0,0	*0,0*	86,8	6,9	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 13 – Water resource flow account disaggregated by land cover for the Breede Catchment, for 2020-2021 (as volumes, depths and percentages)

Breede Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km²)	%[1]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]
		12 562,0	*100,0*		8 721,5	*69,4*		3 577,8	*28,5*		38,2	*0,3*		224,6	*1,8*
Water resource details 2020-2021	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**
Total In	8 523,3	678,5													
Precipitation	8 523,3	678,5	*100,0*	5 797,3	461,5	*68,0*	2 556,0	203,5	*30,0*	20,1	1,6	*0,2*	149,9	11,9	*1,8*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	8 396,7	668,4													
Total Evaporation (ET)	5 722,8	455,6	*68,2*	3 618,1	288,0	*63,2*	1 935,8	154,1	*33,8*	12,0	1,0	*0,2*	156,9	12,5	*2,7*
Landscape ET	5 552,9	442,0	*97,0*	3 618,1	288,0	*65,2*	1 771,5	141,0	*31,9*	6,4	0,5	*0,1*	156,9	12,5	*2,8*
Incremental ET	169,8	13,5	*3,0*	0,0	0,0	*0,0*	164,3	13,1	*96,7*	5,6	0,4	*3,3*	0,0	0,0	*0,0*
Interception ET	571,9	45,5	*10,0*	441,5	35,1	*77,2*	127,9	10,2	*22,4*	1,6	0,1	*0,3*	0,9	0,1	*0,2*
Transpiration ET	1 126,1	89,6	*19,7*	837,8	66,7	*74,4*	279,6	22,3	*24,8*	3,3	0,3	*0,3*	5,4	0,4	*0,5*
Soil Water ET	3 838,7	305,6	*67,1*	2 338,8	186,2	*60,9*	1 492,7	118,8	*38,9*	5,5	0,4	*0,1*	1,8	0,1	*0,0*
Open Water ET	186,1	14,8	*3,3*	0,0	0,0	*0,0*	35,6	2,8	*19,1*	1,6	0,1	*0,9*	148,9	11,9	*80,0*
Outflows	2 674,0	212,9	*31,8*												
$Q_{out\ SW}$	2 523,7	200,9	*30,1*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	150,3	12,0	*1,8*												
Total Change In Storage	-126,9	-10,1		-33,6	-2,7		-48,4	-3,9		-8,6	-0,7		-36,4	-2,9	
$DS_{f\ SW}$	-37,3	-3,0		5,4	0,4		1,7	0,1		-8,5	-0,7		-36,0	-2,9	
$DS_{f\ SoilM}$	73,1	5,8		53,6	4,3		19,7	1,6		0,1	0,0		-0,3	0,0	
$DS_{f\ GW}$	-162,7	-13,0		-92,6	-7,4		-69,8	-5,6		-0,2	0,0		-0,2	0,0	
Internal Flows															
Interception	564,7	45,0		436,0	34,7	*77,2*	126,2	10,0	*22,3*	1,6	0,1	*0,3*	0,9	0,1	*0,2*
Surface Runoff	769,0	61,2		550,2	43,8	*71,6*	194,7	15,5	*25,3*	3,1	0,2	*0,4*	20,9	1,7	*2,7*
Infiltration	7 210,4	574,0		4 811,0	383,0	*66,7*	2 386,8	190,0	*33,1*	10,8	0,9	*0,2*	1,8	0,1	*0,0*
Pot. GW Recharge	2 324,4	185,0		1 688,1	134,4	*72,6*	634,2	50,5	*27,3*	2,1	0,2	*0,1*			
Baseflow	2 120,2	168,8		1 457,3	116,0	*68,7*	651,4	51,9	*30,7*	4,2	0,3	*0,2*	7,4	0,6	*0,3*
Irrigation	151,7	12,1		0,0	0,0	*0,0*	151,7	12,1	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

3.1.3 Water resource flow account with reference states

Water resource flow account with reference states refers to water resource flow accounts compiled for a scenario where the sub-accounting area is fully covered by natural or semi-natural land cover and contains no built water infrastructure, such as dams or inter-catchment transfers (i.e. a reference state prior to land cover change with associated infrastructure). These accounts provide a baseline against which impacts of actual land cover and water management on water resources can be further explored.

These accounts therefore provide the water resource flow accounts per accounting period for the Breede Catchment sub-accounting area with (i) **actual** land cover in 2018 and water infrastructure, (ii) with **reference state**, and (iii) the percentage **difference** between these, as presented in Table 14 to Table 19. The water resource flow accounts for actual are the same as in Table 8 to Table 13, repeated here to support comparison with the reference state.

The climatic conditions are actual climate conditions modelled per accounting period, so as to compare water resources under actual land cover conditions with water resources as they would be if the Breede Catchment were not developed. In other words, this is exploring the impact of land cover change, not climate change which would require modelling climate conditions at a historical point in time. This is why precipitation is the same across actual and reference land cover conditions.

The difference between the water variables under actual and reference scenarios is calculated as the reference value subtracted from the actual value and divided by the reference value. This should be compared in absolute terms and in terms of the direction of the difference and the quantum of the difference. A difference that is a positive value, means that the actual conditions are greater than the reference state in absolute terms (and vice versa).

Total evaporation was slightly greater under actual conditions than under the reference state, with the difference varying from 0,8% (2017-2018) to 6,3% in the driest year (2016-2017). This was largely driven by the large difference in open water evaporation, as in the reference state there were no dams driving this variable. Evaporation of water intercepted by vegetation and other surfaces (Interception ET) and water transpired by vegetation (Transpiration ET) were lower under actual conditions than under the reference state. The difference in interception varied from -10,8% (2019-2020) to -8,2% (2015-2016) and the difference in transpiration varied from -18,0 (2019-2020) to -9,8% (2016-2017). Surface water outflows in the Breede Catchment were consistently lower under actual conditions than under the reference state, with the difference varying from -22,1% (2016-2017) to -12,1% (2020-2021). Under the reference state, there would be more water flowing out of the catchment, because there would be no dams to store water flows.

In terms of flows of water inside the catchment, interception was lower under actual conditions (the difference varied from -10,9% in 2019-2020 to -8,2% in 2015-2016), surface water runoff was generally lower under actual conditions (the difference varied from -7,3% in 2016-2017 to 0,0% in 2018-2019) and infiltration was greater under actual conditions (the difference varied from 1,1% in 2017-2018 to 5,4% in 2016-2017). In other words, in a reference state, the Breede Catchment would have more interception and surface water runoff, and slightly less infiltration of water into groundwater and baseflows. This was very similar to the findings in the uMngeni and Mooi Catchments. Of the water that infiltrates, it was under actual conditions that there was more potential groundwater recharge (the difference varied from 0,3% in 2020-2021 to 24,2% in 2016-2017) and generally more baseflow (positive in all years except 2020-2021 (-0,9%)).

Table 14 – Water resource flow account with reference state for the Breede Catchment, for 2015-2016 (as volumes, depths and percentages)

Breede Catchment		Total			Reference		*Difference*
Area		(km²)	%		(km²)	%	
		12 562,0	*100,0*		12 562,0	*100,0*	
Water resource details 2015-2016	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	4 974,8	396,0		4 974,8	396,0		*0,0*
Precipitation	4 974,8	396,0	*100,0*	4 974,8	396,0	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	5 349,2	425,8		5 167,7	411,4		*3,5*
Total Evaporation (ET)	4 161,6	331,3	*77,8*	4 028,3	320,7	*78,0*	*3,3*
Landscape ET	4 002,5	318,6	*96,2*	4 028,3	320,7	*100,0*	*-0,6*
Incremental ET	159,1	12,7	*3,8*	0,0	0,0	*0,0*	-
Interception ET	417,4	33,2	*10,0*	454,9	36,2	*11,3*	*-8,2*
Transpiration ET	786,3	62,6	*18,9*	920,8	73,3	*22,9*	*-14,6*
Soil Water ET	2 785,5	221,7	*66,9*	2 621,6	208,7	*65,1*	*6,3*
Open Water ET	172,4	13,7	*4,1*	30,9	2,5	*0,8*	*457,5*
Outflows	1 187,6	94,5	*22,2*	1 139,5	90,7	*22,0*	*4,2*
$Q_{out\ SW}$	939,1	74,8	*17,6*	1 139,5	90,7	*22,0*	*-17,6*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	248,5	19,8	*4,6*	0,0	0,0	*0,0*	-
Total Change In Storage	374,4	29,8		192,9	15,4		*94,1*
$DS_{f\ SW}$	209,8	16,7		0,9	0,1		*24 269,6*
$DS_{f\ SoilM}$	101,2	8,1		115,6	9,2		*-12,4*
$DS_{f\ GW}$	63,3	5,0		76,5	6,1		*-17,2*
Internal Flows							
Interception	416,7	33,2		454,2	36,2		*-8,2*
Surface Runoff	362,2	28,8		369,8	29,4		*-2,1*
Infiltration	4 259,0	339,0		4 141,5	329,7		*2,8*
Pot. GW Recharge	794,1	63,2		722,3	57,5		*9,9*
Baseflow	828,0	65,9		798,8	63,6		*3,7*
Irrigation	141,0	11,2		0,0	0,0		-

Table 15 – Water resource flow account with reference state for the Breede Catchment, for 2016-2017 (as volumes, depths and percentages)

Breede Catchment	Total			Reference			Difference
Area		(km²)	%		(km²)	%	
		12 562,0	*100,0*		12 562,0	*100,0*	
Water resource details 2016-2017	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**%**
Total In	2 930,6	233,3		2 930,6	233,3		*0,0*
Precipitation	2 930,6	233,3	*100,0*	2 930,6	233,3	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	3 294,0	262,2		3 168,7	252,2		*4,0*
Total Evaporation (ET)	2 799,6	222,9	*85,0*	2 634,3	209,7	*83,1*	*6,3*
Landscape ET	2 653,8	211,3	*94,8*	2 634,3	209,7	*100,0*	*0,7*
Incremental ET	145,8	11,6	*5,2*	0,0	0,0	*0,0*	-
Interception ET	274,4	21,8	*9,8*	306,0	24,4	*11,6*	*-10,3*
Transpiration ET	534,3	42,5	*19,1*	592,6	47,2	*22,5*	*-9,8*
Soil Water ET	1 844,9	146,9	*65,9*	1 710,6	136,2	*64,9*	*7,9*
Open Water ET	145,9	11,6	*5,2*	25,2	2,0	*1,0*	*479,4*
Outflows	494,4	39,4	*15,0*	534,3	42,5	*16,9*	*-7,5*
$Q_{out\ SW}$	416,2	33,1	*12,6*	534,3	42,5	*16,9*	*-22,1*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	78,2	6,2	*2,4*	0,0	0,0	*0,0*	-
Total Change In Storage	363,3	28,9		238,1	19,0		*52,6*
$DS_{f\ SW}$	123,5	9,8		0,1	0,0		*194 796,6*
$DS_{f\ SoilM}$	17,2	1,4		19,5	1,6		*-12,1*
$DS_{f\ GW}$	222,6	17,7		218,5	17,4		*1,9*
Internal Flows							
Interception	274,4	21,8		306,0	24,4		*-10,3*
Surface Runoff	110,9	8,8		119,7	9,5		*-7,3*
Infiltration	2 633,3	209,6		2 498,8	198,9		*5,4*
Pot. GW Recharge	275,9	22,0		222,2	17,7		*24,2*
Baseflow	464,7	37,0		440,7	35,1		*5,5*
Irrigation	130,3	10,4		0,0	0,0		-

Table 16 – Water resource flow account with reference state for the Breede Catchment, for 2017-2018 (as volumes, depths and percentages)

Breede Catchment	Total			Reference			*Difference*
Area		(km^2)	*%*		(km^2)	*%*	
		12 562,0	*100,0*		12 562,0	*100,0*	
Water resource details 2017-2018	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	4 874,7	388,1		4 874,7	388,1		*0,0*
Precipitation	4 874,7	388,1	*100,0*	4 874,7	388,1	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	4 704,1	374,5		4 780,2	380,5		*-1,6*
Total Evaporation (ET)	4 226,1	336,4	*89,8*	4 191,4	333,7	*87,7*	*0,8*
Landscape ET	4 152,0	330,5	*98,2*	4 191,4	333,7	*100,0*	*-0,9*
Incremental ET	74,1	5,9	*1,8*	0,0	0,0	*0,0*	-
Interception ET	449,0	35,7	*10,6*	489,8	39,0	*11,7*	*-8,3*
Transpiration ET	843,8	67,2	*20,0*	1 025,9	81,7	*24,5*	*-17,8*
Soil Water ET	2 817,2	224,3	*66,7*	2 651,6	211,1	*63,3*	*6,2*
Open Water ET	116,1	9,2	*2,7*	24,0	1,9	*0,6*	*383,3*
Outflows	478,0	38,1	*10,2*	588,8	46,9	*12,3*	*-18,8*
$Q_{out\ SW}$	461,8	36,8	*9,8*	588,8	46,9	*12,3*	*-21,6*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	16,2	1,3	*0,3*	0,0	0,0	*0,0*	-
Total Change In Storage	-170,5	-13,6		-94,5	-7,5		*80,4*
$DS_{f\ SW}$	-65,4	-5,2		-0,1	0,0		*68 199,8*
$DS_{f\ SoilM}$	-40,8	-3,2		-50,7	-4,0		*-19,4*
$DS_{f\ GW}$	-64,3	-5,1		-43,8	-3,5		*47,0*
Internal Flows							
Interception	449,0	35,7		489,8	39,0		*-8,3*
Surface Runoff	169,9	13,5		171,3	13,6		*-0,8*
Infiltration	4 251,8	338,5		4 204,5	334,7		*1,1*
Pot. GW Recharge	554,8	44,2		483,1	38,5		*14,8*
Baseflow	476,9	38,0		439,3	35,0		*8,5*
Irrigation	72,9	5,8		0,0	0,0		-

Table 17 – Water resource flow account with reference state for the Breede Catchment, for 2018-2019 (as volumes, depths and percentages)

Breede Catchment		Total			Reference		*Difference*
Area		(km^2)	%		(km^2)	%	
		12 562,0	*100,0*		12 562,0	*100,0*	
Water resource details 2018-2019	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	4 412,2	351,2		4 412,2	351,2		*0,0*
Precipitation	4 412,2	351,2	*100,0*	4 412,2	351,2	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	4 388,5	349,3		4 367,0	347,6		*0,5*
Total Evaporation (ET)	3 849,9	306,5	*87,7*	3 766,5	299,8	*86,2*	*2,2*
Landscape ET	3 734,7	297,3	*97,0*	3 766,5	299,8	*100,0*	*-0,8*
Incremental ET	115,2	9,2	*3,0*	0,0	0,0	*0,0*	-
Interception ET	384,7	30,6	*10,0*	424,3	33,8	*11,3*	*-9,3*
Transpiration ET	755,4	60,1	*19,6*	907,3	72,2	*24,1*	*-16,7*
Soil Water ET	2 580,1	205,4	*67,0*	2 411,1	191,9	*64,0*	*7,0*
Open Water ET	129,6	10,3	*3,4*	23,9	1,9	*0,6*	*443,1*
Outflows	538,6	42,9	*12,3*	600,5	47,8	*13,8*	*-10,3*
$Q_{out\ SW}$	507,1	40,4	*11,6*	600,5	47,8	*13,8*	*-15,5*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	31,5	2,5	*0,7*	0,0	0,0	*0,0*	-
Total Change In Storage	-23,7	-1,9		-45,2	-3,6		*-47,5*
$DS_{f\ SW}$	21,2	1,7		-0,3	0,0		*-6 762,2*
$DS_{f\ SoilM}$	-93,0	-7,4		-89,9	-7,2		*3,5*
$DS_{f\ GW}$	48,1	3,8		45,0	3,6		*6,7*
Internal Flows							
Interception	384,7	30,6		424,3	33,8		*-9,3*
Surface Runoff	184,2	14,7		184,1	14,7		*0,0*
Infiltration	3 880,8	308,9		3 794,6	302,1		*2,3*
Pot. GW Recharge	457,6	36,4		393,7	31,3		*16,2*
Baseflow	484,6	38,6		438,7	34,9		*10,5*
Irrigation	106,0	8,4		0,0	0,0		-

Table 18 – Water resource flow account with reference state for the Breede Catchment, for 2019-2020 (as volumes, depths and percentages)

Breede Catchment	Total			Reference			Difference
Area		(km^2)	%		(km^2)	%	
		12 562,0	*100,0*		12 562,0	*100,0*	
Water resource details 2019-2020	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	6 880,1	547,7		6 880,1	547,7		*0,0*
Precipitation	6 880,1	547,7	*100,0*	6 880,1	547,7	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	6 413,8	510,6		6 521,9	519,2		*-1,7*
Total Evaporation (ET)	5 278,8	420,2	*82,3*	5 201,6	414,1	*79,8*	*1,5*
Landscape ET	5 189,4	413,1	*98,3*	5 201,6	414,1	*100,0*	*-0,2*
Incremental ET	89,4	7,1	*1,7*	0,0	0,0	*0,0*	-
Interception ET	543,9	43,3	*10,3*	610,0	48,6	*11,7*	*-10,8*
Transpiration ET	1 011,3	80,5	*19,2*	1 232,6	98,1	*23,7*	*-18,0*
Soil Water ET	3 596,2	286,3	*68,1*	3 326,6	264,8	*64,0*	*8,1*
Open Water ET	127,4	10,1	*2,4*	32,4	2,6	*0,6*	*293,6*
Outflows	1 135,0	90,4	*17,7*	1 320,3	105,1	*20,2*	*-14,0*
$Q_{out\ SW}$	1 081,9	86,1	*16,9*	1 320,3	105,1	*20,2*	*-18,1*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	53,1	4,2	*0,8*	0,0	0,0	*0,0*	-
Total Change In Storage	-466,0	-37,1		-358,2	-28,5		*30,1*
$DS_{f\ SW}$	-139,7	-11,1		-8,1	-0,6		*1 620,8*
$DS_{f\ SoilM}$	37,4	3,0		19,8	1,6		*88,9*
$DS_{f\ GW}$	-363,7	-29,0		-369,9	-29,4		*-1,7*
Internal Flows							
Interception	551,2	43,9		618,4	49,2		*-10,9*
Surface Runoff	335,4	26,7		349,2	27,8		*-4,0*
Infiltration	5 968,6	475,1		5 900,4	469,7		*1,2*
Pot. GW Recharge	1 403,8	111,7		1 368,2	108,9		*2,6*
Baseflow	1 027,7	81,8		998,3	79,5		*2,9*
Irrigation	86,8	6,9		0,0	0,0		-

Table 19 – Water resource flow account with reference state for the Breede Catchment, for 2020-2021 (as volumes, depths and percentages)

Breede Catchment		Total			Reference		*Difference*
Area		(km^2)	%		(km^2)	%	
		12 562,0	*100,0*		12 562,0	*100,0*	
Water resource details 2020-2021	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	8 523,3	678,5		8 523,3	678,5		*0,0*
Precipitation	8 523,3	678,5	*100,0*	8 523,3	678,5	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	8 396,7	668,4		8 443,2	672,1		*-0,6*
Total Evaporation (ET)	5 722,8	455,6	*68,2*	5 573,5	443,7	*66,0*	*2,7*
Landscape ET	5 552,9	442,0	*97,0*	5 573,5	443,7	*100,0*	*-0,4*
Incremental ET	169,8	13,5	*3,0*	0,0	0,0	*0,0*	-
Interception ET	571,9	45,5	*10,0*	637,6	50,8	*11,4*	*-10,3*
Transpiration ET	1 126,1	89,6	*19,7*	1 346,5	107,2	*24,2*	*-16,4*
Soil Water ET	3 838,7	305,6	*67,1*	3 539,8	281,8	*63,5*	*8,4*
Open Water ET	186,1	14,8	*3,3*	49,6	4,0	*0,9*	*274,9*
Outflows	2 674,0	212,9	*31,8*	2 869,7	228,4	*34,0*	*-6,8*
$Q_{out\ SW}$	2 523,7	200,9	*30,1*	2 869,7	228,4	*34,0*	*-12,1*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	150,3	12,0	*1,8*	0,0	0,0	*0,0*	-
Total Change In Storage	-126,9	-10,1		-80,1	-6,4		*58,4*
$DS_{f\ SW}$	-37,3	-3,0		8,3	0,7		*-549,3*
$DS_{f\ SoilM}$	73,1	5,8		90,4	7,2		*-19,2*
$DS_{f\ GW}$	-162,7	-13,0		-178,9	-14,2		*-9,0*
Internal Flows							
Interception	564,7	45,0		629,4	50,1		*-10,3*
Surface Runoff	769,0	61,2		770,6	61,3		*-0,2*
Infiltration	7 210,4	574,0		7 106,1	565,7		*1,5*
Pot. GW Recharge	2 324,4	185,0		2 317,8	184,5		*0,3*
Baseflow	2 120,2	168,8		2 138,9	170,3		*-0,9*
Irrigation	151,7	12,1		0,0	0,0		-

3.2 uMngeni Catchment sub-accounting area

The uMngeni Catchment sub-accounting area was 4 454,1 km^2. In the uMngeni Catchment, separate water resource flow accounts were compiled for the sub-accounting area as a whole and the 12 quaternary catchments for six hydrological years from 2015-2016 to 2020-2021.

The uMngeni Catchment was the only sub-accounting area for which water resource managed flow accounts were compiled.

3.2.1 Water resource flow accounts

Water resource flow accounts provide flow information that is the basis for water balance graphs (showing a time series of catchment inflows and outflows). The water resource flow account as annual volumes (Mm^3) over the six hydrological years from October 2015 to September 2021 (Table 20) is shown as a time series graph of catchment total inflows (Total In) and total outflows (Total Out) for the uMngeni Catchment sub-accounting area in Figure 11. They are also provided as normalised depths (mm) (Table 21) and shown as a time series graph in Figure 12.

These tables and graphs describe the total inflows of water to a catchment (in the form of precipitation, surface water inflows and inflowing inter-catchment transfers), the water consumption within a catchment (in the form of evaporation and transpiration), the total outflows of water from a catchment (in the form of surface water outflows and outflowing inter-catchment transfers) and changes in water storage within the catchment (surface water stores, soil moisture stores and groundwater stores). In Figure 11 and Figure 12, the difference in height between the Total In and Total Out bars in a hydrological year represents the change in water storage. If Total In is less than Total Out, then water storage in the catchment is being drawn down. If Total In is greater than Total Out, then water storage in the catchment is being replenished. The overall water balance, as illustrated in Figure 11 and Figure 12, was the smallest in 2018-2019 and the greatest in 2017-2018.

Precipitation (as one form of water inflow) into the uMngeni Catchment sub-accounting area was the lowest in 2018-2019 with 815,6 mm per annum and also low in 2016-2017 with 819,6 mm. Precipitation was the highest in 2017-2018 with 1 034,0 mm per annum. Inflows from surface water were zero at the level of the whole sub-accounting area as there are no upstream catchments but there were inflows of between 87,7 million m^3 (19,7 mm) in 2016-2017 and 123,8 million m^3 (27,8 mm) in 2019-2020 from inter-catchment transfers from other catchments into the uMngeni Catchment sub-accounting area. Groundwater inflows were not shown due to a lack of information at this time.

Water leaves the catchment through evaporation (which includes transpiration) and outflows of surface water, groundwater and inter-catchment transfers. Total evaporation was the largest outflow. Total evaporation ranged from 655,5 mm per annum in 2018-2019 to 769,2 mm per annum in 2017-2018, matching the years of lowest precipitation and highest precipitation. While evaporation is generally high relative to precipitation, it is relatively more so in dry years. Total evaporation is broken down in Table 20 and Table 21 into evaporation of precipitated water from the landscape (Landscape ET) and evaporation of irrigated water (Incremental ET). Incremental evaporation is a useful measure of the portion of total evaporation over which there is some management control.

Outflows are the sum of surface water outflows, groundwater outflows (which are not measured in these accounts) and inter-catchment transfer outflows. Surface water outflows were lowest in 2015-2016 and highest in 2017-2018, which was the wettest year. Transfers out of the catchment were the lowest in 2015-2016 and the highest in 2020-2021. Of the exploitable water physically present in the surface water network and aquifers for potential abstraction and consumption, there are two variables that are useful to track: the portion that is reserved for outflow, and thus not available for use in the catchment (reserved outflow); and the portion that is unused flows that could be used for further development in the catchment (utilisable outflow). Reserved outflows could include inter-catchment transfers, supply to irrigation and urban users in other catchments and environmental flow requirements. The uMngeni Catchment does not have any downstream catchments and environmental flows are not currently represented in these accounts; thus reserved outflow only includes that which is allocated to inter-catchment transfers. In this case, utilisable outflow is the same as the surface water outflows leaving the catchment.

The total change in water storage is the subtraction of inflows from outflows. When this value is positive, it means that inflows were less than outflows, and the water storage in the catchment is being drawn down. When the value is negative, it means that inflows were greater than outflows and there is replenishment of water being stored in the catchment. Water may be stored in surface waterbodies, the soil profile or as groundwater. In the uMngeni Catchment, the total change in storage is always a negative value, meaning that inflows were greater than outflows and there is water being stored in the catchment in all years. This is different to the Breede Catchment.

These summaries provide a useful overview of the catchment water balance which can be examined in more detail for each of the 12 quaternary catchments.

Figure 11 – Time series of catchment total inflows and total outflows for the uMngeni Catchment, as volume in millions of cubic metres (Mm^3), 2015 to 2021

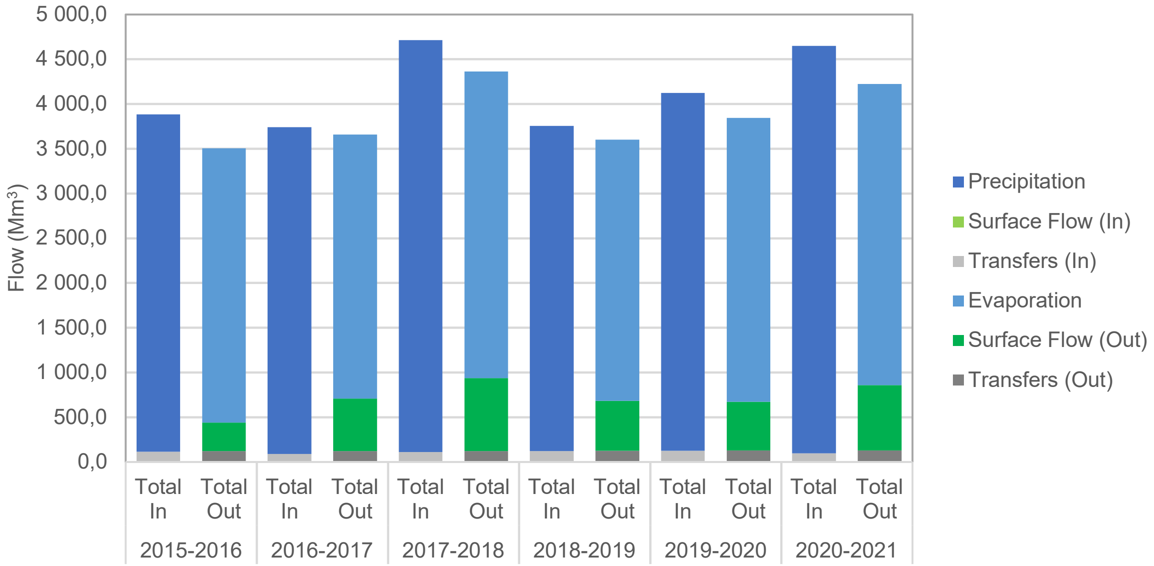


Figure 12 – Time series of catchment total inflows and total outflows for the uMngeni Catchment, as normalised depths (mm), 2015 to 2021

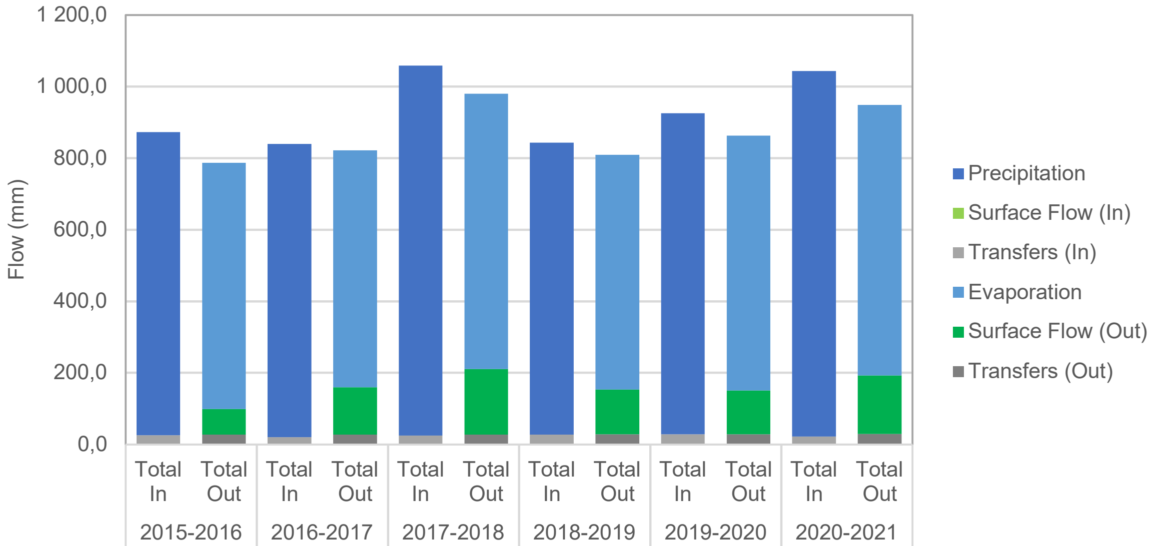


Table 20 – Water resource flow account for the uMngeni Catchment, 2015-2021, for six accounting periods (as volume in millions of cubic metres (Mm^3))

uMngeni Catchment sub-accounting area (4 454,1 km^2)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total In	3884,3	3738,3	4713,5	3754,2	4120,5	4647,2
Precipitation	3772,5	3650,6	4605,5	3632,7	3996,7	4550,7
Inflows	111,8	87,7	108,1	121,5	123,8	96,6
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ GW}$						
$Q_{in\ Transfers}$	111,8	87,7	108,1	121,5	123,8	96,6
Total Out	3502,1	3658,9	4362,5	3601,6	3843,4	4222,7
Total Evaporation (ET)	3064,0	2950,7	3426,0	2919,8	3171,5	3366,6
Landscape ET	3001,7	2887,2	3363,4	2855,8	3111,0	3311,0
Incremental ET	62,3	63,4	62,6	64,0	60,5	55,6
Outflows	438,1	708,2	936,5	681,8	671,9	856,1
$Q_{out\ SW}$	319,1	587,8	814,2	557,6	545,5	728,2
$Q_{out\ GW}$						
$Q_{out\ Transfers}$	119,0	120,5	122,3	124,1	126,4	127,9
Reserved outflows	119,0	120,5	122,3	124,1	126,4	127,9
Utilisable outflows	319,1	587,8	814,2	557,6	545,5	728,2
Total Change in Storage	-382,2	-79,4	-351,1	-152,6	-277,1	-424,5
$DS_{f\ SW}$	-278,6	-188,3	-295,4	-223,2	-244,9	-310,4
$DS_{f\ SoilM}$	-98,6	104,5	-38,0	36,2	-29,7	-106,9
$DS_{f\ GW}$	-5,0	4,4	-17,7	34,4	-2,6	-7,2

Table 21 – Water resource flow account for the uMngeni Catchment, 2015-2021, for six accounting periods (as depth in millimetres (mm))

uMngeni Catchment sub-accounting area (4 454,1 km^2)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total In	872,1	839,3	1058,2	842,9	925,1	1043,4
Precipitation	847,0	819,6	1034,0	815,6	897,3	1021,7
Inflows	25,1	19,7	24,3	27,3	27,8	21,7
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ GW}$						
$Q_{in\ Transfers}$	25,1	19,7	24,3	27,3	27,8	21,7
Total Out	786,3	821,5	979,4	808,6	862,9	948,0
Total Evaporation (ET)	687,9	662,5	769,2	655,5	712,0	755,8
Landscape ET	673,9	648,2	755,1	641,2	698,5	743,4
Incremental ET	14,0	14,2	14,1	14,4	13,6	12,5
Outflows	98,4	159,0	210,2	153,1	150,8	192,2
$Q_{out\ SW}$	71,6	132,0	182,8	125,2	122,5	163,5
$Q_{out\ GW}$						
$Q_{out\ Transfers}$	26,7	27,0	27,5	27,9	28,4	28,7
Reserved outflows	26,7	27,0	27,5	27,9	28,4	28,7
Utilisable outflows	71,6	132,0	182,8	125,2	122,5	163,5
Total Change in Storage	-85,8	-17,8	-78,8	-34,3	-62,2	-95,3
$DS_{f\ SW}$	-62,6	-42,3	-66,3	-50,1	-55,0	-69,7
$DS_{f\ SoilM}$	-22,1	23,5	-8,5	8,1	-6,7	-24,0
$DS_{f\ GW}$	-1,1	1,0	-4,0	7,7	-0,6	-1,6

3.2.2 Water resource flow accounts disaggregated by land cover

Changes in the extent of different land cover classes within a catchment, especially the extent of highly modified land cover, can affect both water quantity and quality. This section includes water resource flow accounts disaggregated by four broad land cover classes, namely natural or semi-natural, cultivated, built-up and waterbodies (refer to Section 2.3). Figure 13 shows the distribution of these broad land cover classes across the uMngeni Catchment sub-accounting area and the land cover composition per quaternary catchment is provided in Appendix 1 (1). The water resource flow accounts disaggregated by land cover were compiled per accounting period from 2015-2016 to 2020-2021, provided in Table 22 to Table 27. The tables include detail on the extent of each broad land cover class in the uMngeni Catchment sub-accounting area, a similar catchment water balance on the left-hand side to what is presented in Table 20 and Table 21, but provide more detail of the types of evaporation and also internal catchment flows such as surface runoff, infiltration and baseflow.

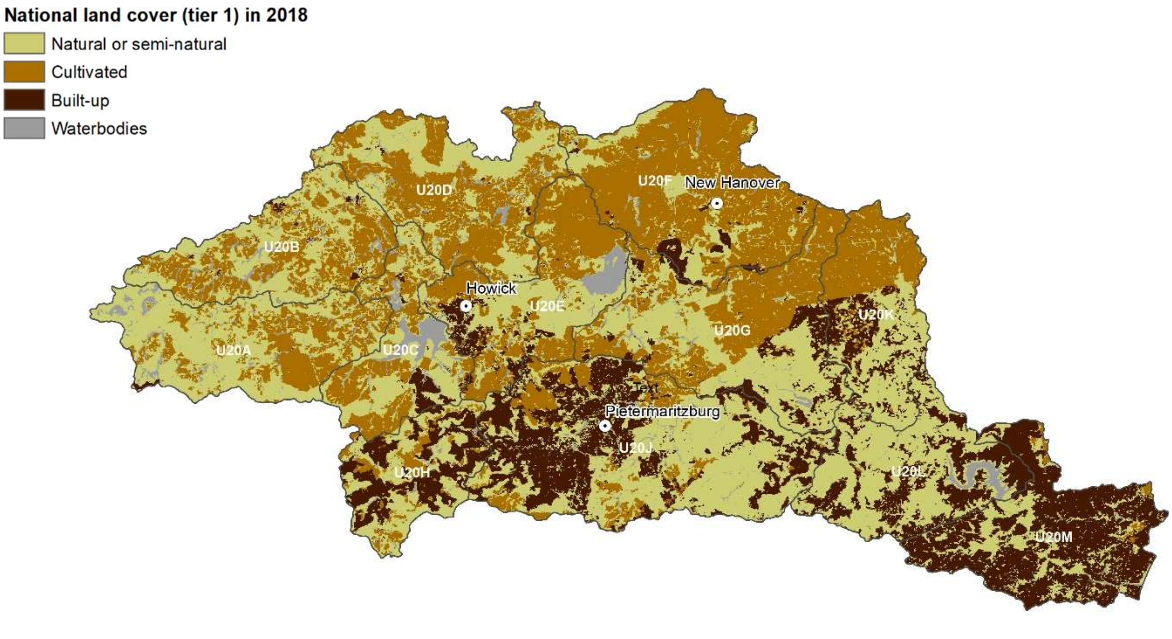
The uMngeni Catchment was largely converted to intensively modified land cover being either cultivated (33,5%) or built-up (17,9%). Natural or semi-natural land cover (45,4%) was the lowest proportion of natural or semi-natural land cover compared to the other sub-accounting areas.

The proportional extent of land cover classes can be compared to the proportional attribution of each of the water resource variables. For instance, in 2015-2016, natural or semi-natural land cover made up 45,4% of the uMngeni Catchment, and 44,0% of precipitation fell across these areas. Precipitation was generally proportional to area in the uMngeni Catchment.

Evaporation, in contrast, was not proportional to the area of land cover. Land cover (e.g. the types of plants, hard surfaces of built-up areas) influence evaporation. In the uMngeni Catchment, total evaporation was proportionally higher in cultivated land (proportion of cultivated land was 33,5% and proportion of total evaporation on cultivated land was between 37,4% in 2018-2019 and 39,3% in 2015-2016). Land use and cover influence how water is made available for evaporation, and the main ways in which it is evaporated.

The water resource accounts disaggregated by land cover provide additional detail on these different types of evaporation, to provide further insights into the relationships between water resources and land cover. Firstly, in the same manner as in the water resource flow accounts, total evaporation is partitioned into evaporation of precipitated water from the landscape (Landscape ET) and evaporation of irrigated water (Incremental ET). This enables useful partitioning of what is evaporated largely from precipitation and largely from irrigated water (where the water that is being evaporated came from). Landscape evaporation on natural or semi-natural land cover varies between 48,5% (2015-2016, 2016-2017) and 49,9% (2018-2019), which was proportionally slightly higher than the area of natural or semi-natural land cover (45,4%). Landscape evaporation on cultivated land was proportionally slightly higher than the area of cultivated land (33,5%), where it varies between 37,9% (2018-2019) and 39,8% (2015-2016). Incremental evaporation only takes place in cultivated or built-up areas, with the majority being evaporated from built-up areas (82,6% to 89,8%).

Figure 13 – Broad land cover classes in the uMngeni Catchment sub-accounting area



Secondly, total evaporation of water that was either precipitated and/or irrigated (regardless of where it came from) is partitioned by how the water is evaporated: water that has been intercepted by vegetation and other surfaces and then evaporated (Interception ET); water transpired by vegetation (Transpiration ET); evaporation from the soil water store (Soil Water ET); and evaporation from open water surfaces (Open Water ET). Water intercepted by vegetation in the uMngeni Catchment was proportionally greater in natural or semi-natural areas, varying from 56,6% (2015-2016) to 58,5% (2018-2019), where there was more vegetation and vegetative material on the soil surface. Transpiration in the uMngeni Catchment was lower in natural or semi-natural areas and relatively higher in cultivated areas, varying from 46,9% (2018-2019) to 50,2% (2015-2016). This was different from the finding in the Breede Catchment and may have to do with the plants being cultivated (which include timber plantations). Soil water evaporation was proportionally lower on cultivated land, varying from 28,2% (2020-2021) to 32,0% (2018-2019), and proportionally higher in natural or semi-natural areas where soil water evaporation ranges from 54,8% (2016-2017) to 58,6% (2020-2021).

This type of account table expands on the water resource flow accounts to provide information on flows inside the catchment (internal flows), which provides more information about the impacts of land cover. The internal flows describe:

- **Where precipitated and irrigated water flows**, partitioning this into: the water that gets intercepted on plants and hard surfaces (and thus does not move into the soil or rivers and dams, it is typically lost as evaporation) (interception); the water that infiltrates into the soil where it replenishes the water in the soil matrix (infiltration)[10]; and water that runs off the surface into rivers, wetlands and dams (surface runoff).
- **What happens to water that has infiltrated into the soil profile**: specifically, the portion of infiltrated water that percolates down the root zone where it might be available to recharge groundwater stores (potential groundwater recharge), a portion of which becomes baseflow.
- **Irrigation** is the amount of water applied as irrigation within the catchment. Just like rainfall, some of it is intercepted, infiltrates and if over-irrigating some of it might contribute to surface runoff and baseflow.

In the uMngeni Catchment sub-accounting area, the total surface runoff varies from 65,8 mm in the driest year (2015-2016) to 108,1 mm in 2020-2021 (though 2017/2018 had the highest rainfall). Across the broad land cover types, surface runoff was proportionally higher on built-up land (varying from 27,4% in 2016-2017 to 44,1% in 2015-2016), due to a larger proportion of hard impervious surfaces, and on waterbodies (varying from 8,7% in 2018-2019 to 13,3% in 2019-2020), due to open water surfaces and wetter soil profiles in wetlands. Total infiltration varies from 503,6 mm in the year with the lowest precipitation (2018-2019) to 679,0 mm in the year with the highest precipitation (2017-2018). Across the broad land cover types, infiltration was proportionally equal on natural or semi-natural land cover and a little higher on cultivated land (varying from 41,3% in 2018-2019 to 43,8% in 2017-2018). Of the water that infiltrates, the amount that might recharge groundwater relative to the extent of the land cover type was proportionally higher in built-up areas (varying from 12,0% in 2017-2018 to 27,0% in 2015-2016) and in cultivated areas (varying from 37,1% in 2015-2016 to 47,8% in 2017-2018). The same was true for baseflow. Built-up and cultivated areas make a proportionally higher contribution to baseflow in the uMngeni Catchment. This may have to do with the slope and substrate of these highly modified areas that make up such a large proportion of the uMngeni Catchment and has implications for the quality of water moving to groundwater recharge and baseflow. Surface runoff, baseflow and groundwater recharge are components of the water balance that help to provide for domestic, industrial and agricultural requirements.

The amount of water irrigated in the uMngeni Catchment varied between 6,3 million m^3 (1,4 mm) in 2020-2021 and 10,5 million m^3 (2,3 mm) in 2017-2018. This was much lower than the Breede Catchment.

[10] Some of this infiltrated water may be lost as evaporation from the soil surface (Soil Water ET) and through transpiration by plants (Transpiration ET).

Table 22 – Water resource flow account disaggregated by land cover for the uMngeni Catchment, for 2015-2016 (as volumes, depths and percentages)

uMngeni Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km²)	%[1]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]
		4 454,1	*100,0*		2 022,6	*45,4*		1 490,5	*33,5*		796,4	*17,9*		144,6	*3,2*
Water resource details 2015-2016	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**
Total In	3 884,3	872,1													
Precipitation	3 772,5	847,0	*97,1*	1 660,6	372,8	*44,0*	1 335,3	299,8	*35,4*	662,4	148,7	*17,6*	114,2	25,6	*3,0*
Inflows	111,8	25,1	*2,9*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	111,8	25,1	*2,9*												
Total Out	3 502,1	786,3													
Total Evaporation (ET)	3 064,0	687,9	*87,5*	1 456,7	327,0	*47,5*	1 202,9	270,1	*39,3*	294,5	66,1	*9,6*	109,9	24,7	*3,6*
Landscape ET	3 001,7	673,9	*98,0*	1 456,7	327,0	*48,5*	1 193,9	268,0	*39,8*	241,1	54,1	*8,0*	109,9	24,7	*3,7*
Incremental ET	62,3	14,0	*2,0*	0,0	0,0	*0,0*	9,0	2,0	*14,4*	53,4	12,0	*85,6*	0,0	0,0	*0,0*
Interception ET	781,3	175,4	*25,5*	442,3	99,3	*56,6*	264,8	59,4	*33,9*	70,0	15,7	*9,0*	4,2	1,0	*0,5*
Transpiration ET	1 324,6	297,4	*43,2*	545,5	122,5	*41,2*	664,5	149,2	*50,2*	99,0	22,2	*7,5*	15,6	3,5	*1,2*
Soil Water ET	854,8	191,9	*27,9*	468,9	105,3	*54,9*	271,5	61,0	*31,8*	105,3	23,6	*12,3*	9,1	2,0	*1,1*
Open Water ET	103,3	23,2	*3,4*	0,0	0,0	*0,0*	2,1	0,5	*2,1*	20,2	4,5	*19,5*	81,0	18,2	*78,4*
Outflows	438,1	98,4	*12,5*												
$Q_{out\ SW}$	319,1	71,6	*9,1*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	119,0	26,7	*3,4*												
Total Change In Storage	-382,2	-85,8		-53,1	-11,9		-31,8	-7,1		-254,4	-57,1		-42,9	-9,6	
$DS_{f\ SW}$	-278,6	-62,6		3,0	0,7		2,9	0,7		-241,2	-54,1		-43,4	-9,7	
$DS_{f\ SoilM}$	-98,6	-22,1		-49,8	-11,2		-41,6	-9,3		-7,2	-1,6		0,0	0,0	
$DS_{f\ GW}$	-5,0	-1,1		-6,3	-1,4		6,9	1,5		-6,0	-1,4		0,5	0,1	
Internal Flows															
Interception	774,9	174,0		439,3	98,6	*56,7*	261,8	58,8	*33,8*	69,6	15,6	*9,0*	4,2	0,9	*0,5*
Surface Runoff	293,3	65,8		92,8	20,8	*31,6*	38,4	8,6	*13,1*	129,3	29,0	*44,1*	32,7	7,3	*11,2*
Infiltration	2 443,9	548,7		1 128,6	253,4	*46,2*	1 044,1	234,4	*42,7*	260,0	58,4	*10,6*	11,3	2,5	*0,5*
Pot. GW Recharge	179,4	40,3		64,4	14,5	*35,9*	66,5	14,9	*37,1*	48,5	10,9	*27,0*			
Baseflow	183,8	41,3		56,8	12,8	*30,9*	70,0	15,7	*38,1*	55,2	12,4	*30,1*	1,7	0,4	*0,9*
Irrigation	9,1	2,0		0,0	0,0	*0,0*	9,1	2,0	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 23 – Water resource flow account disaggregated by land cover for the uMngeni Catchment, for 2016-2017 (as volumes, depths and percentages)

uMngeni Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		4 454,1	*100,0*		2 022,6	*45,4*		1 490,5	*33,5*		796,4	*17,9*		144,6	*3,2*
Water resource details 2016-2017	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	3 738,3	839,3													
Precipitation	3 650,6	819,6	*97,7*	1 621,4	364,0	*44,4*	1 318,1	295,9	*36,1*	594,8	133,5	*16,3*	116,3	26,1	*3,2*
Inflows	87,7	19,7	*2,3*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	87,7	19,7	*2,3*												
Total Out	3 658,9	821,5													
Total Evaporation (ET)	2 950,7	662,5	*80,6*	1 401,4	314,6	*47,5*	1 147,2	257,6	*38,9*	294,2	66,0	*10,0*	107,9	24,2	*3,7*
Landscape ET	2 887,2	648,2	*97,8*	1 401,4	314,6	*48,5*	1 137,0	255,3	*39,4*	240,8	54,1	*8,3*	107,9	24,2	*3,7*
Incremental ET	63,4	14,2	*2,2*	0,0	0,0	*0,0*	10,1	2,3	*16,0*	53,3	12,0	*84,0*	0,0	0,0	*0,0*
Interception ET	761,3	170,9	*25,8*	433,3	97,3	*56,9*	251,9	56,6	*33,1*	71,8	16,1	*9,4*	4,2	0,9	*0,6*
Transpiration ET	1 308,7	293,8	*44,4*	543,0	121,9	*41,5*	645,6	144,9	*49,3*	106,4	23,9	*8,1*	13,7	3,1	*1,0*
Soil Water ET	775,9	174,2	*26,3*	425,2	95,5	*54,8*	247,3	55,5	*31,9*	95,7	21,5	*12,3*	7,7	1,7	*1,0*
Open Water ET	104,8	23,5	*3,6*	0,0	0,0	*0,0*	2,3	0,5	*2,2*	20,3	4,5	*19,3*	82,3	18,5	*78,5*
Outflows	708,2	159,0	*19,4*												
$Q_{out\ SW}$	587,8	132,0	*16,1*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	120,5	27,0	*3,3*												
Total Change In Storage	-79,4	-17,8		54,3	12,2		46,5	10,4		-205,2	-46,1		25,0	5,6	
$DS_{f\ SW}$	-188,3	-42,3		0,1	0,0		0,0	0,0		-213,1	-47,9		24,8	5,6	
$DS_{f\ SoilM}$	104,5	23,5		49,8	11,2		51,3	11,5		2,7	0,6		0,6	0,1	
$DS_{f\ GW}$	4,4	1,0		4,4	1,0		-4,8	-1,1		5,2	1,2		-0,3	-0,1	
Internal Flows															
Interception	761,0	170,9		433,2	97,3	*56,9*	251,9	56,6	*33,1*	71,7	16,1	*9,4*	4,2	0,9	*0,6*
Surface Runoff	380,0	85,3		140,6	31,6	*37,0*	97,1	21,8	*25,6*	104,1	23,4	*27,4*	38,2	8,6	*10,1*
Infiltration	2 277,9	511,4		1 047,6	235,2	*46,0*	978,9	219,8	*43,0*	244,2	54,8	*10,7*	7,2	1,6	*0,3*
Pot. GW Recharge	311,4	69,9		129,3	29,0	*41,5*	137,3	30,8	*44,1*	44,8	10,1	*14,4*			
Baseflow	325,3	73,0		115,8	26,0	*35,6*	128,3	28,8	*39,4*	78,0	17,5	*24,0*	3,1	0,7	*1,0*
Irrigation	9,8	2,2		0,0	0,0	*0,0*	9,8	2,2	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 24 – Water resource flow account disaggregated by land cover for the uMngeni Catchment, for 2017-2018 (as volumes, depths and percentages)

uMngeni Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		4 454,1	*100,0*		2 022,6	*45,4*		1 490,5	*33,5*		796,4	*17,9*		144,6	*3,2*
Water resource details 2017-2018	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	4 713,5	1 058,2													
Precipitation	4 605,5	1 034,0	*97,7*	2 050,5	460,4	*44,5*	1 686,8	378,7	*36,6*	716,6	160,9	*15,6*	151,6	34,0	*3,3*
Inflows	108,1	24,3	*2,3*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	108,1	24,3	*2,3*												
Total Out	4 362,5	979,4													
Total Evaporation (ET)	3 426,0	769,2	*78,5*	1 662,3	373,2	*48,5*	1 340,3	300,9	*39,1*	313,3	70,3	*9,1*	110,1	24,7	*3,2*
Landscape ET	3 363,4	755,1	*98,2*	1 662,3	373,2	*49,4*	1 329,5	298,5	*39,5*	261,5	58,7	*7,8*	110,1	24,7	*3,3*
Incremental ET	62,6	14,1	*1,8*	0,0	0,0	*0,0*	10,9	2,4	*17,4*	51,8	11,6	*82,6*	0,0	0,0	*0,0*
Interception ET	825,3	185,3	*24,1*	471,3	105,8	*57,1*	279,8	62,8	*33,9*	69,7	15,7	*8,5*	4,4	1,0	*0,5*
Transpiration ET	1 596,4	358,4	*46,6*	678,8	152,4	*42,5*	787,4	176,8	*49,3*	116,8	26,2	*7,3*	13,3	3,0	*0,8*
Soil Water ET	895,8	201,1	*26,1*	512,1	115,0	*57,2*	270,6	60,8	*30,2*	106,9	24,0	*11,9*	6,1	1,4	*0,7*
Open Water ET	108,6	24,4	*3,2*	0,0	0,0	*0,0*	2,5	0,6	*2,3*	19,9	4,5	*18,3*	86,2	19,4	*79,4*
Outflows	936,5	210,2	*21,5*												
$Q_{out\ SW}$	814,2	182,8	*18,7*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	122,3	27,5	*2,8*												
Total Change In Storage	-351,1	-78,8		-20,5	-4,6		-34,7	-7,8		-263,1	-59,1		-32,7	-7,3	
$DS_{f\ SW}$	-295,4	-66,3		0,0	0,0		0,1	0,0		-264,5	-59,4		-31,0	-7,0	
$DS_{f\ SoilM}$	-38,0	-8,5		-14,6	-3,3		-23,2	-5,2		1,0	0,2		-1,2	-0,3	
$DS_{f\ GW}$	-17,7	-4,0		-6,0	-1,3		-11,5	-2,6		0,4	0,1		-0,6	-0,1	
Internal Flows															
Interception	825,3	185,3		471,3	105,8	*57,1*	279,8	62,8	*33,9*	69,7	15,7	*8,5*	4,4	1,0	*0,5*
Surface Runoff	453,4	101,8		169,3	38,0	*37,3*	92,9	20,8	*20,5*	135,4	30,4	*29,9*	55,8	12,5	*12,3*
Infiltration	3 024,5	679,0		1 409,8	316,5	*46,6*	1 324,6	297,4	*43,8*	283,8	63,7	*9,4*	6,3	1,4	*0,2*
Pot. GW Recharge	508,8	114,2		204,3	45,9	*40,1*	243,3	54,6	*47,8*	61,2	13,7	*12,0*			
Baseflow	500,6	112,4		192,2	43,2	*38,4*	220,1	49,4	*44,0*	81,7	18,3	*16,3*	6,6	1,5	*1,3*
Irrigation	10,5	2,3		0,0	0,0	*0,0*	10,5	2,3	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 25 – Water resource flow account disaggregated by land cover for the uMngeni Catchment, for 2018-2019 (as volumes, depths and percentages)

uMngeni Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		4 454,1	*100,0*		2 022,6	*45,4*		1 490,5	*33,5*		796,4	*17,9*		144,6	*3,2*
Water resource details 2018-2019	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	3 754,2	842,9													
Precipitation	3 632,7	815,6	*96,8*	1 646,4	369,6	*45,3*	1 236,4	277,6	*34,0*	639,9	143,7	*17,6*	110,0	24,7	*3,0*
Inflows	121,5	27,3	*3,2*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	121,5	27,3	*3,2*												
Total Out	3 601,6	808,6													
Total Evaporation (ET)	2 919,8	655,5	*81,1*	1 425,2	320,0	*48,8*	1 092,3	245,2	*37,4*	292,2	65,6	*10,0*	110,1	24,7	*3,8*
Landscape ET	2 855,8	641,2	*97,8*	1 425,2	320,0	*49,9*	1 081,4	242,8	*37,9*	239,1	53,7	*8,4*	110,1	24,7	*3,9*
Incremental ET	64,0	14,4	*2,2*	0,0	0,0	*0,0*	10,9	2,5	*17,1*	53,1	11,9	*82,9*	0,0	0,0	*0,0*
Interception ET	739,0	165,9	*25,3*	432,0	97,0	*58,5*	238,0	53,4	*32,2*	65,0	14,6	*8,8*	4,0	0,9	*0,5*
Transpiration ET	1 262,6	283,5	*43,2*	545,5	122,5	*43,2*	592,1	132,9	*46,9*	110,0	24,7	*8,7*	15,0	3,4	*1,2*
Soil Water ET	811,1	182,1	*27,8*	447,7	100,5	*55,2*	259,8	58,3	*32,0*	97,0	21,8	*12,0*	6,5	1,5	*0,8*
Open Water ET	107,1	24,1	*3,7*	0,0	0,0	*0,0*	2,4	0,5	*2,3*	20,2	4,5	*18,8*	84,5	19,0	*78,9*
Outflows	681,8	153,1	*18,9*												
$Q_{out\ SW}$	557,6	125,2	*15,5*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	124,1	27,9	*3,4*												
Total Change In Storage	-152,6	-34,3		27,1	6,1		32,0	7,2		-231,3	-51,9		19,6	4,4	
$DS_{f\ SW}$	-223,2	-50,1		-3,4	-0,8		-3,0	-0,7		-234,2	-52,6		17,4	3,9	
$DS_{f\ SoilM}$	36,2	8,1		16,3	3,6		16,9	3,8		1,8	0,4		1,3	0,3	
$DS_{f\ GW}$	34,4	7,7		14,3	3,2		18,0	4,1		1,1	0,3		0,9	0,2	
Internal Flows															
Interception	746,1	167,5		435,4	97,8	*58,4*	240,9	54,1	*32,3*	65,7	14,7	*8,8*	4,0	0,9	*0,5*
Surface Runoff	396,1	88,9		150,7	33,8	*38,0*	80,6	18,1	*20,4*	130,4	29,3	*32,9*	34,4	7,7	*8,7*
Infiltration	2 243,1	503,6		1 060,3	238,0	*47,3*	925,3	207,7	*41,3*	248,4	55,8	*11,1*	9,1	2,0	*0,4*
Pot. GW Recharge	216,8	48,7		83,3	18,7	*38,4*	90,3	20,3	*41,7*	43,2	9,7	*19,9*			
Baseflow	260,7	58,5		92,7	20,8	*35,5*	101,1	22,7	*38,8*	64,6	14,5	*24,8*	2,3	0,5	*0,9*
Irrigation	10,4	2,3		0,0	0,0	*0,0*	10,4	2,3	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 26 – Water resource flow account disaggregated by land cover for the uMngeni Catchment, for 2019-2020 (as volumes, depths and percentages)

uMngeni Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		4 454,1	*100,0*		2 022,6	*45,4*		1 490,5	*33,5*		796,4	*17,9*		144,6	*3,2*
Water resource details 2019-2020	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	4 120,5	925,1													
Precipitation	3 996,7	897,3	*97,0*	1 777,3	399,0	*44,5*	1 439,7	323,2	*36,0*	651,3	146,2	*16,3*	128,4	28,8	*3,2*
Inflows	123,8	27,8	*3,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	123,8	27,8	*3,0*												
Total Out	3 843,4	862,9													
Total Evaporation (ET)	3 171,5	712,0	*82,5*	1 531,3	343,8	*48,3*	1 235,7	277,4	*39,0*	294,3	66,1	*9,3*	110,2	24,7	*3,5*
Landscape ET	3 111,0	698,5	*98,1*	1 531,3	343,8	*49,2*	1 228,7	275,9	*39,5*	240,8	54,1	*7,7*	110,2	24,7	*3,5*
Incremental ET	60,5	13,6	*1,9*	0,0	0,0	*0,0*	7,0	1,6	*11,6*	53,5	12,0	*88,4*	0,0	0,0	*0,0*
Interception ET	801,3	179,9	*25,3*	466,7	104,8	*58,2*	265,6	59,6	*33,2*	64,8	14,5	*8,1*	4,2	0,9	*0,5*
Transpiration ET	1 466,8	329,3	*46,2*	612,2	137,5	*41,7*	727,2	163,3	*49,6*	113,6	25,5	*7,7*	13,8	3,1	*0,9*
Soil Water ET	796,1	178,7	*25,1*	452,3	101,5	*56,8*	241,2	54,1	*30,3*	95,7	21,5	*12,0*	6,9	1,6	*0,9*
Open Water ET	107,3	24,1	*3,4*	0,0	0,0	*0,0*	1,7	0,4	*1,6*	20,3	4,6	*18,9*	85,3	19,2	*79,5*
Outflows	671,9	150,8	*17,5*												
$Q_{out\ SW}$	545,5	122,5	*14,2*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	126,4	28,4	*3,3*												
Total Change In Storage	-277,1	-62,2		-11,8	-2,6		-13,7	-3,1		-240,2	-53,9		-11,4	-2,6	
$DS_{f\ SW}$	-244,9	-55,0		2,9	0,6		1,8	0,4		-238,8	-53,6		-10,7	-2,4	
$DS_{f\ SoilM}$	-29,7	-6,7		-15,1	-3,4		-12,2	-2,7		-2,1	-0,5		-0,4	-0,1	
$DS_{f\ GW}$	-2,6	-0,6		0,4	0,1		-3,4	-0,8		0,7	0,2		-0,3	-0,1	
Internal Flows															
Interception	795,9	178,7		463,9	104,1	*58,3*	263,8	59,2	*33,1*	64,1	14,4	*8,1*	4,1	0,9	*0,5*
Surface Runoff	328,9	73,8		107,4	24,1	*32,7*	56,8	12,7	*17,3*	120,9	27,1	*36,8*	43,8	9,8	*13,3*
Infiltration	2 605,2	584,9		1 206,0	270,8	*46,3*	1 126,4	252,9	*43,2*	265,2	59,5	*10,2*	7,6	1,7	*0,3*
Pot. GW Recharge	326,2	73,2		126,4	28,4	*38,8*	145,9	32,8	*44,7*	53,9	12,1	*16,5*			
Baseflow	333,1	74,8		119,3	26,8	*35,8*	133,4	29,9	*40,0*	76,9	17,3	*23,1*	3,6	0,8	*1,1*
Irrigation	7,3	1,6		0,0	0,0	*0,0*	7,3	1,6	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 27 – Water resource flow account disaggregated by land cover for the uMngeni Catchment, for 2020-2021 (as volumes, depths and percentages)

uMngeni Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		4 454,1	*100,0*		2 022,6	*45,4*		1 490,5	*33,5*		796,4	*17,9*		144,6	*3,2*
Water resource details 2020-2021	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	4 647,2	1 043,4													
Precipitation	4 550,7	1 021,7	*97,9*	2 020,9	453,7	*44,4*	1 568,8	352,2	*34,5*	819,4	184,0	*18,0*	141,6	31,8	*3,1*
Inflows	96,6	21,7	*2,1*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	96,6	21,7	*2,1*												
Total Out	4 222,7	948,0													
Total Evaporation (ET)	3 366,6	755,8	*79,7*	1 650,4	370,5	*49,0*	1 291,6	290,0	*38,4*	317,3	71,2	*9,4*	107,3	24,1	*3,2*
Landscape ET	3 311,0	743,4	*98,3*	1 650,4	370,5	*49,8*	1 285,9	288,7	*38,8*	267,4	60,0	*8,1*	107,3	24,1	*3,2*
Incremental ET	55,6	12,5	*1,7*	0,0	0,0	*0,0*	5,7	1,3	*10,2*	49,9	11,2	*89,8*	0,0	0,0	*0,0*
Interception ET	762,7	171,2	*22,7*	437,5	98,2	*57,4*	254,1	57,1	*33,3*	66,8	15,0	*8,8*	4,3	1,0	*0,6*
Transpiration ET	1 651,1	370,7	*49,0*	716,9	161,0	*43,4*	797,4	179,0	*48,3*	123,8	27,8	*7,5*	12,9	2,9	*0,8*
Soil Water ET	846,5	190,1	*25,1*	496,0	111,4	*58,6*	238,5	53,6	*28,2*	107,1	24,0	*12,7*	4,9	1,1	*0,6*
Open Water ET	106,3	23,9	*3,2*	0,0	0,0	*0,0*	1,5	0,3	*1,4*	19,6	4,4	*18,4*	85,2	19,1	*80,2*
Outflows	856,1	192,2	*20,3*												
$Q_{out\ SW}$	728,2	163,5	*17,2*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	127,9	28,7	*3,0*												
Total Change In Storage	-424,5	-95,3		-66,5	-14,9		-39,4	-8,9		-320,0	-71,8		1,4	0,3	
$DS_{f\ SW}$	-310,4	-69,7		-2,9	-0,6		-1,9	-0,4		-307,7	-69,1		2,1	0,5	
$DS_{f\ SoilM}$	-106,9	-24,0		-59,6	-13,4		-38,2	-8,6		-8,4	-1,9		-0,7	-0,2	
$DS_{f\ GW}$	-7,2	-1,6		-4,1	-0,9		0,7	0,1		-3,8	-0,8		0,0	0,0	
Internal Flows															
Interception	768,2	172,5		440,4	98,9	*57,3*	256,0	57,5	*33,3*	67,5	15,2	*8,8*	4,3	1,0	*0,6*
Surface Runoff	481,3	108,1		169,1	38,0	*35,1*	94,2	21,2	*19,6*	167,2	37,5	*34,7*	50,8	11,4	*10,6*
Infiltration	2 954,8	663,4		1 411,4	316,9	*47,8*	1 224,9	275,0	*41,5*	313,2	70,3	*10,6*	5,3	1,2	*0,2*
Pot. GW Recharge	363,4	81,6		138,9	31,2	*38,2*	150,7	33,8	*41,5*	73,9	16,6	*20,3*			
Baseflow	365,7	82,1		134,4	30,2	*36,8*	142,8	32,1	*39,0*	83,8	18,8	*22,9*	4,7	1,1	*1,3*
Irrigation	6,3	1,4		0,0	0,0	*0,0*	6,3	1,4	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

3.2.3 Water resource flow account with reference states

Water resource flow account with reference states refers to water resource flow accounts compiled for a scenario where the sub-accounting area is fully covered by natural or semi-natural land cover and contains no built water infrastructure, such as dams or inter-catchment transfers (i.e. a reference state prior to land cover change with associated infrastructure). These accounts provide a baseline against which impacts of actual land cover and water management on water resources can be further explored.

These accounts therefore provide the water resource flow accounts per accounting period for the uMngeni Catchment sub-accounting area with (i) **actual** land cover in 2018 and water infrastructure, (ii) with **reference state**, and (iii) the percentage **difference** between these, as presented in Table 28 to Table 33. The water resource flow accounts for actual are the same as in Table 22 to Table 27, repeated here to support comparison with the reference state.

The climatic conditions are actual climate conditions modelled per accounting period, so as to compare water resources under actual land cover conditions with water resources as they would be if the uMngeni Catchment were not developed. In other words, this is exploring the impact of land cover change, not climate change which would require modelling climate conditions at a historical point in time. This is why precipitation is the same across actual and reference land cover conditions.

The difference between the water variables under actual and reference scenarios is calculated as the reference value subtracted from the actual value and divided by the reference value. This should be compared in absolute terms and in terms of the direction of the difference and the quantum of the difference. A difference that is a positive value, means that the actual conditions are greater than the reference state in absolute terms (and vice versa).

Total evaporation under actual conditions was lower than what it would be under the reference state, with the difference varying from -7,8% (2020-2021) to -5,4% (2015-2016). Evaporation of water intercepted by vegetation and other surfaces (Interception ET) and water evaporated from soil (Soil Water ET) have a consistently negative difference, meaning that there was less of these types of evaporation under actual conditions than there would be in the reference state. Water transpired by vegetation (Transpiration ET) and open water evaporation (Open Water ET) have a consistently positive difference, meaning that these were greater under actual conditions. The reference state had less water evaporated from open water because there were no dams. Surface water outflows in the uMngeni Catchment were consistently lower under actual conditions than under the reference state, with the difference varying from -27,0% in 2015-2016 to -4,5% in 2019-2020. Under the reference state, there would be more water flowing out of the catchment, because there would be no dams to store water flows.

In terms of flows of water inside the catchment, interception was lower under actual conditions (varying from -24,6% in 2019-2020 to -22,5% in 2016-2017), surface runoff was lower under actual conditions (varying from -16,7% in 2017-2018 to -9,3% in 2018-2019) and infiltration was generally slightly greater under actual conditions (greater in all years except 2020-2021 (-1,6%)). In other words, under actual conditions there was less surface water runoff and slightly more infiltration, which was largely similar in the Breede Catchment and the Mooi Catchment. Of the water that infiltrates, it was under actual conditions that there was more potential groundwater recharge (varying from 34,5% more in 2017-2018 to 62,3% more in 2018-2019) and more baseflow (varying from 38,4% more in 2017-2018 to 53,3% more in 2018-2019).

Table 28 – Water resource flow account with reference state for the uMngeni Catchment, for 2015-2016 (as volumes, depths and percentages)

uMngeni Catchment		Total			Reference		*Difference*
Area		(km^2)	%		(km^2)	%	
		4 454,1	*100,0*		4 454,1	*100,0*	
Water resource details 2015-2016	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	3 884,3	872,1		3 772,5	847,0		*3,0*
Precipitation	3 772,5	847,0	*97,1*	3 772,5	847,0	*100,0*	*0,0*
Inflows	111,8	25,1	*2,9*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	111,8	25,1	*2,9*	0,0	0,0	*0,0*	-
Total Out	3 502,1	786,3		3 676,3	825,4		*-4,7*
Total Evaporation (ET)	3 064,0	687,9	*87,5*	3 238,9	727,2	*88,1*	*-5,4*
Landscape ET	3 001,7	673,9	*98,0*	3 238,9	727,2	*100,0*	*-7,3*
Incremental ET	62,3	14,0	*2,0*	0,0	0,0	*0,0*	-
Interception ET	781,3	175,4	*25,5*	1 007,4	226,2	*31,1*	*-22,4*
Transpiration ET	1 324,6	297,4	*43,2*	1 140,3	256,0	*35,2*	*16,2*
Soil Water ET	854,8	191,9	*27,9*	1 085,0	243,6	*33,5*	*-21,2*
Open Water ET	103,3	23,2	*3,4*	6,3	1,4	*0,2*	*1 531,5*
Outflows	438,1	98,4	*12,5*	437,4	98,2	*11,9*	*0,2*
$Q_{out\ SW}$	319,1	71,6	*9,1*	437,4	98,2	*11,9*	*-27,0*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	119,0	26,7	*3,4*	0,0	0,0	*0,0*	-
Total Change In Storage	-382,2	-85,8		-96,3	-21,6		*297,1*
$DS_{f\ SW}$	-278,6	-62,6		6,8	1,5		*-4 191,7*
$DS_{f\ SoilM}$	-98,6	-22,1		-116,5	-26,2		*-15,4*
$DS_{f\ GW}$	-5,0	-1,1		13,4	3,0		*-137,5*
Internal Flows							
Interception	774,9	174,0		1 000,6	224,6		*-22,6*
Surface Runoff	293,3	65,8		335,2	75,3		*-12,5*
Infiltration	2 443,9	548,7		2 435,1	546,7		*0,4*
Pot. GW Recharge	179,4	40,3		111,0	24,9		*61,6*
Baseflow	183,8	41,3		124,4	27,9		*47,7*
Irrigation	9,1	2,0		0,0	0,0		-

Table 29 – Water resource flow account with reference state for the uMngeni Catchment, for 2016-2017 (as volumes, depths and percentages)

uMngeni Catchment		Total			Reference		*Difference*
Area		(km²)	%		(km²)	%	
		4 454,1	*100,0*		4 454,1	*100,0*	
Water resource details 2016-2017	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**%**
Total In	3 738,3	839,3		3 650,6	819,6		*2,4*
Precipitation	3 650,6	819,6	*97,7*	3 650,6	819,6	*100,0*	*0,0*
Inflows	87,7	19,7	*2,3*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	87,7	19,7	*2,3*	0,0	0,0	*0,0*	-
Total Out	3 658,9	821,5		3 772,3	846,9		*-3,0*
Total Evaporation (ET)	2 950,7	662,5	*80,6*	3 135,0	703,8	*83,1*	*-5,9*
Landscape ET	2 887,2	648,2	*97,8*	3 135,0	703,8	*100,0*	*-7,9*
Incremental ET	63,4	14,2	*2,2*	0,0	0,0	*0,0*	-
Interception ET	761,3	170,9	*25,8*	982,3	220,5	*31,3*	*-22,5*
Transpiration ET	1 308,7	293,8	*44,4*	1 152,2	258,7	*36,8*	*13,6*
Soil Water ET	775,9	174,2	*26,3*	992,0	222,7	*31,6*	*-21,8*
Open Water ET	104,8	23,5	*3,6*	8,5	1,9	*0,3*	*1 132,7*
Outflows	708,2	159,0	*19,4*	637,3	143,1	*16,9*	*11,1*
$Q_{out\ SW}$	587,8	132,0	*16,1*	637,3	143,1	*16,9*	*-7,8*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	120,5	27,0	*3,3*	0,0	0,0	*0,0*	-
Total Change In Storage	-79,4	-17,8		121,7	27,3		*-414,1*
$DS_{f\ SW}$	-188,3	-42,3		0,4	0,1		*-45 228,8*
$DS_{f\ SoilM}$	104,5	23,5		120,4	27,0		*-13,3*
$DS_{f\ GW}$	4,4	1,0		0,9	0,2		*414,7*
Internal Flows							
Interception	761,0	170,9		981,9	220,5		*-22,5*
Surface Runoff	380,0	85,3		432,3	97,1		*-12,1*
Infiltration	2 277,9	511,4		2 235,0	501,8		*1,9*
Pot. GW Recharge	311,4	69,9		227,8	51,1		*36,7*
Baseflow	325,3	73,0		228,6	51,3		*42,3*
Irrigation	9,8	2,2		0,0	0,0		-

Table 30 – Water resource flow account with reference state for the uMngeni Catchment, for 2017-2018 (as volumes, depths and percentages)

uMngeni Catchment	Total			Reference			Difference
Area		(km^2)	%		(km^2)	%	
		4 454,1	100,0		4 454,1	100,0	
Water resource details 2017-2018	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	4 713,5	1 058,2		4 605,5	1 034,0		2,3
Precipitation	4 605,5	1 034,0	97,7	4 605,5	1 034,0	100,0	0,0
Inflows	108,1	24,3	2,3	0,0	0,0	0,0	-
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	108,1	24,3	2,3	0,0	0,0	0,0	-
Total Out	4 362,5	979,4		4 553,6	1 022,3		-4,2
Total Evaporation (ET)	3 426,0	769,2	78,5	3 674,9	825,1	80,7	-6,8
Landscape ET	3 363,4	755,1	98,2	3 674,9	825,1	100,0	-8,5
Incremental ET	62,6	14,1	1,8	0,0	0,0	0,0	-
Interception ET	825,3	185,3	24,1	1 069,2	240,1	29,1	-22,8
Transpiration ET	1 596,4	358,4	46,6	1 421,8	319,2	38,7	12,3
Soil Water ET	895,8	201,1	26,1	1 173,1	263,4	31,9	-23,6
Open Water ET	108,6	24,4	3,2	10,8	2,4	0,3	907,4
Outflows	936,5	210,2	21,5	878,7	197,3	19,3	6,6
$Q_{out\ SW}$	814,2	182,8	18,7	878,7	197,3	19,3	-7,3
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	122,3	27,5	2,8	0,0	0,0	0,0	-
Total Change In Storage	-351,1	-78,8		-51,9	-11,6		576,7
$DS_{f\ SW}$	-295,4	-66,3		0,0	0,0		-67 945 247,6
$DS_{f\ SoilM}$	-38,0	-8,5		-35,1	-7,9		8,2
$DS_{f\ GW}$	-17,7	-4,0		-16,8	-3,8		5,3
Internal Flows							
Interception	825,3	185,3		1 069,2	240,1		-22,8
Surface Runoff	453,4	101,8		544,5	122,2		-16,7
Infiltration	3 024,5	679,0		2 990,2	671,3		1,1
Pot. GW Recharge	508,8	114,2		378,4	85,0		34,5
Baseflow	500,6	112,4		361,6	81,2		38,4
Irrigation	10,5	2,3		0,0	0,0		-

Table 31 – Water resource flow account with reference state for the uMngeni Catchment, for 2018-2019 (as volumes, depths and percentages)

uMngeni Catchment	Total			Reference			Difference
Area		(km^2)	%		(km^2)	%	
		4 454,1	*100,0*		4 454,1	*100,0*	
Water resource details 2018-2019	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	3 754,2	842,9		3 632,7	815,6		*3,3*
Precipitation	3 632,7	815,6	*96,8*	3 632,7	815,6	*100,0*	*0,0*
Inflows	121,5	27,3	*3,2*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	121,5	27,3	*3,2*	0,0	0,0	*0,0*	-
Total Out	3 601,6	808,6		3 698,1	830,3		*-2,6*
Total Evaporation (ET)	2 919,8	655,5	*81,1*	3 112,4	698,8	*84,2*	*-6,2*
Landscape ET	2 855,8	641,2	*97,8*	3 112,4	698,8	*100,0*	*-8,2*
Incremental ET	64,0	14,4	*2,2*	0,0	0,0	*0,0*	-
Interception ET	739,0	165,9	*25,3*	972,3	218,3	*31,2*	*-24,0*
Transpiration ET	1 262,6	283,5	*43,2*	1 126,4	252,9	*36,2*	*12,1*
Soil Water ET	811,1	182,1	*27,8*	1 005,8	225,8	*32,3*	*-19,4*
Open Water ET	107,1	24,1	*3,7*	7,9	1,8	*0,3*	*1 251,9*
Outflows	681,8	153,1	*18,9*	585,7	131,5	*15,8*	*16,4*
$Q_{out\ SW}$	557,6	125,2	*15,5*	585,7	131,5	*15,8*	*-4,8*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	124,1	27,9	*3,4*	0,0	0,0	*0,0*	-
Total Change In Storage	-152,6	-34,3		65,4	14,7		*-333,3*
$DS_{f\ SW}$	-223,2	-50,1		-8,1	-1,8		*2 669,8*
$DS_{f\ SoilM}$	36,2	8,1		37,0	8,3		*-2,0*
$DS_{f\ GW}$	34,4	7,7		36,5	8,2		*-5,7*
Internal Flows							
Interception	746,1	167,5		980,3	220,1		*-23,9*
Surface Runoff	396,1	88,9		436,5	98,0		*-9,3*
Infiltration	2 243,1	503,6		2 214,5	497,2		*1,3*
Pot. GW Recharge	216,8	48,7		133,6	30,0		*62,3*
Baseflow	260,7	58,5		170,1	38,2		*53,3*
Irrigation	10,4	2,3		0,0	0,0		-

Table 32 – Water resource flow account with reference state for the uMngeni Catchment, for 2019-2020 (as volumes, depths and percentages)

uMngeni Catchment		Total			Reference		Difference
Area		(km²)	%		(km²)	%	
		4 454,1	*100,0*		4 454,1	*100,0*	
Water resource details 2019-2020	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**%**
Total In	4 120,5	925,1		3 996,7	897,3		*3,1*
Precipitation	3 996,7	897,3	*97,0*	3 996,7	897,3	*100,0*	*0,0*
Inflows	123,8	27,8	*3,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	123,8	27,8	*3,0*	0,0	0,0	*0,0*	-
Total Out	3 843,4	862,9		3 956,2	888,2		*-2,9*
Total Evaporation (ET)	3 171,5	712,0	*82,5*	3 385,1	760,0	*85,6*	*-6,3*
Landscape ET	3 111,0	698,5	*98,1*	3 385,1	760,0	*100,0*	*-8,1*
Incremental ET	60,5	13,6	*1,9*	0,0	0,0	*0,0*	-
Interception ET	801,3	179,9	*25,3*	1 062,0	238,4	*31,4*	*-24,5*
Transpiration ET	1 466,8	329,3	*46,2*	1 290,8	289,8	*38,1*	*13,6*
Soil Water ET	796,1	178,7	*25,1*	1 023,6	229,8	*30,2*	*-22,2*
Open Water ET	107,3	24,1	*3,4*	8,7	1,9	*0,3*	*1 137,9*
Outflows	671,9	150,8	*17,5*	571,2	128,2	*14,4*	*17,6*
$Q_{out\ SW}$	545,5	122,5	*14,2*	571,2	128,2	*14,4*	*-4,5*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	126,4	28,4	*3,3*	0,0	0,0	*0,0*	-
Total Change In Storage	-277,1	-62,2		-40,5	-9,1		*584,9*
$DS_{f\ SW}$	-244,9	-55,0		6,2	1,4		*-4 067,5*
$DS_{f\ SoilM}$	-29,7	-6,7		-41,9	-9,4		*-29,2*
$DS_{f\ GW}$	-2,6	-0,6		-4,7	-1,1		*-44,6*
Internal Flows							
Interception	795,9	178,7		1 055,7	237,0		*-24,6*
Surface Runoff	328,9	73,8		375,6	84,3		*-12,4*
Infiltration	2 605,2	584,9		2 563,9	575,6		*1,6*
Pot. GW Recharge	326,2	73,2		224,9	50,5		*45,0*
Baseflow	333,1	74,8		220,3	49,4		*51,2*
Irrigation	7,3	1,6		0,0	0,0		-

Table 33 – Water resource flow account with reference state for the uMngeni Catchment, for 2020-2021 (as volumes, depths and percentages)

uMngeni Catchment		Total			Reference		*Difference*
Area		(km²)	%		(km²)	%	
		4 454,1	*100,0*		4 454,1	*100,0*	
Water resource details 2020-2021	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**%**
Total In	4 647,2	1 043,4		4 550,7	1 021,7		*2,1*
Precipitation	4 550,7	1 021,7	*97,9*	4 550,7	1 021,7	*100,0*	*0,0*
Inflows	96,6	21,7	*2,1*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	96,6	21,7	*2,1*	0,0	0,0	*0,0*	-
Total Out	4 222,7	948,0		4 423,8	993,2		*-4,5*
Total Evaporation (ET)	3 366,6	755,8	*79,7*	3 652,4	820,0	*82,6*	*-7,8*
Landscape ET	3 311,0	743,4	*98,3*	3 652,4	820,0	*100,0*	*-9,3*
Incremental ET	55,6	12,5	*1,7*	0,0	0,0	*0,0*	-
Interception ET	762,7	171,2	*22,7*	998,2	224,1	*27,3*	*-23,6*
Transpiration ET	1 651,1	370,7	*49,0*	1 496,1	335,9	*41,0*	*10,4*
Soil Water ET	846,5	190,1	*25,1*	1 147,7	257,7	*31,4*	*-26,2*
Open Water ET	106,3	23,9	*3,2*	10,4	2,3	*0,3*	*919,9*
Outflows	856,1	192,2	*20,3*	771,4	173,2	*17,4*	*11,0*
$Q_{out\ SW}$	728,2	163,5	*17,2*	771,4	173,2	*17,4*	*-5,6*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	127,9	28,7	*3,0*	0,0	0,0	*0,0*	-
Total Change In Storage	-424,5	-95,3		-126,8	-28,5		*234,7*
$DS_{f\ SW}$	-310,4	-69,7		-6,6	-1,5		*4 588,2*
$DS_{f\ SoilM}$	-106,9	-24,0		-120,5	-27,1		*-11,3*
$DS_{f\ GW}$	-7,2	-1,6		0,3	0,1		*-2 492,7*
Internal Flows							
Interception	768,2	172,5		1 004,4	225,5		*-23,5*
Surface Runoff	481,3	108,1		542,9	121,9		*-11,3*
Infiltration	2 954,8	663,4		3 001,4	673,9		*-1,6*
Pot. GW Recharge	363,4	81,6		253,8	57,0		*43,2*
Baseflow	365,7	82,1		254,1	57,0		*44,0*
Irrigation	6,3	1,4		0,0	0,0		-

3.2.4 Water resource managed flow accounts

The water resource managed flow accounts, shown in Table 34 as annual volumes (Mm³) and Table 35 as normalised depths (mm), include information on the total water resource demand in terms of withdrawals, consumption and returns of water in the uMngeni Catchment and disaggregate this by the demands from cultivated and built-up areas, for each accounting period. The water resource flow accounts for the uMngeni Catchment (Section 3.2.1) provide a catchment scale overview of water resources, which is dominated by rainfall and evaporation over which we have little control. Managed flow accounts provide additional information on flows over which we have some control in the catchment – for example by promoting more efficient use, reducing losses between source and user, tariffs and user education.

A time series of flows over several consecutive years enables comparison between years. In the uMngeni Catchment, total demand was highest in 2018-2019, which was the year with the least precipitation. The withdrawals to supply urban or mining water requirements (which are the land uses in the built-up land cover class) were substantially more than withdrawals for cultivation. Water returns were relatively consistent over time. There was a small supply deficit in each of the six years. Most of this deficit was found to occur in quaternary catchment U20D (the Karkloof Catchment) (refer to associated spreadsheets). The validity of this deficit would need further investigation to confirm its accuracy, as this could possibly result from an underestimation of rainfall in this high rainfall catchment, or incorrect assumptions regarding the source of water for irrigation in this catchment (data gaps associated with managed flow accounts are discussed in Section 5.2).

Table 34 – Water resource managed flow accounts for the uMngeni Catchment, 2015-2021, for six accounting periods (as annual volumes in million cubic metres (Mm³))

uMngeni Catchment	Volume (Mm³)					
Area = 4 454,1 km²	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total Demand	129,4	130,4	128,8	132,6	127,5	121,7
Total Withdrawal	128,0	129,1	128,0	129,5	126,2	121,3
Cultivated	11,2	12,1	12,8	12,9	9,0	7,8
Built-up	116,7	117,0	115,2	116,6	117,2	113,4
Total Consumed	51,3	52,1	51,5	52,6	49,8	45,8
Cultivated	6,8	7,8	8,4	8,5	5,3	4,2
Built-up	44,4	44,3	43,1	44,1	44,5	41,6
Total Returned	63,2	63,6	63,1	63,4	63,6	63,4
Cultivated						
Built-up	63,2	63,6	63,1	63,4	63,6	63,4
Deficit	1,4	1,3	0,8	3,1	1,3	0,5

Table 35 – Water resource managed flow accounts for the uMngeni Catchment, 2015-2021, for six accounting periods (as normalised depths in millimetres (mm))

uMngeni Catchment	Depth (mm)					
Area = 4 454,1 km²	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total Demand	29,0	29,3	28,9	29,8	28,6	27,3
Total Withdrawal	28,7	29,0	28,7	29,1	28,3	27,2
Cultivated	2,5	2,7	2,9	2,9	2,0	1,8
Built-up	26,2	26,3	25,9	26,2	26,3	25,5
Total Consumed	11,5	11,7	11,6	11,8	11,2	10,3
Cultivated	1,5	1,8	1,9	1,9	1,2	0,9
Built-up	10,0	9,9	9,7	9,9	10,0	9,3
Total Returned	14,2	14,3	14,2	14,2	14,3	14,2
Cultivated						
Built-up	14,2	14,3	14,2	14,2	14,3	14,2
Deficit	0,3	0,3	0,2	0,7	0,3	0,1

3.3 Mooi Catchment sub-accounting area

The Mooi Catchment sub-accounting area was 2 868,5 km^2. In the Mooi Catchment, separate water resource flow accounts were compiled for the sub-accounting area as a whole and the nine quaternary catchments for six hydrological years from 2015-2016 to 2020-2021.

3.3.1 Water resource flow accounts

Water resource flow accounts provide flow information that is the basis for water balance graphs (showing a time series of catchment inflows and outflows). The water resource flow account as annual volumes (Mm^3) over the six hydrological years from October 2015 to September 2021 (Table 36) is shown as a time series graph of catchment total inflows (Total In) and total outflows (Total Out) for the Mooi Catchment sub-accounting area in Figure 14. They were also provided as normalised depths (mm) (Table 37) and shown as a time series graph in Figure 15.

These tables and graphs describe the total inflows of water to a catchment (in the form of precipitation, surface water inflows and inflowing inter-catchment transfers), the water consumption within a catchment (in the form of evaporation and transpiration), the total outflows of water from a catchment (in the form of surface water outflows and outflowing inter-catchment transfers) and changes in water storage within the catchment (surface water stores, soil moisture stores and groundwater stores). In Figure 14 and Figure 15, the difference in height between the Total In and Total Out bars in a hydrological year represents the change in water storage. If Total In is less than Total Out, then water storage in the catchment is being drawn down. If Total In is greater than Total Out, then water storage in the catchment is being replenished. The overall water balance, as illustrated in Figure 14 and Figure 15, was the smallest in 2019-2020 and the greatest in 2020-2021.

Precipitation (as one form of water inflow) into the Mooi Catchment sub-accounting area was the lowest in 2019-2020 with 548,3 mm per annum and the highest in 2020-2021 with 915,0 mm per annum. Inflows from surface water were zero at the level of the whole sub-accounting area as there are no upstream catchments and there were no inflows from inter-catchment transfers from other catchments into the Mooi Catchment sub-accounting area. Groundwater inflows were not shown due to a lack of information at this time.

Water leaves the catchment through evaporation (which includes transpiration) and outflows of surface water, groundwater and inter-catchment transfers. Total evaporation was the largest outflow. Total evaporation ranged from 522,4 mm per annum in 2019-2020 to 705,5 mm per annum in 2020-2021, matching the years of lowest precipitation and highest precipitation. While evaporation is generally high relative to precipitation, it is relatively more so in dry years. Total evaporation is broken down in Table 36 and Table 37 into evaporation of precipitated water from the landscape (Landscape ET) and evaporation of irrigated water (Incremental ET). Incremental evaporation is a useful measure of the portion of total evaporation over which there is some management control.

Outflows are the sum of surface water outflows, groundwater outflows (which are not measured in these accounts) and inter-catchment transfer outflows. Surface water outflows were the lowest in 2019-2020 (the year with the least precipitation) and the highest in 2015-2016 (the year with the third highest precipitation). Transfers out of the catchment were the lowest in 2019-2020 and the highest in 2018-2019 (a year with the second lowest precipitation in the Mooi Catchment but a year with the lowest precipitation in the uMngeni Catchment to which water was transferred i.e. a high demand for transfers). Of the exploitable water physically present in the surface water network and aquifers for potential abstraction and consumption, there are two variables that are useful to track: the portion that is reserved for outflow, and thus not available for use in the catchment (reserved outflow); and the portion that is unused flows that could be used for further development in the catchment (utilisable outflow). Reserved outflows could include inter-catchment transfers, supply to irrigation and urban users in other catchments and environmental flow requirements. The Mooi Catchment does not have any downstream catchments and environmental flows are not currently represented in these accounts; thus reserved outflow only includes that which was allocated to inter-catchment transfers. In this case, utilisable outflow was the same as the surface water outflows leaving the catchment.

The total change in water storage is the subtraction of inflows from outflows. When this value is positive, it means that inflows were less than outflows, and the water storage in the catchment is being drawn down. When the value is negative, it means that inflows were greater than outflows and there is replenishment of water being stored in the catchment. Water may be stored in surface waterbodies, the soil profile or as groundwater. In the Mooi Catchment, the total change in storage was greatest in 2020-2021 with -222,9 million m^3, meaning that the water being stored in the catchment increased. The only other year where there was a net gain in flows was in 2015-2016 with 77,1 million m^3. In the intervening years, change in storage showed positive values meaning that inflows were less than outflows and water stored in the Mooi Catchment was being drawn down.

These summaries provide a useful overview of the catchment water balance which can be examined in more detail for each of the nine quaternary catchments.

Figure 14 – Time series of catchment total inflows and total outflows for the Mooi Catchment, as volume in millions of cubic metres (Mm^3), 2015 to 2021

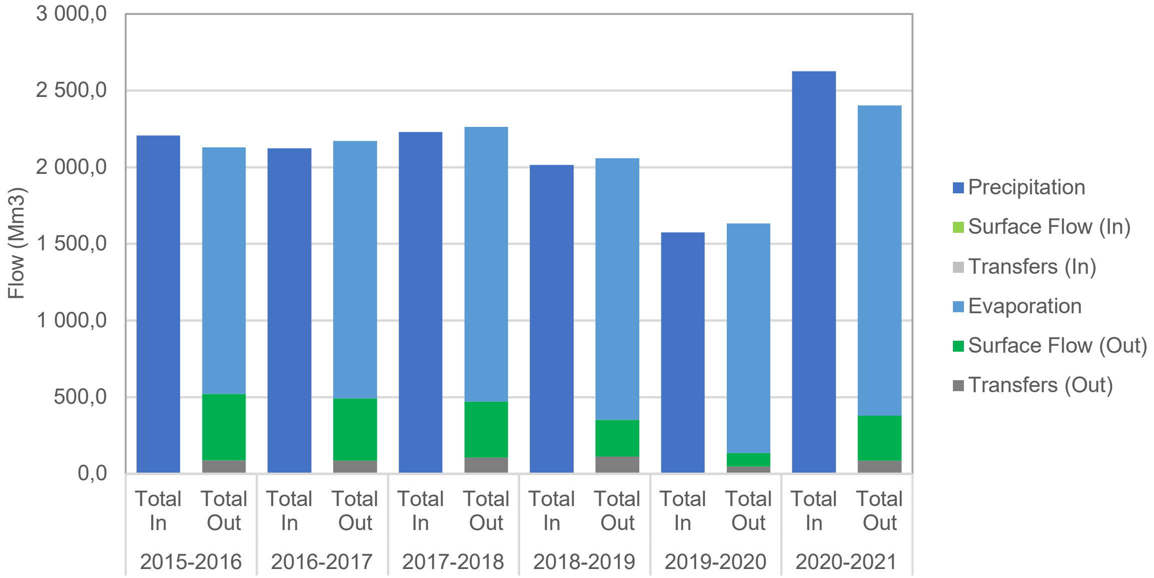


Figure 15 – Time series of catchment total inflows and total outflows for the Mooi Catchment, as normalised depths (mm), 2015 to 2021

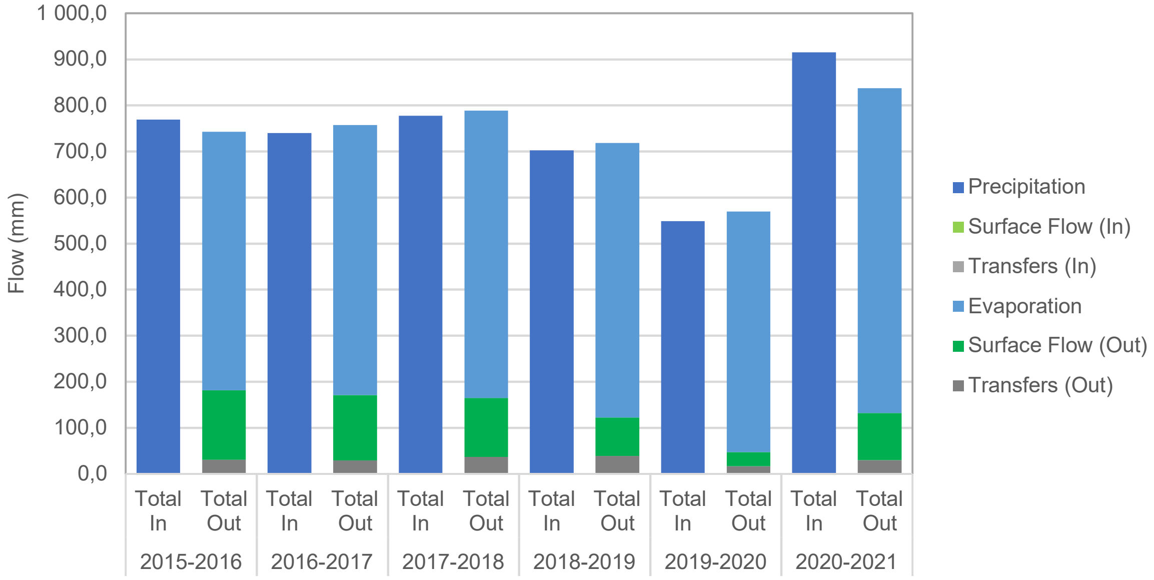


Table 36 – Water resource flow accounts for the Mooi Catchment, 2015-2021, for six accounting periods (as volume in millions of cubic metres (Mm³))

Mooi Catchment sub-accounting area (2 868,5 km²)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total In	2206,1	2122,3	2230,1	2013,4	1572,9	2624,7
Precipitation	2206,1	2122,3	2230,1	2013,4	1572,9	2624,7
Inflows	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ GW}$						
$Q_{in\ Transfers}$	0,0	0,0	0,0	0,0	0,0	0,0
Total Out	2129,0	2171,2	2261,9	2059,0	1632,8	2401,8
Total Evaporation (ET)	1609,2	1680,3	1790,8	1708,4	1498,6	2023,7
Landscape ET	1578,7	1655,2	1757,4	1676,0	1460,3	1996,5
Incremental ET	30,5	25,1	33,4	32,4	38,3	27,2
Outflows	519,8	490,9	471,1	350,6	134,2	378,1
$Q_{out\ SW}$	432,9	407,0	366,2	238,8	86,8	294,1
$Q_{out\ GW}$						
$Q_{out\ Transfers}$	86,9	83,9	104,9	111,8	47,4	84,0
Reserved outflows	86,9	83,9	104,9	111,8	47,4	84,0
Utilisable outflows	432,9	407,0	366,2	238,8	86,8	294,1
Total Change in Storage	-77,1	48,9	31,8	45,6	59,9	-222,9
$DS_{f\ SW}$	-9,0	-53,8	32,5	51,8	4,6	-101,8
$DS_{f\ SoilM}$	-25,9	55,0	-15,1	-8,9	27,4	-101,6
$DS_{f\ GW}$	-42,1	47,7	14,4	2,7	28,0	-19,5

Table 37 – Water resource flow account for the Mooi Catchment, 2015-2021, for six accounting periods (as depth in millimetres (mm))

Mooi Catchment sub-accounting area (2 868,5 km^2)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Total In	769,1	739,9	777,5	701,9	548,3	915,0
Precipitation	769,1	739,9	777,5	701,9	548,3	915,0
Inflows	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ SW}$	0,0	0,0	0,0	0,0	0,0	0,0
$Q_{in\ GW}$						
$Q_{in\ Transfers}$	0,0	0,0	0,0	0,0	0,0	0,0
Total Out	742,2	756,9	788,5	717,8	569,2	837,3
Total Evaporation (ET)	561,0	585,8	624,3	595,6	522,4	705,5
Landscape ET	550,4	577,0	612,7	584,3	509,1	696,0
Incremental ET	10,6	8,8	11,7	11,3	13,3	9,5
Outflows	181,2	171,1	164,2	122,2	46,8	131,8
$Q_{out\ SW}$	150,9	141,9	127,7	83,3	30,3	102,5
$Q_{out\ GW}$						
$Q_{out\ Transfers}$	30,3	29,2	36,6	39,0	16,5	29,3
Reserved outflows	30,3	29,2	36,6	39,0	16,5	29,3
Utilisable outflows	150,9	141,9	127,7	83,3	30,3	102,5
Total Change in Storage	-26,9	17,0	11,1	15,9	20,9	-77,7
$DS_{f\ SW}$	-3,1	-18,7	11,3	18,1	1,6	-35,5
$DS_{f\ SoilM}$	-9,0	19,2	-5,3	-3,1	9,5	-35,4
$DS_{f\ GW}$	-14,7	16,6	5,0	0,9	9,8	-6,8

3.3.2 Water resource flow accounts disaggregated by land cover

Changes in the extent of different land cover classes within a catchment, especially the extent of highly modified land cover, can affect both water quantity and quality. This section includes water resource flow accounts disaggregated by four broad land cover classes, namely natural or semi-natural, cultivated, built-up and waterbodies (refer to Section 2.3). Figure 16 shows the distribution of these broad land cover classes across the Mooi Catchment sub-accounting area and the land cover composition per quaternary catchment is provided in Appendix 1 (Table 53). The water resource flow accounts disaggregated by land cover were compiled per accounting period from 2015-2016 to 2020-2021, as provided in Table 38 to Table 43. The tables include detail on the extent of each broad land cover class in the Mooi Catchment sub-accounting area, a similar catchment water balance on the left-hand side to what is presented in Table 36 and Table 37, but provide more detail of the types of evaporation and also internal catchment flows such as surface runoff, infiltration and baseflow.

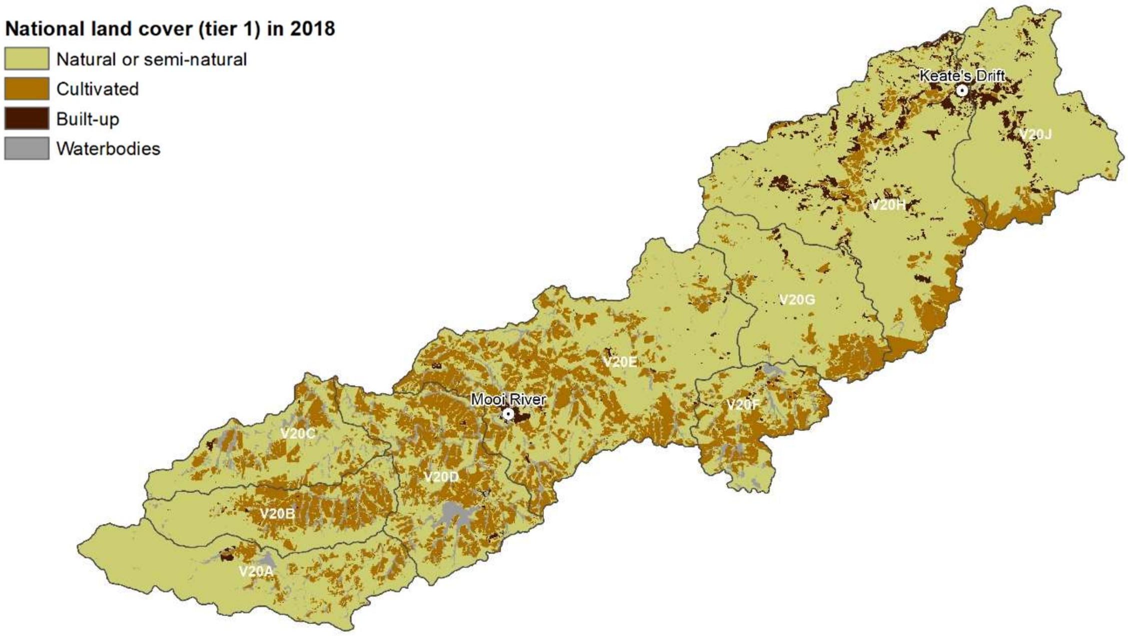
The Mooi Catchment was largely natural or semi-natural land cover (71,0%), followed by cultivated land (21,8%). The Mooi Catchment had the highest proportion of land that was waterbodies (4,1%) compared with the other sub-accounting areas and 3,1% was built-up areas.

The proportional extent of land cover classes can be compared to the proportional attribution of each of the water resource variables. For instance, in 2015-2016, natural or semi-natural land cover made up 71,0% of the Mooi Catchment and 71,9% of precipitation fell across these areas. Precipitation was generally proportional to area in the Mooi Catchment.

Evaporation, in contrast, was not proportional to area of land cover. Land cover (e.g. the types of plants, hard surfaces of built-up areas) influences evaporation. In the Mooi Catchment, total evaporation was proportionally higher in cultivated land (the proportion of cultivated land was 21,8% and the proportion of total evaporation on cultivated land was between 23,3% in 2020-2021 and 24,2% in 2018-2019). Land use and cover influence how water was made available for evaporation, and the main ways in which it was evaporated.

The water resource accounts disaggregated by land cover provide additional detail on these different types of evaporation, to provide further insights into the relationships between water resources and land cover. Firstly, in the same manner as in the water resource flow accounts, total evaporation is partitioned into evaporation of precipitated water from the landscape (Landscape ET) and evaporation of irrigated water (Incremental ET). This enables useful partition of what is evaporated largely from precipitation and largely from irrigated water (where the water that is being evaporated came from). Landscape evaporation was generally proportional to the area of natural or semi-natural land cover (varying from 71,5% in 2016-2017 to 72,9% in 2020-2021) and to the area that was cultivated land (varying from 22,2% in 2019-2020 to 23,1% in 2016-2017). Incremental evaporation only takes place in cultivated or built-up areas, with the majority evaporated from cultivated areas (varying from 89,3% in 2016-2017 to 93,0% in 2019-2020).

Figure 16 – Broad land cover classes in the Mooi Catchment sub-accounting area



Secondly, total evaporation of water that was either precipitated and/or irrigated (regardless of where it came from) is partitioned by how the water is evaporated: water that has been intercepted by vegetation and other surfaces and then evaporated (Interception ET); water transpired by vegetation (Transpiration ET); evaporation from the soil water store (Soil Water ET); and evaporation from open water surfaces (Open Water ET). Water intercepted by vegetation in the Mooi Catchment was proportionally greater in natural or semi-natural areas, varying from 81,9% (2015-2016) to 82,8% (2018-2019, 2019-2020), where there was more vegetation and vegetative material on the soil surface. Transpiration evaporation in the Mooi Catchment was lower in natural or semi-natural areas relative to its areal extent, varying from 64,6% (2015-2016) to 67,6% (2020-2021), and relatively higher in cultivated areas (from 28,1% in 2017-2018 to 30,0% in 2018-2019). Soil water evaporation was proportionally higher on cultivated land, varying from 22,5% (2020-2021) to 25,8% (2016-2017).

This type of account table expands on the water resource flow accounts to provide information on flows inside the catchment (internal flows), which provide more information about some of the impacts of land cover. The internal flows describe:

- **Where precipitated and irrigated water flows**, partitioning this into: the water that gets intercepted on plants and hard surfaces (and thus does not move into the soil or rivers and dams, it is typically lost as evaporation) (interception); the water that infiltrates into the soil where it replenishes the water in the soil matrix (infiltration)[11]; and water that runs off the surface into rivers, wetlands and dams (surface runoff).

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[11] Some of this infiltrated water may be lost as evaporation from the soil surface (Soil Water ET) and through transpiration by plants (Transpiration ET).

- **What happens to water that has infiltrated into the soil profile**: specifically, the portion of infiltrated water that percolates down the root zone where it might be available to recharge groundwater stores (potential groundwater recharge), a portion of which becomes baseflow.
- **Irrigation** is the amount of water applied as irrigation within the catchment. Just like rainfall, some of it is intercepted, infiltrates and if over-irrigating some of it might contribute to surface runoff and baseflow.

In the Mooi Catchment sub-accounting area, the total surface runoff varies from 33,5 mm in the year with the lowest precipitation (2019-2020) to 147,6 mm in 2015-2016. Across the broad land cover types, surface runoff was proportionally higher on built-up land (varying from 3,5% in 2016-2017 to 6,4% in 2019-2020), due to a larger proportion of hard impervious surfaces, and on waterbodies (varying from 10,4% in 2015-2016 to 27,9% in 2019-2020), due to open water surfaces and wetter soil profiles in wetlands. Total infiltration varies from 384,2 mm in the year with lowest precipitation (2019-2020) to 639,2 mm in the year with the highest precipitation (2020-2021). Across the broad land cover types, infiltration was proportionally equal on natural or semi-natural land cover and a little higher on cultivated land (varying from 26,0% in 2015-2016 to 27,7% in 2018-2019). Of the water that infiltrates, the amount that might recharge groundwater relative to the extent of the land cover type was proportionally a little higher in natural or semi-natural areas (varying from 65,5% in 2018-2019 to 78,8% in 2015-2016) and in cultivated areas (varying from 19,3% in 2015-2016 to 32,6% in 2018-2019). Cultivated land and built-up areas make a proportionally higher contribution to baseflow in the Mooi Catchment. Surface runoff, baseflow and groundwater recharge are components of the water balance that help to provide for domestic, industrial and agricultural requirements.

The amount of water irrigated in the Mooi Catchment varied between 23,2 million m^3 (8,1 mm) in 2016-2017 and 34,6 million m^3 (12,1 mm) in 2019-2020.

Table 38 – Water resource flow account disaggregated by land cover for the Mooi Catchment, for 2015-2016 (as volumes, depths and percentages)

Mooi Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		2 868,5	*100,0*		2 035,4	*71,0*		626,5	*21,8*		88,5	*3,1*		118,0	*4,1*
Water resource details 2015-2016	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	2 206,1	769,1													
Precipitation	2 206,1	769,1	*100,0*	1 585,5	552,7	*71,9*	467,0	162,8	*21,2*	67,1	23,4	*3,0*	86,4	30,1	*3,9*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	2 129,0	742,2													
Total Evaporation (ET)	1 609,2	561,0	*75,6*	1 130,2	394,0	*70,2*	384,0	133,9	*23,9*	29,0	10,1	*1,8*	66,0	23,0	*4,1*
Landscape ET	1 578,7	550,4	*98,1*	1 130,2	394,0	*71,6*	356,3	124,2	*22,6*	26,3	9,2	*1,7*	66,0	23,0	*4,2*
Incremental ET	30,5	10,6	*1,9*	0,0	0,0	*0,0*	27,7	9,7	*91,0*	2,7	1,0	*9,0*	0,0	0,0	*0,0*
Interception ET	355,3	123,9	*22,1*	291,2	101,5	*81,9*	55,4	19,3	*15,6*	5,1	1,8	*1,4*	3,7	1,3	*1,0*
Transpiration ET	541,8	188,9	*33,7*	350,2	122,1	*64,6*	162,0	56,5	*29,9*	9,1	3,2	*1,7*	20,5	7,1	*3,8*
Soil Water ET	671,9	234,2	*41,8*	488,9	170,4	*72,8*	160,5	56,0	*23,9*	13,8	4,8	*2,1*	8,7	3,0	*1,3*
Open Water ET	40,1	14,0	*2,5*	0,0	0,0	*0,0*	6,0	2,1	*15,0*	1,0	0,4	*2,6*	33,1	11,5	*82,4*
Outflows	519,8	181,2	*24,4*												
$Q_{out\ SW}$	432,9	150,9	*20,3*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	86,9	30,3	*4,1*												
Total Change In Storage	-77,1	-26,9		-49,9	-17,4		-13,9	-4,9		-22,5	-7,8		9,3	3,2	
$DS_{f\ SW}$	-9,0	-3,1		1,8	0,6		0,7	0,2		-21,5	-7,5		10,0	3,5	
$DS_{f\ SoilM}$	-25,9	-9,0		-18,3	-6,4		-7,4	-2,6		-0,1	0,0		-0,1	0,0	
$DS_{f\ GW}$	-42,1	-14,7		-33,4	-11,7		-7,2	-2,5		-0,9	-0,3		-0,6	-0,2	
Internal Flows															
Interception	352,6	122,9		289,3	100,9	*82,0*	54,7	19,1	*15,5*	5,0	1,7	*1,4*	3,7	1,3	*1,0*
Surface Runoff	423,5	147,6		291,9	101,7	*68,9*	72,2	25,2	*17,0*	15,7	5,5	*3,7*	43,8	15,3	*10,4*
Infiltration	1 406,4	490,3		1 004,3	350,1	*71,4*	365,9	127,6	*26,0*	26,6	9,3	*1,9*	9,5	3,3	*0,7*
Pot. GW Recharge	186,5	65,0		146,9	51,2	*78,8*	35,9	12,5	*19,3*	3,7	1,3	*2,0*			
Baseflow	144,8	50,5		96,9	33,8	*66,9*	38,1	13,3	*26,3*	7,5	2,6	*5,2*	2,4	0,8	*1,6*
Irrigation	25,7	9,0		0,0	0,0	*0,0*	25,7	9,0	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 39 – Water resource flow account disaggregated by land cover for the Mooi Catchment, for 2016-2017 (as volumes, depths and percentages)

Mooi Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km²)	%[1]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]
		2 868,5	*100,0*		2 035,4	*71,0*		626,5	*21,8*		88,5	*3,1*		118,0	*4,1*
Water resource details 2016-2017	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**
Total In	2 122,3	739,9													
Precipitation	2 122,3	739,9	*100,0*	1 505,6	524,9	*70,9*	466,1	162,5	*22,0*	57,2	19,9	*2,7*	93,3	32,5	*4,4*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	2 171,2	756,9													
Total Evaporation (ET)	1 680,3	585,8	*77,4*	1 184,0	412,8	*70,5*	405,3	141,3	*24,1*	28,5	9,9	*1,7*	62,4	21,8	*3,7*
Landscape ET	1 655,2	577,0	*98,5*	1 184,0	412,8	*71,5*	382,9	133,5	*23,1*	25,8	9,0	*1,6*	62,4	21,8	*3,8*
Incremental ET	25,1	8,8	*1,5*	0,0	0,0	*0,0*	22,4	7,8	*89,3*	2,7	0,9	*10,7*	0,0	0,0	*0,0*
Interception ET	386,8	134,8	*23,0*	319,8	111,5	*82,7*	57,6	20,1	*14,9*	5,5	1,9	*1,4*	3,9	1,4	*1,0*
Transpiration ET	604,2	210,6	*36,0*	402,3	140,3	*66,6*	175,4	61,1	*29,0*	9,4	3,3	*1,6*	17,0	5,9	*2,8*
Soil Water ET	646,8	225,5	*38,5*	461,9	161,0	*71,4*	166,9	58,2	*25,8*	12,6	4,4	*2,0*	5,4	1,9	*0,8*
Open Water ET	42,5	14,8	*2,5*	0,0	0,0	*0,0*	5,4	1,9	*12,8*	1,0	0,4	*2,4*	36,1	12,6	*84,8*
Outflows	490,9	171,1	*22,6*												
$Q_{out\ SW}$	407,0	141,9	*18,7*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	83,9	29,2	*3,9*												
Total Change In Storage	48,9	17,0		76,6	26,7		23,0	8,0		-16,0	-5,6		-34,6	-12,1	
$DS_{f\ SW}$	-53,8	-18,7		0,0	0,0		0,1	0,0		-18,0	-6,3		-36,0	-12,5	
$DS_{f\ SoilM}$	55,0	19,2		37,7	13,1		15,7	5,5		0,7	0,2		0,8	0,3	
$DS_{f\ GW}$	47,7	16,6		38,8	13,5		7,1	2,5		1,2	0,4		0,5	0,2	
Internal Flows															
Interception	386,8	134,8		319,8	111,5	*82,7*	57,6	20,1	*14,9*	5,5	1,9	*1,4*	3,9	1,4	*1,0*
Surface Runoff	312,4	108,9		200,8	70,0	*64,3*	47,9	16,7	*15,3*	10,8	3,8	*3,5*	52,9	18,5	*16,9*
Infiltration	1 397,4	487,2		985,0	343,4	*70,5*	383,9	133,8	*27,5*	24,7	8,6	*1,8*	3,8	1,3	*0,3*
Pot. GW Recharge	219,2	76,4		158,6	55,3	*72,3*	57,3	20,0	*26,1*	3,3	1,2	*1,5*			
Baseflow	267,3	93,2		186,7	65,1	*69,8*	65,0	22,7	*24,3*	10,7	3,7	*4,0*	4,9	1,7	*1,8*
Irrigation	23,2	8,1		0,0	0,0	*0,0*	23,2	8,1	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 40 – Water resource flow account disaggregated by land cover for the Mooi Catchment, for 2017-2018 (as volumes, depths and percentages)

Mooi Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		2 868,5	*100,0*		2 035,4	*71,0*		626,5	*21,8*		88,5	*3,1*		118,0	*4,1*
Water resource details 2017-2018	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	2 230,1	777,5													
Precipitation	2 230,1	777,5	*100,0*	1 594,4	555,8	*71,5*	479,1	167,0	*21,5*	66,6	23,2	*3,0*	89,9	31,4	*4,0*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	2 261,9	788,5													
Total Evaporation (ET)	1 790,8	624,3	*79,2*	1 269,2	442,5	*70,9*	427,3	149,0	*23,9*	31,6	11,0	*1,8*	62,8	21,9	*3,5*
Landscape ET	1 757,4	612,7	*98,1*	1 269,2	442,5	*72,2*	396,5	138,2	*22,6*	28,9	10,1	*1,6*	62,8	21,9	*3,6*
Incremental ET	33,4	11,7	*1,9*	0,0	0,0	*0,0*	30,8	10,7	*92,0*	2,7	0,9	*8,0*	0,0	0,0	*0,0*
Interception ET	396,9	138,4	*22,2*	327,4	114,1	*82,5*	60,2	21,0	*15,2*	5,5	1,9	*1,4*	3,8	1,3	*1,0*
Transpiration ET	667,1	232,6	*37,3*	450,2	156,9	*67,5*	187,5	65,4	*28,1*	11,5	4,0	*1,7*	17,9	6,2	*2,7*
Soil Water ET	683,8	238,4	*38,2*	491,6	171,4	*71,9*	172,2	60,0	*25,2*	13,5	4,7	*2,0*	6,4	2,2	*0,9*
Open Water ET	43,0	15,0	*2,4*	0,0	0,0	*0,0*	7,3	2,5	*16,9*	1,0	0,4	*2,4*	34,7	12,1	*80,7*
Outflows	471,1	164,2	*20,8*												
$Q_{out\ SW}$	366,2	127,7	*16,2*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	104,9	36,6	*4,6*												
Total Change In Storage	31,8	11,1		2,6	0,9		-4,3	-1,5		-21,0	-7,3		54,5	19,0	
$DS_{f\ SW}$	32,5	11,3		0,0	0,0		0,0	0,0		-21,3	-7,4		53,8	18,8	
$DS_{f\ SoilM}$	-15,1	-5,3		-7,7	-2,7		-7,7	-2,7		0,1	0,0		0,2	0,1	
$DS_{f\ GW}$	14,4	5,0		10,3	3,6		3,5	1,2		0,2	0,1		0,4	0,1	
Internal Flows															
Interception	396,9	138,4		327,4	114,1	*82,5*	60,2	21,0	*15,2*	5,5	1,9	*1,4*	3,8	1,3	*1,0*
Surface Runoff	308,8	107,7		205,2	71,5	*66,4*	42,0	14,6	*13,6*	13,2	4,6	*4,3*	48,5	16,9	*15,7*
Infiltration	1 505,0	524,7		1 061,9	370,2	*70,6*	407,9	142,2	*27,1*	28,4	9,9	*1,9*	6,8	2,4	*0,5*
Pot. GW Recharge	156,2	54,5		112,4	39,2	*71,9*	40,5	14,1	*25,9*	3,4	1,2	*2,2*			
Baseflow	171,1	59,6		114,4	39,9	*66,9*	45,2	15,7	*26,4*	8,4	2,9	*4,9*	3,1	1,1	*1,8*
Irrigation	31,0	10,8		0,0	0,0	*0,0*	31,0	10,8	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 41 – Water resource flow account disaggregated by land cover for the Mooi Catchment, for 2018-2019 (as volumes, depths and percentages)

Mooi Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		2 868,5	*100,0*		2 035,4	*71,0*		626,5	*21,8*		88,5	*3,1*		118,0	*4,1*
Water resource details 2018-2019	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	2 013,4	701,9													
Precipitation	2 013,4	701,9	*100,0*	1 426,0	497,1	*70,8*	443,7	154,7	*22,0*	60,1	21,0	*3,0*	83,6	29,1	*4,2*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	2 059,0	717,8													
Total Evaporation (ET)	1 708,4	595,6	*83,0*	1 202,6	419,2	*70,4*	413,1	144,0	*24,2*	30,5	10,6	*1,8*	62,2	21,7	*3,6*
Landscape ET	1 676,0	584,3	*98,1*	1 202,6	419,2	*71,8*	383,5	133,7	*22,9*	27,7	9,7	*1,7*	62,2	21,7	*3,7*
Incremental ET	32,4	11,3	*1,9*	0,0	0,0	*0,0*	29,6	10,3	*91,6*	2,7	1,0	*8,4*	0,0	0,0	*0,0*
Interception ET	407,1	141,9	*23,8*	337,2	117,5	*82,8*	60,8	21,2	*14,9*	5,4	1,9	*1,3*	3,8	1,3	*0,9*
Transpiration ET	608,4	212,1	*35,6*	395,5	137,9	*65,0*	182,8	63,7	*30,0*	10,8	3,8	*1,8*	19,3	6,7	*3,2*
Soil Water ET	655,4	228,5	*38,4*	469,9	163,8	*71,7*	162,8	56,8	*24,8*	13,3	4,6	*2,0*	9,4	3,3	*1,4*
Open Water ET	37,5	13,1	*2,2*	0,0	0,0	*0,0*	6,8	2,4	*18,0*	1,0	0,4	*2,7*	29,7	10,4	*79,2*
Outflows	350,6	122,2	*17,0*												
$Q_{out\ SW}$	238,8	83,3	*11,6*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	111,8	39,0	*5,4*												
Total Change In Storage	45,6	15,9		-8,9	-3,1		0,4	0,1		-19,5	-6,8		73,6	25,7	
$DS_{f\ SW}$	51,8	18,1		-2,2	-0,8		-0,7	-0,2		-19,1	-6,6		73,7	25,7	
$DS_{f\ SoilM}$	-8,9	-3,1		-10,8	-3,8		2,4	0,9		-0,6	-0,2		0,1	0,0	
$DS_{f\ GW}$	2,7	0,9		4,1	1,4		-1,4	-0,5		0,2	0,1		-0,2	-0,1	
Internal Flows															
Interception	410,1	143,0		339,4	118,3	*82,7*	61,5	21,4	*15,0*	5,5	1,9	*1,3*	3,8	1,3	*0,9*
Surface Runoff	224,1	78,1		141,0	49,2	*62,9*	33,4	11,7	*14,9*	10,8	3,8	*4,8*	38,9	13,6	*17,4*
Infiltration	1 361,6	474,7		945,6	329,6	*69,4*	377,7	131,7	*27,7*	26,6	9,3	*2,0*	11,7	4,1	*0,9*
Pot. GW Recharge	105,8	36,9		69,3	24,2	*65,5*	34,5	12,0	*32,6*	2,0	0,7	*1,9*			
Baseflow	109,0	38,0		61,9	21,6	*56,8*	38,5	13,4	*35,3*	6,4	2,2	*5,9*	2,2	0,8	*2,0*
Irrigation	28,8	10,1		0,0	0,0	*0,0*	28,8	10,1	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 42 – Water resource flow account disaggregated by land cover for the Mooi Catchment, for 2019-2020 (as volumes, depths and percentages)

Mooi Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]		(km^2)	%[2]
		2 868,5	*100,0*		2 035,4	*71,0*		626,5	*21,8*		88,5	*3,1*		118,0	*4,1*
Water resource details 2019-2020	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**
Total In	1 572,9	548,3													
Precipitation	1 572,9	548,3	*100,0*	1 132,5	394,8	*72,0*	331,9	115,7	*21,1*	44,8	15,6	*2,8*	63,7	22,2	*4,0*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	1 632,8	569,2													
Total Evaporation (ET)	1 498,6	522,4	*91,8*	1 058,0	368,8	*70,6*	359,8	125,4	*24,0*	27,7	9,7	*1,8*	53,1	18,5	*3,5*
Landscape ET	1 460,3	509,1	*97,4*	1 058,0	368,8	*72,4*	324,3	113,0	*22,2*	25,0	8,7	*1,7*	53,1	18,5	*3,6*
Incremental ET	38,3	13,3	*2,6*	0,0	0,0	*0,0*	35,6	12,4	*93,0*	2,7	0,9	*7,0*	0,0	0,0	*0,0*
Interception ET	377,7	131,7	*25,2*	312,6	109,0	*82,8*	56,5	19,7	*15,0*	5,2	1,8	*1,4*	3,4	1,2	*0,9*
Transpiration ET	501,6	174,9	*33,5*	329,9	115,0	*65,8*	143,8	50,1	*28,7*	9,3	3,3	*1,9*	18,6	6,5	*3,7*
Soil Water ET	588,7	205,2	*39,3*	415,4	144,8	*70,6*	151,5	52,8	*25,7*	12,2	4,2	*2,1*	9,6	3,4	*1,6*
Open Water ET	30,6	10,7	*2,0*	0,0	0,0	*0,0*	8,1	2,8	*26,5*	1,0	0,3	*3,2*	21,5	7,5	*70,3*
Outflows	134,2	46,8	*8,2*												
$Q_{out\ SW}$	86,8	30,3	*5,3*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	47,4	16,5	*2,9*												
Total Change In Storage	59,9	20,9		37,9	13,2		16,0	5,6		-12,7	-4,4		18,8	6,5	
$DS_{f\ SW}$	4,6	1,6		1,4	0,5		0,4	0,1		-13,7	-4,8		16,4	5,7	
$DS_{f\ SoilM}$	27,4	9,5		17,7	6,2		7,7	2,7		0,5	0,2		1,4	0,5	
$DS_{f\ GW}$	28,0	9,8		18,7	6,5		7,9	2,8		0,4	0,2		0,9	0,3	
Internal Flows															
Interception	375,8	131,0		311,2	108,5	*82,8*	56,0	19,5	*14,9*	5,2	1,8	*1,4*	3,4	1,2	*0,9*
Surface Runoff	96,2	33,5		53,5	18,6	*55,6*	9,7	3,4	*10,1*	6,1	2,1	*6,4*	26,8	9,4	*27,9*
Infiltration	1 102,1	384,2		767,8	267,7	*69,7*	300,8	104,9	*27,3*	21,5	7,5	*1,9*	12,0	4,2	*1,1*
Pot. GW Recharge	53,9	18,8		40,2	14,0	*74,6*	13,2	4,6	*24,5*	0,5	0,2	*0,9*			
Baseflow	82,3	28,7		51,5	17,9	*62,5*	24,9	8,7	*30,2*	4,3	1,5	*5,3*	1,6	0,6	*2,0*
Irrigation	34,6	12,1		0,0	0,0	*0,0*	34,6	12,1	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 43 – Water resource flow account disaggregated by land cover for the Mooi Catchment, for 2020-2021 (as volumes, depths and percentages)

Mooi Catchment	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies		
Area		(km²)	%[1]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]		(km²)	%[2]
		2 868,5	*100,0*		2 035,4	*71,0*		626,5	*21,8*		88,5	*3,1*		118,0	*4,1*
Water resource details 2020-2021	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**	**Volume (Mm³)**	**Depth (mm)**	**%**
Total In	2 624,7	915,0													
Precipitation	2 624,7	915,0	*100,0*	1 866,5	650,7	*71,1*	572,4	199,5	*21,8*	75,9	26,4	*2,9*	110,0	38,4	*4,2*
Inflows	0,0	0,0	*0,0*												
$Q_{in\ SW}$	0,0	0,0	*0,0*												
$Q_{in\ GW}$															
$Q_{in\ Transfers}$	0,0	0,0	*0,0*												
Total Out	2 401,8	837,3													
Total Evaporation (ET)	2 023,7	705,5	*84,3*	1 455,3	507,3	*71,9*	471,6	164,4	*23,3*	35,7	12,5	*1,8*	61,1	21,3	*3,0*
Landscape ET	1 996,5	696,0	*98,7*	1 455,3	507,3	*72,9*	446,9	155,8	*22,4*	33,3	11,6	*1,7*	61,1	21,3	*3,1*
Incremental ET	27,2	9,5	*1,3*	0,0	0,0	*0,0*	24,7	8,6	*90,9*	2,5	0,9	*9,1*	0,0	0,0	*0,0*
Interception ET	408,7	142,5	*20,2*	335,1	116,8	*82,0*	63,7	22,2	*15,6*	5,7	2,0	*1,4*	4,2	1,5	*1,0*
Transpiration ET	786,2	274,1	*38,8*	531,2	185,2	*67,6*	224,3	78,2	*28,5*	13,0	4,5	*1,7*	17,7	6,2	*2,3*
Soil Water ET	791,8	276,0	*39,1*	589,0	205,3	*74,4*	177,8	62,0	*22,5*	16,0	5,6	*2,0*	9,0	3,1	*1,1*
Open Water ET	37,0	12,9	*1,8*	0,0	0,0	*0,0*	5,9	2,0	*15,9*	1,0	0,3	*2,6*	30,2	10,5	*81,5*
Outflows	378,1	131,8	*15,7*												
$Q_{out\ SW}$	294,1	102,5	*12,2*												
$Q_{out\ GW}$															
$Q_{out\ Transfers}$	84,0	29,3	*3,5*												
Total Change In Storage	-222,9	-77,7		-81,4	-28,4		-36,9	-12,8		-26,1	-9,1		-78,6	-27,4	
$DS_{f\ SW}$	-101,8	-35,5		-1,4	-0,5		-0,5	-0,2		-24,4	-8,5		-75,4	-26,3	
$DS_{f\ SoilM}$	-101,6	-35,4		-67,4	-23,5		-30,3	-10,6		-1,4	-0,5		-2,4	-0,8	
$DS_{f\ GW}$	-19,5	-6,8		-12,5	-4,4		-6,0	-2,1		-0,3	-0,1		-0,7	-0,3	
Internal Flows															
Interception	410,6	143,2		336,5	117,3	*81,9*	64,2	22,4	*15,6*	5,7	2,0	*1,4*	4,3	1,5	*1,0*
Surface Runoff	344,4	120,1		220,8	77,0	*64,1*	52,2	18,2	*15,2*	14,2	4,9	*4,1*	57,3	20,0	*16,6*
Infiltration	1 833,6	639,2		1 309,2	456,4	*71,4*	481,0	167,7	*26,2*	33,1	11,5	*1,8*	10,2	3,6	*0,6*
Pot. GW Recharge	172,9	60,3		121,6	42,4	*70,3*	48,7	17,0	*28,1*	2,6	0,9	*1,5*			
Baseflow	153,8	53,6		103,8	36,2	*67,5*	40,7	14,2	*26,5*	5,6	1,9	*3,6*	3,6	1,3	*2,4*
Irrigation	25,1	8,7		0,0	0,0	*0,0*	25,1	8,7	*100,0*				0,0	0,0	*0,0*

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

3.3.3 Water resource flow account with reference states

Water resource flow account with reference states refers to water resource flow accounts compiled for a scenario where the sub-accounting area is fully covered by natural or semi-natural land cover and contains no built water infrastructure, such as dams or inter-catchment transfers (i.e. a reference state prior to land cover change with associated infrastructure). These accounts provide a baseline against which impacts of actual land cover and water management on water resources can be further explored.

These accounts therefore provide the water resource flow accounts per accounting period for the Mooi Catchment sub-accounting area with (i) **actual** land cover in 2018 and water infrastructure, (ii) with **reference state** and (iii) the percentage **difference** between these, as presented in Table 44 to Table 49. The water resource flow accounts for actual are the same as in Table 38 to Table 43, repeated here to support comparison with the reference state.

The climatic conditions are actual climate conditions modelled per accounting period, so as to compare water resources under actual land cover conditions with water resources as they would be if the Mooi Catchment were not developed. In other words, this is exploring the impact of land cover change, not climate change which would require modelling climate conditions at a historical point in time. This is why precipitation is the same across actual and reference land cover conditions.

The difference between the water variables under actual and reference scenarios is calculated as the reference value subtracted from the actual value and divided by the reference value. This should be compared in absolute terms and in terms of the direction of the difference and the quantum of the difference. A difference that is a positive value, means that the actual conditions are greater than the reference state in absolute terms (and vice versa).

Total evaporation under actual conditions was largely the same as it would be under the reference state, with the difference ranging from -1,1% (2020-2021) to 1,5% (2019-2020). As in the Breede Catchment and the uMngeni Catchment, evaporation of water intercepted by vegetation and other surfaces (Interception ET) had a consistently negative difference, meaning that there was less of this type of evaporation under actual conditions than there would be in a reference state (varying from -15,6% in 2018-2019 to -13,9% in 2015-2016). Also, similarly to the Breede Catchment and the uMngeni Catchment, open water evaporation was always positive, because there would be no dams in the catchments under the reference state. Water transpired by vegetation (Transpiration ET) was mostly greater under actual conditions than it would be under the reference state positive for all years except 2017-2018 (-0,1%)) and soil water evaporation was greater than it would be under the reference state (varying from 1,7% more in 2020-2021 to 7,5% more in 2019-2020). Surface water outflows in the Mooi Catchment were consistently lower under actual conditions than under the reference state, with the difference varying from -43,2% in 2019-2020 to -17,9% in 2017-2018. This was the same in the Breede Catchment and the uMngeni Catchment, because under the reference state, there would be more water flowing out the catchment as there would be no dams to store water flows.

In terms of flows of water inside the catchment, interception was lower under actual conditions (varying from -15,5% in 2018-2019 to -13,9% in 2015-2016), surface water runoff was lower under actual conditions (varying from -4,3% in 2016-2017 to -1,8% in 2015-2016) and infiltration was greater under actual conditions (varying from 2,9% more in 2020-2021 to 6,9% more in 2019-2020). In other words, under actual conditions there was less interception, less surface water runoff and slightly more infiltration. Of the water that infiltrates, it was under actual conditions that there was more potential groundwater recharge (from 1,0% more in 2015-2016 to 28,3% more in 2019-2020) and more baseflow (from 4,1% more in 2015-2016 to 18,6% more in 2018-2019).

Table 44 – Water resource flow account with reference state for the Mooi Catchment, for 2015-2016 (as volumes, depths and percentages)

Mooi Catchment		Total			Reference		*Difference*
Area		(km^2)	%		(km^2)	%	
		2 868,5	*100,0*		2 868,5	*100,0*	
Water resource details 2015-2016	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	2 206,1	769,1		2 206,1	769,1		*0,0*
Precipitation	2 206,1	769,1	*100,0*	2 206,1	769,1	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	2 129,0	742,2		2 137,4	745,1		*-0,4*
Total Evaporation (ET)	1 609,2	561,0	*75,6*	1 590,0	554,3	*74,4*	*1,2*
Landscape ET	1 578,7	550,4	*98,1*	1 590,0	554,3	*100,0*	*-0,7*
Incremental ET	30,5	10,6	*1,9*	0,0	0,0	*0,0*	-
Interception ET	355,3	123,9	*22,1*	412,5	143,8	*25,9*	*-13,9*
Transpiration ET	541,8	188,9	*33,7*	523,0	182,3	*32,9*	*3,6*
Soil Water ET	671,9	234,2	*41,8*	651,4	227,1	*41,0*	*3,2*
Open Water ET	40,1	14,0	*2,5*	3,2	1,1	*0,2*	*1 149,3*
Outflows	519,8	181,2	*24,4*	547,4	190,8	*25,6*	*-5,0*
$Q_{out\ SW}$	432,9	150,9	*20,3*	547,4	190,8	*25,6*	*-20,9*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	86,9	30,3	*4,1*	0,0	0,0	*0,0*	-
Total Change In Storage	-77,1	-26,9		-68,7	-23,9		*12,2*
$DS_{f\ SW}$	-9,0	-3,1		2,8	1,0		*-423,3*
$DS_{f\ SoilM}$	-25,9	-9,0		-25,8	-9,0		*0,4*
$DS_{f\ GW}$	-42,1	-14,7		-45,6	-15,9		*-7,7*
Internal Flows							
Interception	352,6	122,9		409,7	142,8		*-13,9*
Surface Runoff	423,5	147,6		431,3	150,3		*-1,8*
Infiltration	1 406,4	490,3		1 364,2	475,6		*3,1*
Pot. GW Recharge	186,5	65,0		184,7	64,4		*1,0*
Baseflow	144,8	50,5		139,1	48,5		*4,1*
Irrigation	25,7	9,0		0,0	0,0		-

Table 45 – Water resource flow account with reference state for the Mooi Catchment, for 2016-2017 (as volumes, depths and percentages)

Mooi Catchment		Total			Reference		*Difference*
Area		(km^2)	%		(km^2)	%	
		2 868,5	*100,0*		2 868,5	*100,0*	
Water resource details 2016-2017	**Volume (Mm^3)**	**Depth (mm)**	*%*	**Volume (Mm^3)**	**Depth (mm)**	*%*	*%*
Total In	2 122,3	739,9		2 122,3	739,9		*0,0*
Precipitation	2 122,3	739,9	*100,0*	2 122,3	739,9	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	2 171,2	756,9		2 228,5	776,9		*-2,6*
Total Evaporation (ET)	1 680,3	585,8	*77,4*	1 677,8	584,9	*75,3*	*0,1*
Landscape ET	1 655,2	577,0	*98,5*	1 677,8	584,9	*100,0*	*-1,4*
Incremental ET	25,1	8,8	*1,5*	0,0	0,0	*0,0*	-
Interception ET	386,8	134,8	*23,0*	454,9	158,6	*27,1*	*-15,0*
Transpiration ET	604,2	210,6	*36,0*	603,1	210,3	*35,9*	*0,2*
Soil Water ET	646,8	225,5	*38,5*	615,6	214,6	*36,7*	*5,1*
Open Water ET	42,5	14,8	*2,5*	4,2	1,5	*0,3*	*911,9*
Outflows	490,9	171,1	*22,6*	550,6	192,0	*24,7*	*-10,9*
$Q_{out\ SW}$	407,0	141,9	*18,7*	550,6	192,0	*24,7*	*-26,1*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	83,9	29,2	*3,9*	0,0	0,0	*0,0*	-
Total Change In Storage	48,9	17,0		106,2	37,0		*-54,0*
$DS_{f\ SW}$	-53,8	-18,7		0,2	0,1		*-28 975,3*
$DS_{f\ SoilM}$	55,0	19,2		54,2	18,9		*1,5*
$DS_{f\ GW}$	47,7	16,6		51,9	18,1		*-8,0*
Internal Flows							
Interception	386,8	134,8		454,9	158,6		*-15,0*
Surface Runoff	312,4	108,9		326,3	113,8		*-4,3*
Infiltration	1 397,4	487,2		1 340,1	467,2		*4,3*
Pot. GW Recharge	219,2	76,4		193,7	67,5		*13,1*
Baseflow	267,3	93,2		245,6	85,6		*8,9*
Irrigation	23,2	8,1		0,0	0,0		-

Table 46 – Water resource flow account with reference state for the Mooi Catchment, for 2017-2018 (as volumes, depths and percentages)

Mooi Catchment	Total			Reference			*Difference*
Area		(km^2)	%		(km^2)	%	
		2 868,5	*100,0*		2 868,5	*100,0*	
Water resource details 2017-2018	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	2 230,1	777,5		2 230,1	777,5		*0,0*
Precipitation	2 230,1	777,5	*100,0*	2 230,1	777,5	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	2 261,9	788,5		2 238,9	780,5		*1,0*
Total Evaporation (ET)	1 790,8	624,3	*79,2*	1 793,0	625,1	*80,1*	*-0,1*
Landscape ET	1 757,4	612,7	*98,1*	1 793,0	625,1	*100,0*	*-2,0*
Incremental ET	33,4	11,7	*1,9*	0,0	0,0	*0,0*	-
Interception ET	396,9	138,4	*22,2*	467,3	162,9	*26,1*	*-15,1*
Transpiration ET	667,1	232,6	*37,3*	668,1	232,9	*37,3*	*-0,1*
Soil Water ET	683,8	238,4	*38,2*	654,2	228,1	*36,5*	*4,5*
Open Water ET	43,0	15,0	*2,4*	3,5	1,2	*0,2*	*1 144,1*
Outflows	471,1	164,2	*20,8*	445,8	155,4	*19,9*	*5,7*
$Q_{out\ SW}$	366,2	127,7	*16,2*	445,8	155,4	*19,9*	*-17,9*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	104,9	36,6	*4,6*	0,0	0,0	*0,0*	-
Total Change In Storage	31,8	11,1		8,8	3,1		*261,7*
$DS_{f\ SW}$	32,5	11,3		-0,1	0,0		*-26 611,1*
$DS_{f\ SoilM}$	-15,1	-5,3		-9,4	-3,3		*61,8*
$DS_{f\ GW}$	14,4	5,0		18,3	6,4		*-21,3*
Internal Flows							
Interception	396,9	138,4		467,3	162,9		*-15,1*
Surface Runoff	308,8	107,7		321,0	111,9		*-3,8*
Infiltration	1 505,0	524,7		1 440,9	502,3		*4,5*
Pot. GW Recharge	156,2	54,5		126,8	44,2		*23,2*
Baseflow	171,1	59,6		145,0	50,6		*17,9*
Irrigation	31,0	10,8		0,0	0,0		-

Table 47 – Water resource flow account with reference state for the Mooi Catchment, for 2018-2019 (as volumes, depths and percentages)

Mooi Catchment		Total			Reference		*Difference*
Area		(km^2)	*%*		(km^2)	*%*	
		2 868,5	*100,0*		2 868,5	*100,0*	
Water resource details 2018-2019	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	2 013,4	701,9		2 013,4	701,9		*0,0*
Precipitation	2 013,4	701,9	*100,0*	2 013,4	701,9	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	2 059,0	717,8		1 996,6	696,1		*3,1*
Total Evaporation (ET)	1 708,4	595,6	*83,0*	1 693,4	590,3	*84,8*	*0,9*
Landscape ET	1 676,0	584,3	*98,1*	1 693,4	590,3	*100,0*	*-1,0*
Incremental ET	32,4	11,3	*1,9*	0,0	0,0	*0,0*	-
Interception ET	407,1	141,9	*23,8*	482,2	168,1	*28,5*	*-15,6*
Transpiration ET	608,4	212,1	*35,6*	587,5	204,8	*34,7*	*3,5*
Soil Water ET	655,4	228,5	*38,4*	620,8	216,4	*36,7*	*5,6*
Open Water ET	37,5	13,1	*2,2*	2,8	1,0	*0,2*	*1 228,6*
Outflows	350,6	122,2	*17,0*	303,2	105,7	*15,2*	*15,6*
$Q_{out\ SW}$	238,8	83,3	*11,6*	303,2	105,7	*15,2*	*-21,2*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	111,8	39,0	*5,4*	0,0	0,0	*0,0*	-
Total Change In Storage	45,6	15,9		-16,8	-5,9		*-371,7*
$DS_{f\ SW}$	51,8	18,1		-3,3	-1,1		*-1 670,6*
$DS_{f\ SoilM}$	-8,9	-3,1		-14,7	-5,1		*-39,9*
$DS_{f\ GW}$	2,7	0,9		1,2	0,4		*121,8*
Internal Flows							
Interception	410,1	143,0		485,4	169,2		*-15,5*
Surface Runoff	224,1	78,1		231,4	80,7		*-3,2*
Infiltration	1 361,6	474,7		1 295,7	451,7		*5,1*
Pot. GW Recharge	105,8	36,9		90,7	31,6		*16,7*
Baseflow	109,0	38,0		91,9	32,0		*18,6*
Irrigation	28,8	10,1		0,0	0,0		-

Table 48 – Water resource flow account with reference state for the Mooi Catchment, for 2019-2020 (as volumes, depths and percentages)

Mooi Catchment		Total			Reference		*Difference*
Area		(km^2)	%		(km^2)	%	
		2 868,5	*100,0*		2 868,5	*100,0*	
Water resource details 2019-2020	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	1 572,9	548,3		1 572,9	548,3		*0,0*
Precipitation	1 572,9	548,3	*100,0*	1 572,9	548,3	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	1 632,8	569,2		1 629,5	568,1		*0,2*
Total Evaporation (ET)	1 498,6	522,4	*91,8*	1 476,8	514,8	*90,6*	*1,5*
Landscape ET	1 460,3	509,1	*97,4*	1 476,8	514,8	*100,0*	*-1,1*
Incremental ET	38,3	13,3	*2,6*	0,0	0,0	*0,0*	-
Interception ET	377,7	131,7	*25,2*	444,7	155,0	*30,1*	*-15,0*
Transpiration ET	501,6	174,9	*33,5*	482,2	168,1	*32,7*	*4,0*
Soil Water ET	588,7	205,2	*39,3*	547,7	191,0	*37,1*	*7,5*
Open Water ET	30,6	10,7	*2,0*	2,2	0,8	*0,1*	*1 291,2*
Outflows	134,2	46,8	*8,2*	152,7	53,2	*9,4*	*-12,1*
$Q_{out\ SW}$	86,8	30,3	*5,3*	152,7	53,2	*9,4*	*-43,2*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	47,4	16,5	*2,9*	0,0	0,0	*0,0*	-
Total Change In Storage	59,9	20,9		56,6	19,7		*5,9*
$DS_{f\ SW}$	4,6	1,6		2,3	0,8		*97,7*
$DS_{f\ SoilM}$	27,4	9,5		24,9	8,7		*9,9*
$DS_{f\ GW}$	28,0	9,8		29,4	10,2		*-4,8*
Internal Flows							
Interception	375,8	131,0		442,5	154,3		*-15,1*
Surface Runoff	96,2	33,5		99,0	34,5		*-2,9*
Infiltration	1 102,1	384,2		1 030,7	359,3		*6,9*
Pot. GW Recharge	53,9	18,8		42,0	14,7		*28,3*
Baseflow	82,3	28,7		71,4	24,9		*15,3*
Irrigation	34,6	12,1		0,0	0,0		-

Table 49 – Water resource flow account with reference state for the Mooi Catchment, for 2020-2021 (as volumes, depths and percentages)

Mooi Catchment		Total			Reference		Difference
Area		(km^2)	%		(km^2)	%	
		2 868,5	*100,0*		2 868,5	*100,0*	
Water resource details 2020-2021	**Volume (Mm^3)**	**Depth (mm)**	**%**	**Volume (Mm^3)**	**Depth (mm)**	**%**	**%**
Total In	2 624,7	915,0		2 624,7	915,0		*0,0*
Precipitation	2 624,7	915,0	*100,0*	2 624,7	915,0	*100,0*	*0,0*
Inflows	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ SW}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
$Q_{in\ GW}$							
$Q_{in\ Transfers}$	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Total Out	2 401,8	837,3		2 514,1	876,5		*-4,5*
Total Evaporation (ET)	2 023,7	705,5	*84,3*	2 046,1	713,3	*81,4*	*-1,1*
Landscape ET	1 996,5	696,0	*98,7*	2 046,1	713,3	*100,0*	*-2,4*
Incremental ET	27,2	9,5	*1,3*	0,0	0,0	*0,0*	-
Interception ET	408,7	142,5	*20,2*	479,3	167,1	*23,4*	*-14,7*
Transpiration ET	786,2	274,1	*38,8*	784,6	273,5	*38,3*	*0,2*
Soil Water ET	791,8	276,0	*39,1*	778,3	271,3	*38,0*	*1,7*
Open Water ET	37,0	12,9	*1,8*	4,0	1,4	*0,2*	*822,9*
Outflows	378,1	131,8	*15,7*	468,0	163,2	*18,6*	*-19,2*
$Q_{out\ SW}$	294,1	102,5	*12,2*	468,0	163,2	*18,6*	*-37,2*
$Q_{out\ GW}$							
$Q_{out\ Transfers}$	84,0	29,3	*3,5*	0,0	0,0	*0,0*	-
Total Change In Storage	-222,9	-77,7		-110,6	-38,6		*101,5*
$DS_{f\ SW}$	-101,8	-35,5		-3,5	-1,2		*2 802,0*
$DS_{f\ SoilM}$	-101,6	-35,4		-95,0	-33,1		*6,9*
$DS_{f\ GW}$	-19,5	-6,8		-12,1	-4,2		*61,6*
Internal Flows							
Interception	410,6	143,2		481,4	167,8		*-14,7*
Surface Runoff	344,4	120,1		359,5	125,3		*-4,2*
Infiltration	1 833,6	639,2		1 782,7	621,5		*2,9*
Pot. GW Recharge	172,9	60,3		143,6	50,1		*20,3*
Baseflow	153,8	53,6		131,5	45,9		*16,9*
Irrigation	25,1	8,7		0,0	0,0		-

4 KEY FINDINGS ACROSS ALL AREAS

This section presents key findings from the water resource accounts for all sub-accounting areas at the level of the quaternary catchment. As described in Section 1.4, accounts were compiled for each of the sub-accounting areas as a whole, and for each of the 56 quaternary catchments in the Breede Catchment sub-accounting area, 12 quaternary catchments in the uMngeni Catchment sub-accounting area, and 9 quaternary catchments in the Mooi Catchment sub-accounting area.

The purpose of this section is to provide greater insight into variability within and between the sub-accounting areas. Additionally, while all the accounts were compiled for all quaternary catchments and are available in spreadsheets on the Stats SA website, this section presents information on selected indicators that were considered useful for water resource management. While indicators are useful for exploring and understanding elements of water resources, especially as they can be visualised in a spatially explicit manner, it is also important to note that they can be easily misinterpreted when viewed in isolation. A wide range of further findings and analyses are possible based on the underlying account tables, and users are encouraged to access the associated spreadsheets.

Note that in the tables, '0' signifies a zero value or a negligible value when rounded off, a blank cell indicates a case where no values could be calculated for these accounts, and a dash indicates values that could not be calculated (such as due to division by zero).

4.1 What does the water balance tell us about natural variability?

Precipitation and total evaporation are the two predominant internal components of a catchment water balance. The ratio of total evaporation to precipitation, referred to as the **evaporation ratio**, provides an indication of the portion of precipitation within a catchment that is “lost” to evaporation and thus unavailable for other use. A higher ratio indicates catchments where evaporation has depleted a greater proportion of the internally generated water from precipitation, and vice versa. At a catchment scale, the opportunities to reduce evaporation losses are limited, but certain cultivation practices for instance can help reduce evaporation.

The evaporation ratio per quaternary catchment was calculated per accounting period, and then averaged across all years for the purposes of mapping the indicator and analysis of spatial variation rather than temporal variation. Table 54 in Appendix 2 provides the values per quaternary catchment, including the coefficient of variation, and Figure 17 shows the average evaporation ratio per quaternary catchment for all three sub-accounting areas.

The average evaporation ratio across all sub-accounting areas ranges from 48,3% to 155,5%[12]. The Breede Catchment (the largest sub-accounting area) had the widest range in evaporation ratio, and the Mooi Catchment (the smallest sub-accounting area) had the narrowest range. Spatial variation of the average evaporation ratio shown in Figure 17, shows the variation in the average evaporation ratios across the three sub-accounting areas. In the Breede Catchment, the quaternary catchments with lower average evaporation ratios were in the upper parts of the catchment, and the quaternary catchments with the higher evaporation ratios were in the central parts of the catchment. In the uMngeni Catchment and the Mooi Catchment, the evaporation ratio was higher in the upper parts of the catchment. Where the evaporation ratio is high, interventions (such as certain cultivation practices) may help to reduce evaporation losses and make a difference to water balance locally.

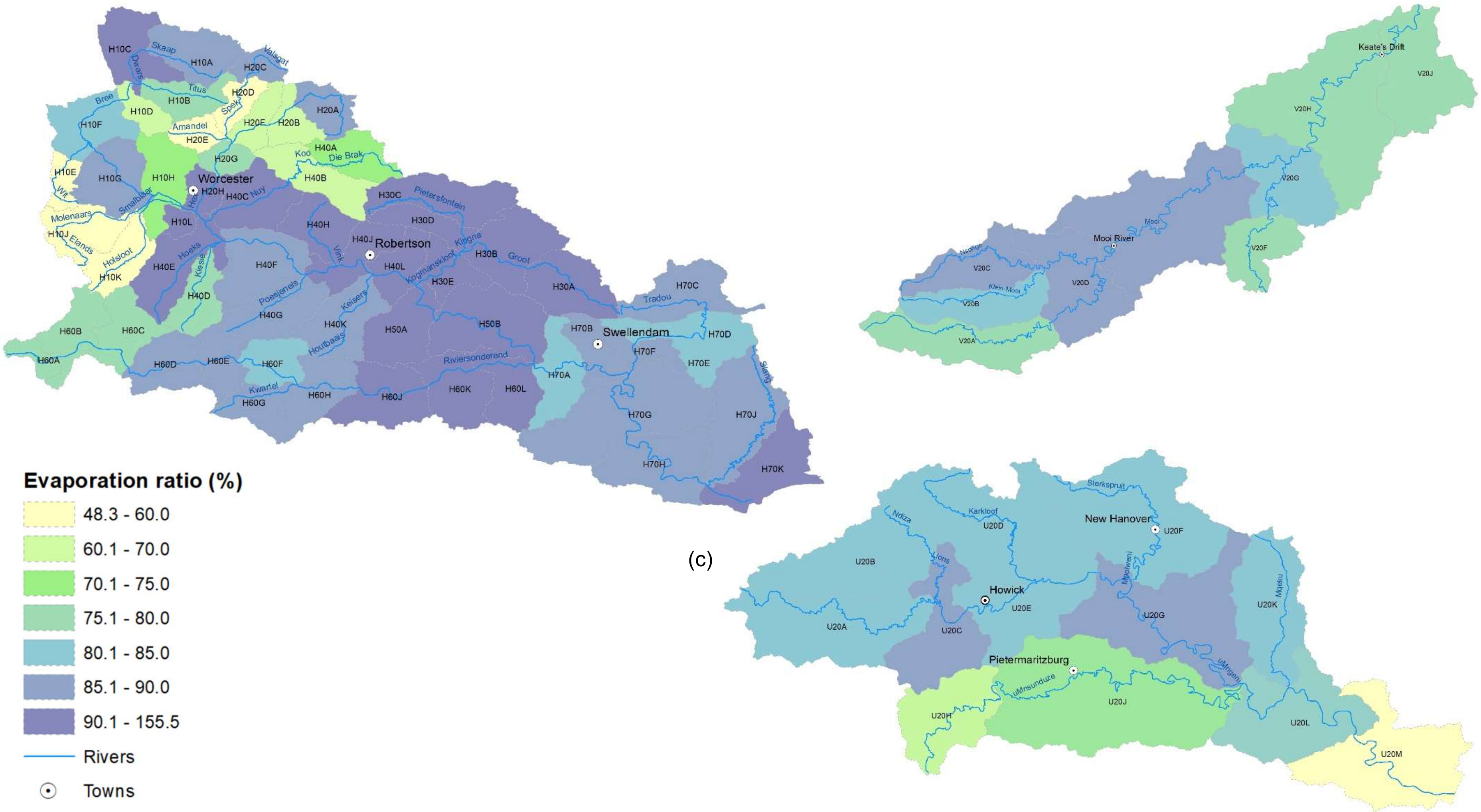
The average evaporation ratio shows that within a sub-accounting area, there was high variability in precipitation and evaporation, the two main drivers of the water balance. The Breede Catchment sub-accounting area is in a drier part of South Africa that has naturally greater variability. This makes

[12] An evaporation ratio in excess of 100% is possible in catchments where a large proportion of the area is a waterbody and water flowing into the waterbody from upstream catchments or transfers is available to be evaporated in addition to evaporation of precipitation inflows. This is the case in quaternary H10L in which Brandvlei Dam is situated.

compilation of water resource accounts that are spatially explicit important for providing evidence to support effective water resource management.

Figure 17 – Evaporation ratio averaged across six hydrological years (2015 to 2021) per quaternary catchment for the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting areas

(a) (b)



4.2 What were the water resources available for use?

Several measures of water resources, in combination with other information such as population, can be used to look at various aspects of water availability.

The main input of water into all three sub-accounting areas was from precipitation. Precipitation contributes to water available for domestic, industrial and agricultural requirements whether it moves on the surface as surface runoff, infiltrates into the soil where it is available to cultivated crops, and contributes to baseflow or groundwater recharge. Indicators that show the ratio of surface runoff, baseflow or groundwater recharge to precipitation relate to availability of water generated on a renewable basis within the catchment.

Figure 18 shows the average ratio of surface runoff to precipitation per quaternary catchment (Table 55 in Appendix 2). This ratio indicates surface water availability (generated within the catchment and contributing to river flows and storage in dams). Mapping **surface water runoff ratio** across the quaternary catchments, indicates the catchments contributing to storage or downstream flows. Catchments contributing the most to storage or downstream flows were those with a high ratio value. In the Breede Catchment, these occur in the upper Breede, north (in H20E with 22,0% surface water runoff) and west of Worcester (in H10E with 21,7% surface water runoff). In the uMngeni Catchment, the highest surface water runoff ratio was in the U20M quaternary catchment with 17,8%. U20M was the quaternary catchment with the highest proportion of built-up land cover as it holds part of the city of Durban in the eThekwini Metropolitan Municipality. This illustrates how land cover can alter the characteristics of water flows in an area. If U20M were not as built-up, the runoff would be more similar to other quaternary catchments in the sub-accounting area. The runoff ratio can highlight catchments where flooding may be a problem. This was also evident in the water resource flow account with reference state for U20M (see Appendix 3).

The surface runoff ratio is only one part of what makes up total water resources available for use in a catchment. **Total water resources** are the sum of internal water resources (from surface runoff, baseflow and groundwater recharge) and external water resources (surface inflows and groundwater inflows[13] from upstream catchments and inflowing inter-catchment transfers) within each quaternary catchment. These are the water resources that would be available for use in a catchment and to provide reserved outflows to downstream catchments or ecosystems, but these exclude water stored in dams in a previous accounting period (which may also be used in the catchment or to provide reserved flows)[14]. Total water resources are typically expressed as a volume (Mm^3). Because the sub-accounting areas differ substantially in size and population, for comparison purposes it is helpful to compare the total water resources divided by the number of people living in the area. Table 50 shows the annual and average total water resources per capita (in other words, the total water resources divided by the number of people living in the catchment based on the 2011 population census). The quaternary catchments with the largest average per capita total water resource values in the Breede Catchment were H70K (1 151 639,1 m^3 per person) and H70H (985 408,5 m^3 per person). These quaternary catchments are near the bottom of the large Breede Catchment, with accumulated flows from higher in the catchment and small populations. The largest average per capita total water resource value in the uMngeni Catchment was U20A (19 972,7 m^3 per person) and in the Mooi Catchment was V20A (58 866,8 m^3 per person). These are headwater catchments with relatively high rainfall and small populations. The quaternary catchments with the greatest coefficients of variation for per capita total water resources, indicating more variability from year-to-year, were in the secondary catchment H7 in the Breede Catchment.

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[13] Not currently modelled or included in the accounts.

[14] As described in Section 1.3, the water resource accounts do not tell us all the water stored in a catchment, rather only the flows in a hydrological year. Excluding the stored water helps to avoid double counting between accounting periods. This is an example of where the difference between water resource flow accounts and water accounts should be noted. The total water available for use in the catchment may be higher.

Table 50 – Per capita total water resources per quaternary catchment, given as annualised volume (m³) from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Population	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	2 547,8	12 128,7	5 608,5	6 451,8	2 358,7	13 372,9	39 907,3	13 304,6	1,0
H10B	1 351,1	30 453,1	12 680,8	23 228,4	16 734,3	49 047,5	83 033,6	35 862,9	0,7
H10C	47 861,8	1 406,0	570,9	914,5	615,8	2 001,4	4 795,1	1 717,3	0,9
H10D	589,5	109 179,5	56 464,9	75 095,1	57 369,0	151 531,3	336 330,5	130 995,0	0,8
H10E	732,7	75 715,1	22 654,5	75 110,7	60 375,1	132 926,1	164 322,4	88 517,3	0,6
H10F	15 925,2	9 036,1	3 492,1	7 273,5	5 158,8	15 159,7	24 653,2	10 795,6	0,7
H10G	11 418,9	23 092,4	9 112,4	16 351,7	13 404,8	36 002,2	57 924,0	25 981,3	0,7
H10H	12 788,0	25 683,0	9 932,1	14 385,3	12 908,1	35 869,5	61 017,4	26 632,6	0,7
H10J	868,2	189 610,2	62 835,7	164 196,8	130 548,0	297 208,0	406 622,4	208 503,5	0,6
H10K	724,3	216 540,8	66 386,5	122 334,3	125 248,6	319 863,2	412 405,3	210 463,1	0,6
H10L	1 363,2	7 221,3	3 075,0	3 301,6	3 294,7	9 068,6	13 649,5	6 601,8	0,6
H20A	4 164,7	3 843,9	2 614,6	1 739,7	1 234,1	4 516,0	10 200,5	4 024,8	0,8
H20B	19 303,8	2 052,3	1 279,7	1 202,1	749,3	2 143,3	4 511,5	1 989,7	0,7
H20C	528,4	20 548,5	9 117,6	14 103,9	7 745,1	32 965,2	75 918,8	26 733,2	1,0
H20D	506,5	103 521,7	42 647,4	53 417,4	60 182,0	129 609,3	235 582,0	104 159,9	0,7
H20E	388,9	140 984,5	48 767,6	77 521,0	58 504,3	184 124,3	230 253,6	123 359,2	0,6
H20F	10 831,7	13 633,2	6 268,4	6 676,5	6 154,5	15 190,8	26 992,1	12 485,9	0,7
H20G	2 089,4	66 408,1	29 693,3	29 548,2	27 969,9	69 466,3	127 189,0	58 379,1	0,7
H20H	89 025,2	4 962,9	1 908,8	2 936,0	2 617,3	7 153,8	12 170,7	5 291,6	0,7
H30A	1 394,7	15 478,9	5 562,9	6 564,4	9 157,5	10 844,6	33 172,0	13 463,4	0,8
H30B	15 701,3	1 181,3	572,4	391,8	454,8	755,2	1 944,6	883,3	0,7
H30C	1 459,5	9 372,2	7 837,8	5 107,4	3 612,5	6 471,0	10 191,4	7 098,7	0,4
H30D	2 807,7	7 267,2	4 661,9	3 949,5	3 108,0	6 290,1	10 443,1	5 953,3	0,4
H30E	16 663,4	2 082,2	997,0	719,2	629,2	905,6	2 386,4	1 286,6	0,6
H40A	165,3	176 825,7	140 392,1	123 134,5	86 364,7	231 460,4	575 895,2	222 345,4	0,8
H40B	1 161,2	83 511,7	51 775,4	44 358,5	39 024,1	103 251,8	202 548,3	87 411,6	0,7
H40C	3 515,5	24 636,8	13 368,9	9 984,0	8 138,2	22 716,3	50 847,0	21 615,2	0,7
H40D	801,7	33 971,4	24 136,7	17 225,5	11 406,2	47 319,9	86 710,8	36 795,1	0,7
H40E	1 834,6	330 836,1	142 983,6	180 424,5	158 601,7	431 194,2	754 236,3	333 046,0	0,7
H40F	2 228,6	258 264,2	113 168,5	141 812,9	123 641,6	344 292,9	623 704,5	267 480,7	0,7
H40G	1 142,8	23 089,6	13 208,8	10 352,3	10 015,4	25 354,8	56 897,6	23 153,1	0,8
H40H	2 091,5	7 937,1	3 046,2	1 360,9	2 803,4	8 363,5	18 562,6	7 012,3	0,9
H40J	25 633,6	23 296,4	10 276,7	12 763,7	11 121,1	30 341,0	55 803,8	23 933,8	0,7
H40K	4 664,1	4 547,6	2 753,9	2 309,9	1 800,9	5 349,0	15 525,6	5 381,2	1,0
H40L	7 428,7	81 170,7	36 123,8	44 535,4	38 782,7	104 745,0	195 215,4	83 428,8	0,7
H50A	2 351,6	272 957,6	122 601,9	146 295,1	127 227,4	338 380,1	643 909,2	275 228,5	0,7
H50B	13 254,6	48 718,3	21 685,5	25 924,4	22 762,5	60 688,8	116 076,0	49 309,3	0,7
H60A, H60B, H60C	20 550,3	8 267,9	3 612,9	7 121,5	6 920,8	14 650,2	17 554,5	9 688,0	0,5
H60D	3 960,8	15 121,0	8 662,5	5 374,8	11 025,3	13 084,2	23 942,9	12 868,4	0,5
H60E	5 103,8	11 664,8	7 267,9	4 095,6	9 018,7	9 987,6	19 312,3	10 224,5	0,5
H60F	4 763,3	16 356,9	9 160,4	5 202,0	10 344,9	14 751,8	32 601,8	14 736,3	0,7
H60G	433,7	41 021,2	17 225,1	20 203,0	11 273,3	37 123,0	127 566,1	42 401,9	1,0
H60H	998,1	104 051,6	57 607,4	37 352,7	55 759,0	83 498,3	250 221,6	98 081,7	0,8
H60J	6 122,7	18 821,2	10 666,1	7 151,5	10 122,3	13 747,1	44 786,8	17 549,1	0,8
H60K	878,5	125 693,4	67 906,5	39 798,7	65 082,6	80 912,0	303 377,7	113 795,2	0,9
H60L	630,5	188 720,2	104 139,7	62 975,9	100 925,0	123 013,0	452 686,8	172 076,8	0,8
H70A	938,7	837 591,6	384 755,6	428 421,8	410 886,0	998 004,5	2 036 706,3	849 394,3	0,7
H70B	17 891,4	45 056,3	20 565,2	22 924,6	22 252,9	53 854,1	110 441,3	45 849,1	0,8
H70C	5 417,7	7 516,5	2 204,8	1 907,4	1 769,7	5 930,7	23 162,8	7 082,0	1,2
H70D	538,2	96 061,1	30 460,6	34 489,5	41 523,9	66 970,1	297 111,9	94 436,2	1,1
H70E	2 607,5	26 257,3	8 549,0	8 561,7	12 427,9	22 055,4	79 745,3	26 266,1	1,0
H70F	2 185,9	33 331,9	10 849,9	12 015,2	17 319,5	27 997,1	102 040,7	33 925,7	1,0
H70G	1 830,4	501 888,3	226 473,8	253 890,7	275 513,0	597 060,4	1 335 873,5	531 783,3	0,8
H70H	993,6	923 808,8	415 009,3	463 217,1	516 701,7	1 096 270,0	2 497 444,3	985 408,5	0,8
H70J	3 849,3	8 785,3	3 940,7	5 834,4	8 187,5	7 985,8	36 672,1	11 901,0	1,0

Table 50 – Per capita total water resources per quaternary catchment, given as annualised volume (m3) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Population	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H70K	867,3	1 087 888,0	482 839,6	535 638,9	591 254,5	1 254 261,2	2 957 952,3	1 151 639,1	0,8
U20A	4 722,6	9 125,7	21 304,3	35 034,8	6 986,9	19 868,7	27 515,6	19 972,7	0,5
U20B	12 520,7	11 617,2	13 810,6	20 129,6	12 411,4	16 341,1	16 906,0	15 202,6	0,2
U20C	36 570,5	5 051,8	7 041,1	10 182,1	5 419,9	7 244,4	8 463,7	7 233,8	0,3
U20D	7 386,3	6 975,2	16 146,3	27 359,1	14 045,0	17 290,1	15 702,1	16 253,0	0,4
U20E	35 963,1	4 627,6	9 379,6	15 294,8	6 984,4	9 660,6	11 177,6	9 520,8	0,4
U20F	30 222,7	1 366,6	3 590,3	6 013,2	2 918,1	3 596,3	3 023,6	3 418,0	0,4
U20G	37 965,2	5 248,4	12 515,8	17 096,1	10 603,9	11 287,0	13 376,1	11 687,9	0,3
U20H	105 526,0	266,3	502,8	821,3	267,2	449,2	615,7	487,1	0,4
U20J	566 912,8	293,9	345,9	437,1	441,2	371,7	477,1	394,5	0,2
U20K	28 296,6	2 044,3	2 572,1	2 445,2	2 164,7	1 808,5	2 478,3	2 252,2	0,1
U20L	125 200,8	2 452,4	4 792,9	6 513,3	4 553,6	4 429,3	5 558,5	4 716,7	0,3
U20M	1 139 829,0	348,3	575,2	775,5	543,9	541,7	713,9	583,1	0,3
V20A	1 695,2	47 799,1	94 477,1	63 468,3	18 049,6	41 913,5	87 493,1	58 866,8	0,5
V20B	1 407,3	29 021,4	51 194,8	32 744,6	23 520,0	20 427,4	52 317,5	34 870,9	0,4
V20C	1 234,3	25 783,9	36 948,2	19 461,1	30 274,6	7 974,3	40 157,8	26 766,6	0,4
V20D	3 334,4	38 515,8	69 915,3	43 237,4	32 280,9	26 875,9	68 048,5	46 479,0	0,4
V20E	23 460,5	6 828,0	8 723,9	6 777,3	4 576,9	2 128,8	5 737,9	5 795,5	0,4
V20F	1 571,0	38 691,9	30 460,9	29 267,7	21 727,5	6 598,8	26 187,2	25 489,0	0,4
V20G	3 840,9	62 093,4	69 242,2	58 972,7	39 441,5	14 964,7	48 162,0	48 812,8	0,4
V20H	37 734,7	10 684,6	10 626,2	9 594,6	6 344,3	2 441,9	7 668,0	7 893,3	0,4
V20J	16 333,5	28 235,5	26 064,1	23 469,3	15 249,9	5 447,9	18 633,7	19 516,7	0,4

Part of the total water resources in a catchment must be reserved as outflow to downstream catchments. Total water resources minus the reserved outflows indicate the **net water resources** that are available for use in a catchment. Dividing this by the population within a catchment indicates the **per capita net water resources,** shown in Figure 19 as an annual volume (m^3/person).

Similar to per capita total water resources, the per capita net water resources were the highest in the Breede Catchment in H70K and H70H. These are catchments at the end of a larger river system and have lower population densities than those in the uMngeni Catchment, where the population in the quaternary catchment at the end of the sub-accounting area (most downstream) had a population of 1 139 829,0 people. Table 56 in Appendix 2 provides the per capita net water resource values per quaternary catchment for each accounting period, as an average and provides the coefficient of variation.

The external water resources as a proportion of the total water resources indicates how dependent a catchment is on external water resources, referred to as the **water resource dependency ratio**. Higher values indicate catchments that are more dependent on other catchments for water resources. Figure 20 shows the average water resources dependency ratio was highest in quaternary catchments along the central mainstem river in each sub-accounting area. Catchments that have no catchments upstream of them and no inter-catchment transfers have a water resource dependency ratio value of zero (see Table 57 in Appendix 2).

Reserved outflows, as a fraction of total water resources indicate catchments that are important to the supply of water downstream. A high value indicates catchments that might be getting close to not meeting demand. Figure 21 shows the average **reserved outflow ratio** per quaternary catchment across the three sub-accounting areas. Quaternary catchment H10L in the Breede Catchment had the highest reserved outflow ratio of 221,7% (Table 58 in Appendix 2). The catchment area of H10L was mostly covered by the Brandvlei Dam. It has low internal water resources but does receive water via transfers from neighbouring catchments. The dam then supplies water downstream and could also transfer water to the sometimes-linked Kwaggaskloof Dam in the neighbouring catchment. In the uMngeni Catchment and the Mooi Catchment, the quaternary catchments with high reserved outflow ratios were those with large dams in them. For instance, V20D in the Mooi Catchment holds Spring Grove Dam which feeds water to U20C in the uMngeni Catchment. Catchments upstream of those with a high reserved outflow ratio are likely to be important to meeting water demands. Efforts to manage ecological infrastructure in those catchments upstream of quaternary catchments with high reserved outflow ratios may be a priority to help in this regard.

As highlighted in the introduction to this section, it is important to consider different indicators together to understand more about flows of water resources. For instance, quaternary catchments H60A, H60B and H60C (which were dealt with together as the Theewaterskloof Dam connects all three) have no water resource dependency because they are at the top of the Breede Catchment but have the third highest reserved outflow ratio (57,3%) because they supply water outside of the Breede Catchment towards the City of Cape Town.

Figure 18 – Surface runoff ratio averaged across six hydrological years (2015 to 2021) per quaternary catchment for the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting

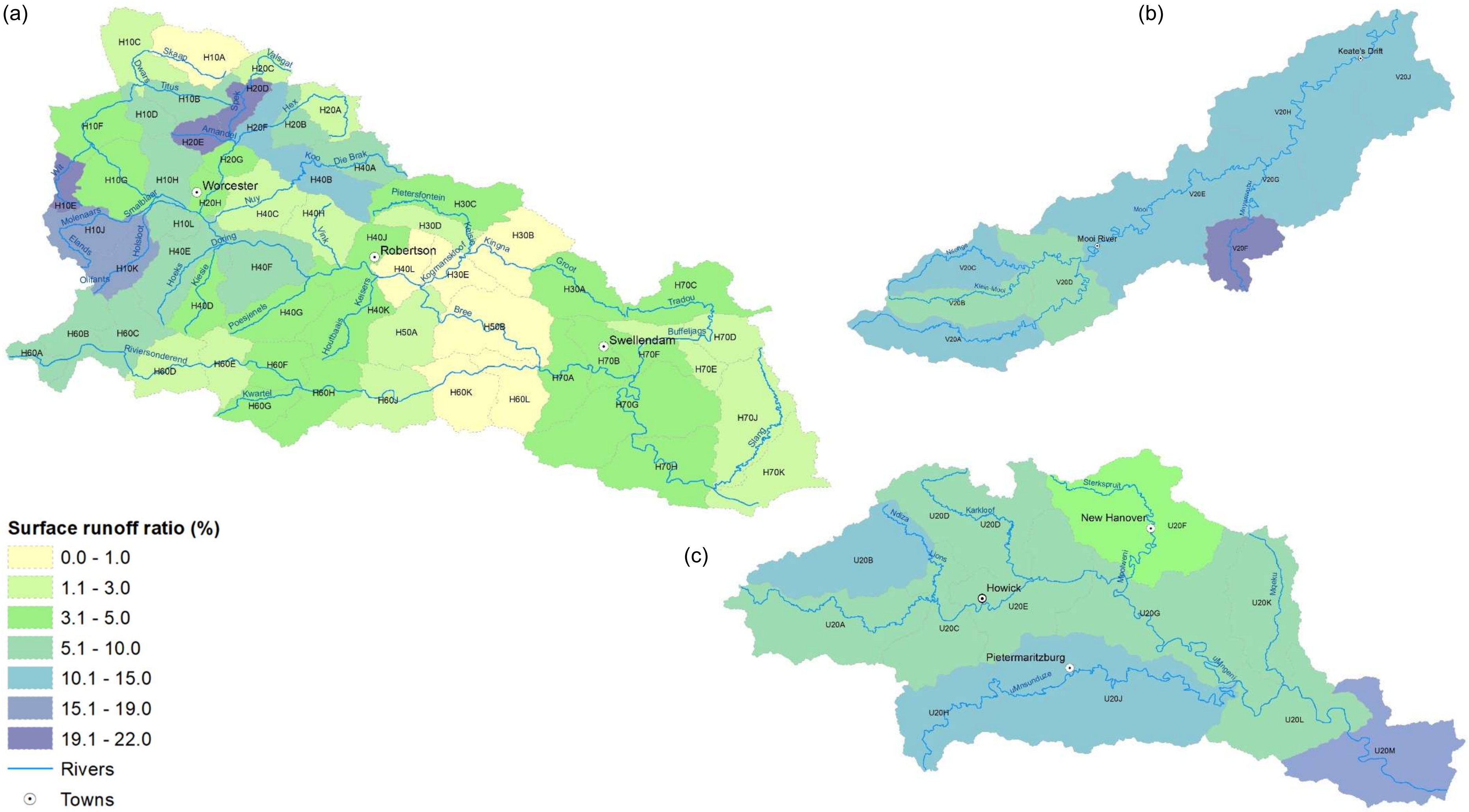


Figure 19 – Per capita net water resource averaged across six hydrological years (2015 to 2021) per quaternary catchment for the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting areas, as cubic metres per person (m³/person)

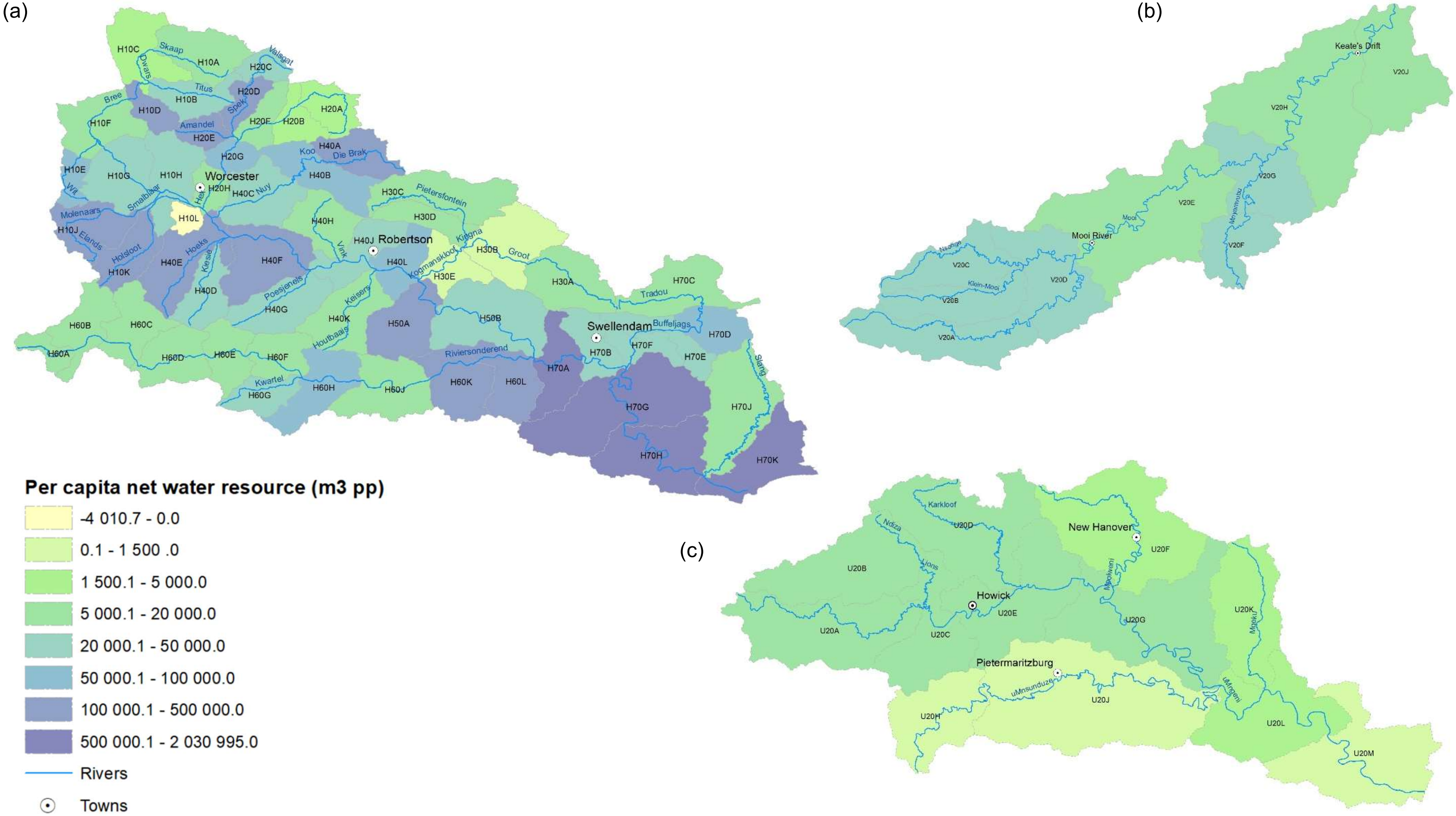


Figure 20 – Water resource dependency ratio averaged across six hydrological years (2015 to 2021) per quaternary catchment for the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting areas

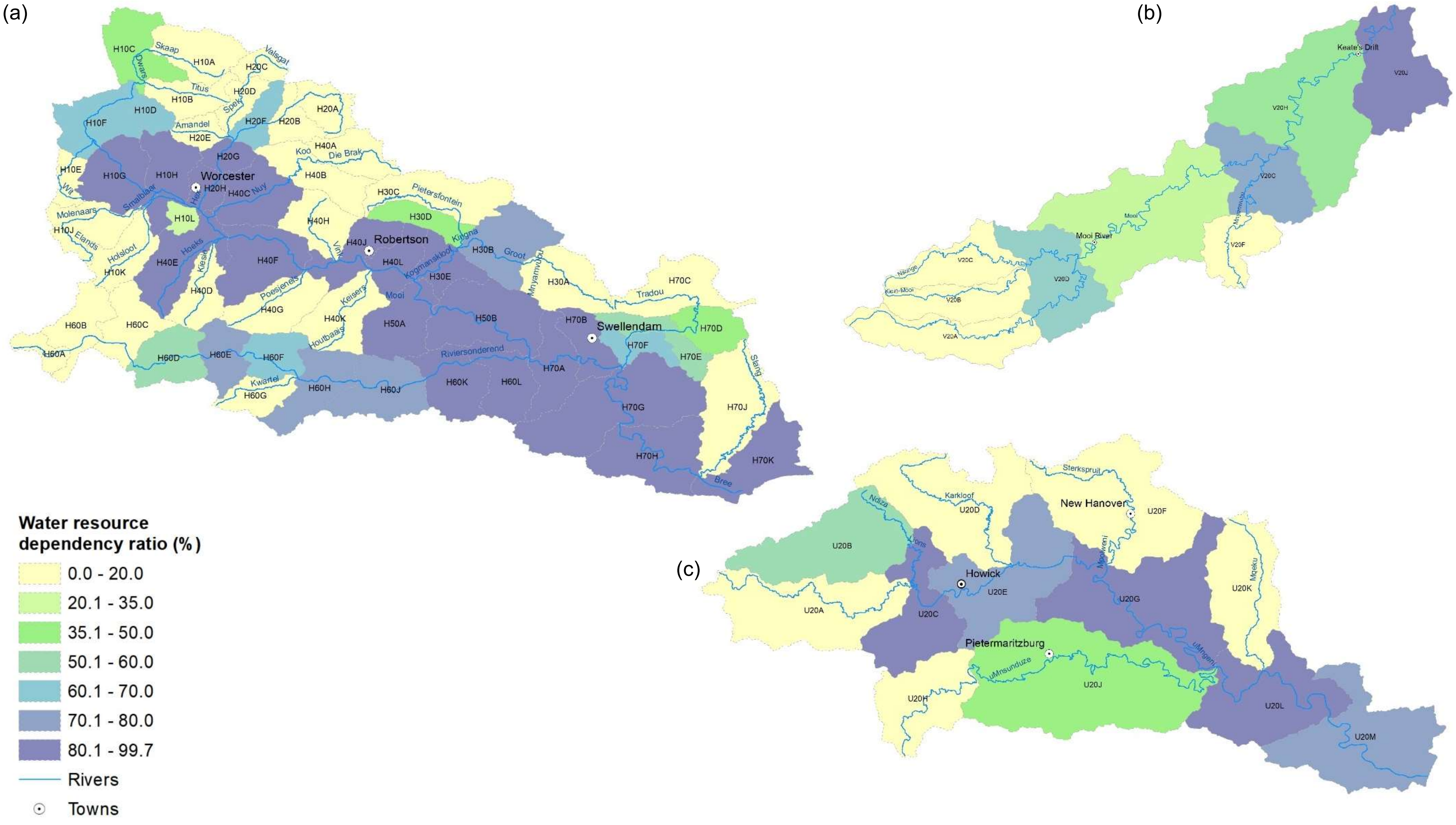
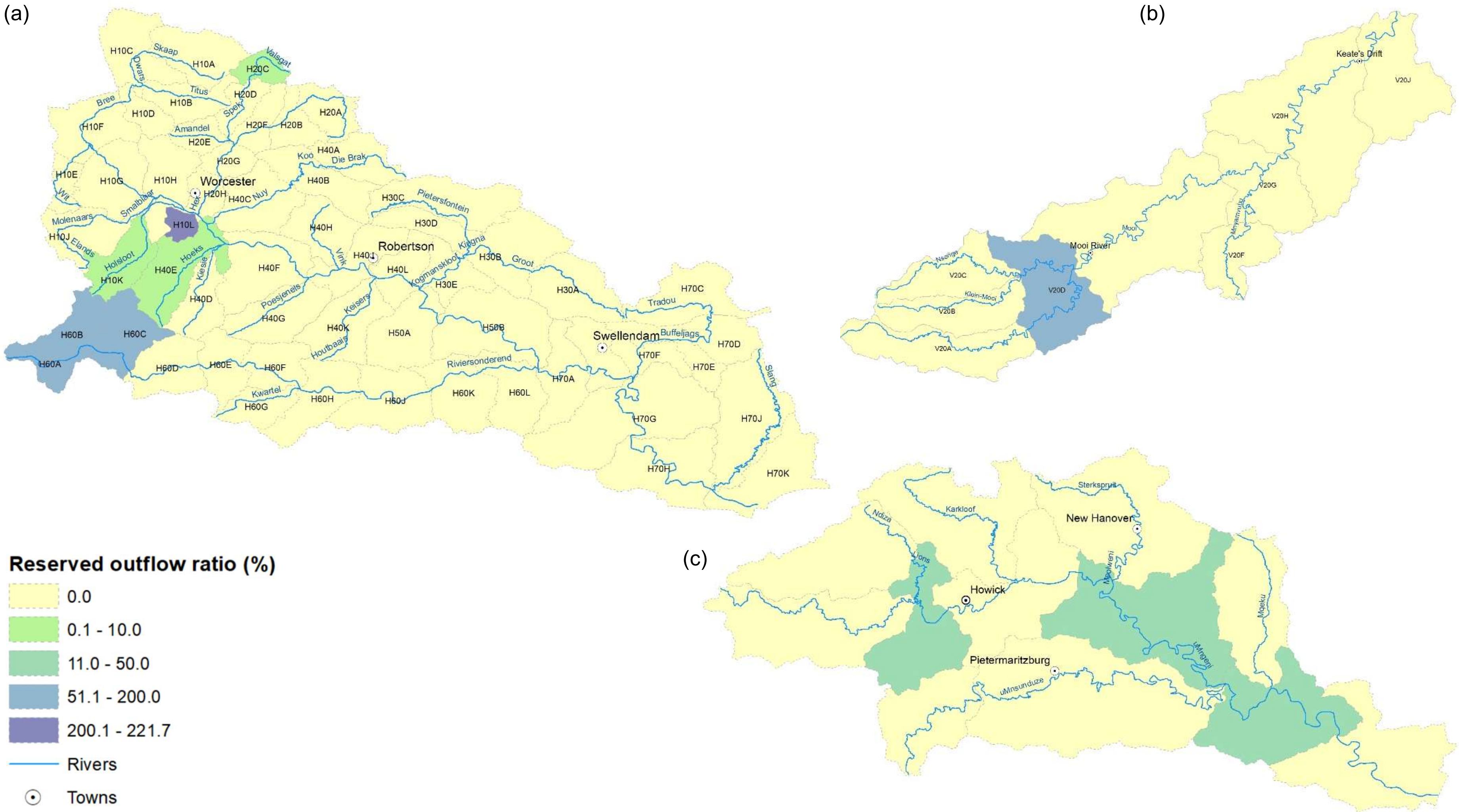


Figure 21 – Reserved outflow ratio averaged across six hydrological years (2015 to 2021) per quaternary catchment for the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting areas



4.3 What can we tell about managed water use?

Incremental evaporation is evaporation of water that would not naturally occur. It is water that is irrigated, either on cultivated or built-up land. Figure 22 shows the broad land cover classes for all three sub-accounting areas (repeating Figure 10, Figure 13 and Figure 16 for ease of reference). Incremental evaporation as a proportion of total evaporation is an indicator of catchments where water is being withdrawn from rivers, dams and groundwater for urban, mining or cultivation purposes and then subsequently lost from further use. Catchments with high ratio of incremental evaporation to total evaporation may also indicate catchments where interventions to reduce incremental evaporation might make a difference. Figure 23 shows the average incremental evaporation ratio mapped across quaternary catchments.

The Breede Catchment sub-accounting area had quaternary catchments with the highest average incremental evaporation ratio (in H20H with a 19,7% average incremental evaporation ratio, and a high of 30,1% incremental evaporation ratio in 2016-2017; see Table 59 in Appendix 2). This quaternary catchment had the highest proportion of built-up land cover in the Breede Catchment (15,6% built-up; see Table 51 in Appendix 1). The quaternary catchments with the highest cultivated land in the Breede Catchment were H70G with 81,6% and H70J with 80,9% but these have low incremental evaporation ratios as there was very little irrigation (see Table 67 to Table 72 in Appendix 3). The uMngeni Catchment sub-accounting area had the highest average incremental evaporation ratio in quaternary catchment U20M with a 16,3% incremental evaporation ratio. This quaternary catchment had the highest proportion of area with built-up land cover (68,1%; see Table 52 in Appendix 1). The Mooi Catchment sub-accounting area had the highest average incremental evaporation ratio in quaternary catchment V20D with a 6,1% average incremental evaporation ratio, which had the highest proportion of cultivated land in the Mooi Catchment (40,9%; see Table 53 in Appendix 1).

The exploitation index is the ratio between abstractions of managed water flows and total water resources. Managed water flows are the sum of water withdrawals by users within a catchment and reserved outflows to other catchments. This is an indicator of water stress. Figure 24 shows the average exploitation index mapped across quaternary catchments in the uMngeni Catchment alone, as it was only in this sub-accounting area that water resource managed flow accounts could be compiled (see Section 3.2.4). The exploitation index shows the catchments from which there was a big demand for managed water, namely U20C (Midmar Dam), U20G (Nagle Dam) and U20L (Inanda Dam). Quaternary catchment U20C had the highest average exploitation index (26,8%; see Table 60 in Appendix 2), which was understandable as it is in the upper uMngeni Catchment and key to providing water to built-up areas in quaternary catchments U20E, U20G, U20H, U20J, U20K, U20L, part of U20M and catchments outside the uMngeni Catchment. The inter-catchment transfer from the neighbouring Mooi Catchment into Midmar dam in U20C is important for water security in the uMngeni Catchment. The exploitation index in U20E was low (0,8%), however, this was misleading as Albert Falls Dam in U20E (the biggest dam on the uMngeni River) releases water downstream to Nagle Dam in U20G. Albert Falls Dam, Nagle Dam and Inanda Dam supply water to built-up areas in U20M catchments outside the uMngeni Catchment.

Figure 22 – Broad land cover classes in the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting areas, in 2018

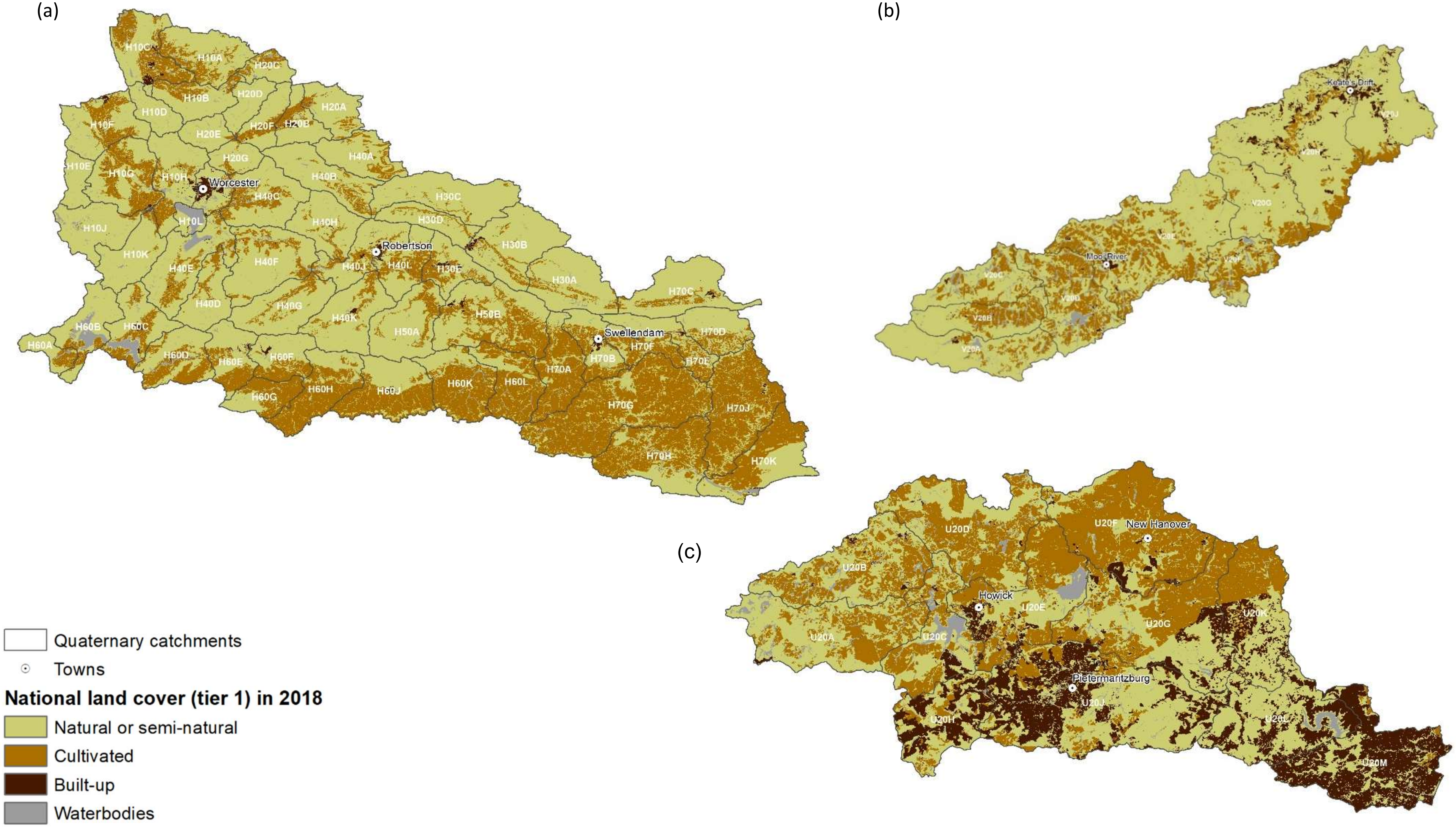


Figure 23 – Incremental evaporation ratio averaged across six hydrological years (2015 to 2021) per quaternary catchment for the (a) Breede Catchment, (b) Mooi Catchment and (c) uMngeni Catchment sub-accounting areas

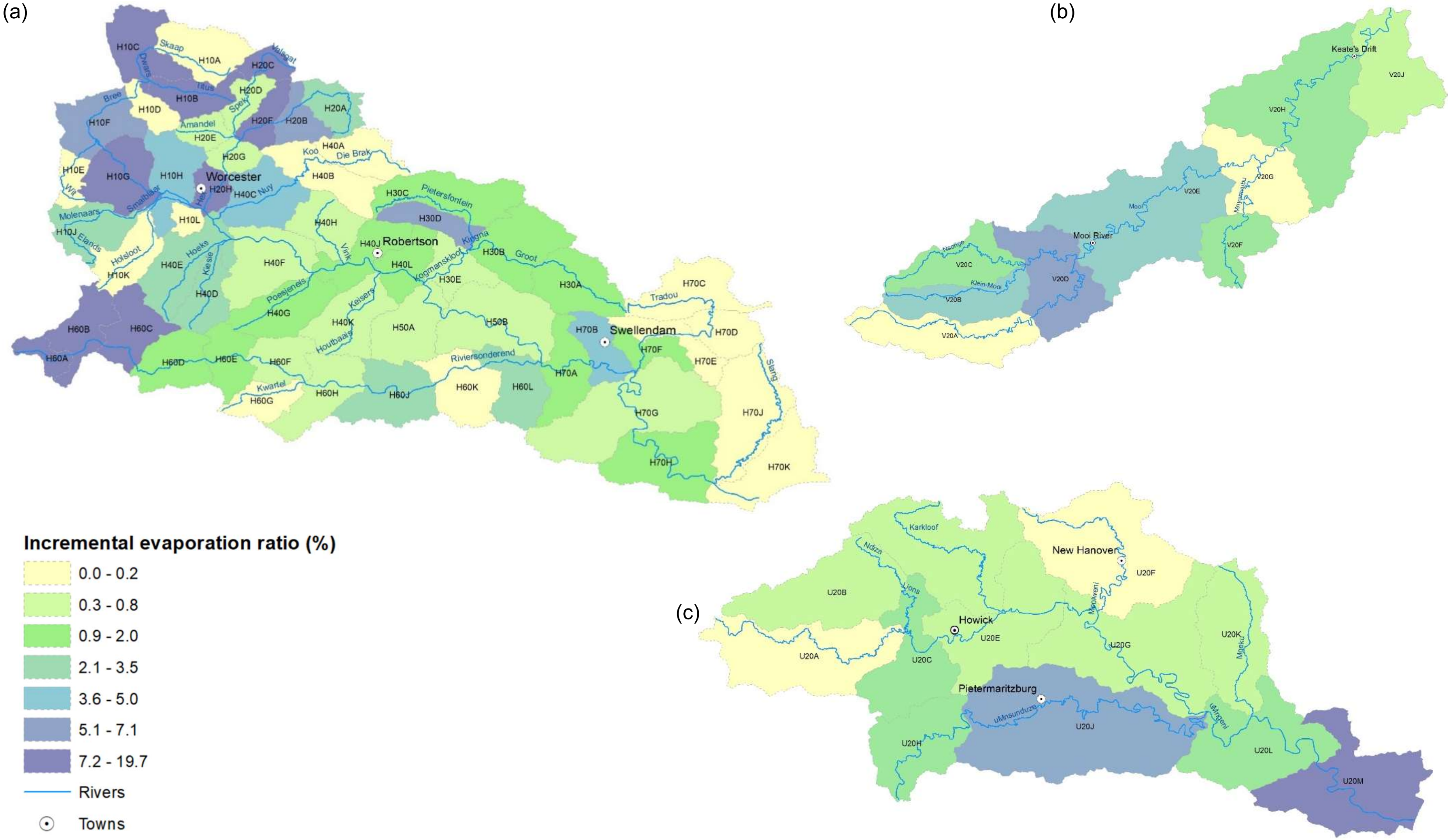


Figure 24 – Exploitation index averaged across six hydrological years (2015 to 2021) per quaternary catchment for the uMngeni Catchment sub-accounting area

5 DIRECTIONS FOR FUTURE WORK

The purpose of compiling sub-national water resource accounts was to refine a methodology and approach that could be used for national water resource accounts, align (where possible) with other natural capital accounts developed in South Africa, and better understand how the information would be used. Through the process of developing the water resource accounts, including through engagements with stakeholders, directions for future work have been identified, which would further enhance and add richness to the work undertaken so far. These are outlined below. More detail is also available in the sources and methods report.

5.1 Towards national water resource accounts at catchment-level

The methodology for compiling catchment-level water resource accounts had been developed through two WRC-funded water accounting projects (Clark, 2015; Clark, 2019) and thus is based on extensive research and piloting. While it is of interest to further improve the scale and detail used in configuring the hydrological model and in compiling water resource accounts, it is imperative that the ultimate objective is kept in mind, which is **to produce annual water resource accounts for the whole country at quaternary catchment level**, and to ensure these are accessible and beneficial to users. It is envisaged that an annual modelled assessment of water resource availability and use at catchment level will be invaluable for informing catchment management and development decisions by providing a holistic picture of catchment water resources. For these to be a useful source of information, they would need to be regularly updated.

Recommendations for future work to support compilation of national water resource accounts at catchment-level (in line with the National NCA Strategy) are:

1. **Pilot catchment-level water resource accounts at a national level**: Modelling at this scale and level of detail for the whole country would use intensive computer processing and it will thus be necessary to identify a suitable model, modelling tools and data structures for use in a high-performance computing environment. The WRC have funded a project titled "*Realisation of a System for Producing Annual Water Resource Accounts on a National Scale in South Africa*" (WRC Project – C2022/2023-00887) to undertake the terrestrial hydrological modelling, but it does not address modelling of engineered flows which is also needed to compile water resource accounts (see Section 5.2 for addressing this foundational data input).

2. **Address data gaps to compile water resource managed flow accounts**: Compilation of water resource managed flow accounts (as produced for the uMngeni Catchment sub-accounting area only) requires accurate measurements or reliable modelled estimates of water demand, withdrawals, losses, consumption and return flows at a catchment scale (see Section 5.2 for addressing this foundational data input).

3. **Explore and compare efficacy of models for catchment-level hydrological modelling at a national scale**: The ACRU semi-distributed physical conceptual model had been used for the hydrological modelling. The ability of the ACRU model to represent land cover/use in a semi-distributed manner as well as both natural and engineered flow networks has been demonstrated, but when producing the accounts for the whole country, the use of the computationally intensive ACRU4 version of the model may need to be reconsidered. The application of a distributed model at the resolution of the BSUs would be even more computationally intensive, but this approach needs to be considered to: (i) promote compatibility with other natural capital accounts, (ii) enable aggregation of appropriate terrestrial hydrological variables from BSUs up to various accounting areas, which may be administrative areas or catchments, (iii) facilitate modelling of land cover and land use change, and (iv) facilitate spatial visualization of modelled information. Distributed models are, however, not typically well suited to representing flow networks, especially dams and engineered flows, and thus, a distributed model representing terrestrial hydrological processes would typically need to be used *together* with a flow network model. There are a few other semi-distributed and distributed models that

may be suitable for application and these should be explored to ensure that the compilation of water resource accounts on a regular basis is feasible. It must be possible to run the hydrological model and compile accounts over reasonable time periods on computers that can reasonably be accessed for this purpose.

4. **Explore ways of serving information from the accounts in more accessible and interactive platforms:** The water resource accounts result in a vast amount of potentially useful and interesting information, which can be analysed and visualised in a range of ways, and ideally needs to be made available online in an accessible and interactive format. It is proposed that some form of interactive platform be developed to help serve information, statistics and graphical visualisations of information in various formats for selected spatial entities (e.g. catchments) at a range of spatial scales, and for different time periods (providing temporal context to the large inter- and intra-annual variability in climate and water resource related variables). This platform should enable users to access and query information from the water resource accounts that are regularly produced.
5. **Explore linkages between National Water Accounts (based on the SEEA-Water framework to be produced by Stats SA) and catchment-level water resource accounts developed for the country**: Water resource accounts provide more detailed and spatially explicit data on water supply and use that offer valuable information to decision-makers at the level of catchment water resource management. With the recent increase in availability of spatially explicit datasets and progression of SEEA Ecosystem Accounting which is spatially explicit, the potential to present certain SEEA Central Framework accounts (which includes water accounts) in a more spatially explicit manner is being explored in the revision of the SEEA Central Framework (underway at the time of release of this discussion document). The objective of exploring linkages between the National Water Accounts and water resource accounts should be to maximise benefits in terms of information for South Africa and to avoid duplication of effort, as water resource accounts are not intended to replace National Water Accounts but to complement these. This requires additional research, the nature of which might be supported by the Water Research Commission.

Accounts and models are only as good as the input data on which they depend. The next section covers recommendations related to improving foundational datasets important to compiling water resource accounts.

5.2 Improvements to foundational datasets

Compiling water resource accounts is data intensive, and the accuracy of the accounts depends on the accuracy of the foundational datasets. As far as possible, the methodology had been developed to use freely available national datasets. Compiling the water resource accounts emphasised the availability of many useful datasets describing biophysical and geophysical characteristics of South Africa. However, it also highlighted the need for: (i) further investment in monitoring, reporting and dataset development, (ii) accessibility of datasets, between government institutions and by NCA practitioners, and (iii) improving the usability of datasets, through centralisation of data repositories and application of data quality controls. The development of the water resource accounts highlighted several ways in which foundational datasets could be strengthened.

Importantly, certain datasets are found to be more important than others in terms of the impact they have on the hydrological model. The accuracy of the modelled flows, for instance, is very dependent on the accuracy of the rainfall data, and relatively less sensitive to other model input data such as land cover/use and soils. Rainfall is a critical variable for catchment scale water accounts as rainfall is often the primary source of water to a catchment. The accuracy of the rainfall data had a significant effect on the accuracy of water resource accounts. This means that: (i) more emphasis needs to be placed on the accuracy of the rainfall data, and (ii) it may be possible to simplify representation of land cover/use in the model, as modelling at a high degree of detail is not justified, given the impact of inaccurate estimates of rainfall. It is recommended that the bias correction and downscaling of satellite remotely sensed rainfall estimates be researched further for application in hydrological modelling and water accounting to improve the accuracy and spatial representation of catchment rainfall estimates. There are several organisations that have rainfall monitoring networks, but the national monitoring networks operated by the South African Weather Service (SAWS) and the Agricultural Research Council (ARC) are important sources of rainfall data for the country for use in bias correction of satellite remotely sensed rainfall estimates or for traditional direct estimates. The cost of accessing rainfall data from SAWS and the ARC was prohibitive in this study. Rainfall datasets are typically not provided to users in a ready for use state and can require substantial effort to identify erroneous measurements and infill missing periods in rainfall time series.

The representation of engineered flows[15] in the form of inter-catchment transfers, abstractions for irrigation and abstractions and return flows for domestic and industrial urban use are another very important part of the accounts as these can decrease flows and water stocks in some catchments and can increase flows in other catchments. However, it is not easy to get information on these flows even though many of these engineered flows are measured. This information needs to include the spatial location of flow abstractions and returns in addition to flow quantities (ideally broken down by economic sector). The recommendation is to explore improvements in information on engineered water flows, which are also needed for the National Water Accounts (in terms of SEEA-Water) that Stats SA and DWS are compiling. The representation of engineered water flows and water use can be complicated, partly due to an apparent lack of good national scale datasets (especially spatial datasets) and the detail in which these engineered water systems would need to be represented in a hydrological model for catchment-level water resource accounts. Further investigation is required to identify potential sources of data and determine if better datasets are available. It is likely that municipalities and other water supply and management bodies (such as water user association and water utility companies) have much valuable data on engineered water flows, but some means of centralised curation of this data would be required. To better represent river flows below large dams, better modelling of dam operating rules to supply downstream users and environmental flows, even in a relatively simplistic manner would be useful.

Further consideration needs to be given to the development of an acceptable set of simplifying assumptions for the estimation of water quantities used for irrigation, urban, mining and power generation and representation of the related flow networks. These anthropogenic water uses were a key data challenge. Only irrigation water requirements are estimated in the hydrological model for water resource accounts at this stage. Urban domestic water use is currently estimated in a simple manner based on population as an input to the hydrological model, but industrial and commercial water use is not represented due to a lack of suitable data or estimates. Information on urban, commercial, industrial, and mining water use and return flows is also needed for the physical supply and use tables in the National Water Accounts following SEEA-Water compiled at national or WMA scale. However, more information is needed at finer spatial resolutions to include these water uses and their return flows into the hydrological modeling at catchment-level. It is recommended that further work is needed to identify and review the quality of available datasets to assist in: (i) quantifying urban residential, commercial, industrial, and mining water use and return flows, (ii) identifying urban water sources, (iii) identifying where return flows enter the river flow network, and (iv) improving estimates of the extent of impervious surfaces in urban areas. With regards to irrigation water use, it is recommended that the Water use Authorization and Registration Management System (WARMS) database be investigated further as a source of information on irrigation water sources, the types of irrigated crops, the type of irrigation system used and irrigation scheduling. The spatial location information associated with the data in the WARMS database also needs further investigation, for instance to clarify where point data represents the locality of the water use applicant or where the water is used. Better information is also required regarding the spatial footprint of the various government and private water schemes across the country.

The water resource flow accounts include a quantification of the portion of the water resources that is reserved for outflow to users in other catchments, either downstream or via inter-catchment transfers. The reserved outflow currently does not include flows to meet downstream environmental flow

[15] Engineered flows are flows where built infrastructure such as dams, canals, tunnels, pipelines and pumps are required to provide water at locations, times, volumes or flow rates where natural water flows are now suited for irrigation, domestic, commercial, industrial or recreational use.

requirements. It is recommended as a future direction of work to investigate how to include environmental flow requirements, specifically the Reserve as per Part 3 of the NWA[16] into water resource accounts. The Reserve determination is not done for every quaternary catchment. Instead, it is determined at a point on a river and could be included in the accounts at that point. However, a method is required to translate the Reserve to point upstream representing individual quaternary catchments (or smaller) to provide an indication of whether individual upstream catchments are contributing a reasonable portion of the Reserve.

Other noteworthy recommendations related to improvements in datasets that would strengthen water resource accounts include:

- **Ecosystem condition of terrestrial ecosystems (vegetation types):** Natural and semi-natural areas exist on a continuum, so drawing a definitive line between natural, near natural and semi-natural areas is challenging. At this stage, it is not possible to reliably distinguish natural areas from semi-natural areas based on remotely sensed imagery, so these are grouped together. A dataset on ecological condition of terrestrial ecosystems, which affects how water moves through or over the catchment, would be useful as the model currently assumes all vegetation types are in good condition, which is not accurate.
- **More detailed information on cultivated crop types**: Currently, the national land cover datasets provide only limited information on the types of specific crops (e.g. sugarcane, pineapples, vines), not differentiating between different field crops and bundling all timber plantation genera together. To improve the configuration of the model, it is recommended that additional national spatial datasets be sought to identify different crop types and genera of timber trees, each of which have different water use characteristics.
- **Alien Invasive Plant (AIP) species**: AIP species (such as pines, wattle, hyacinth) can significantly impact on water resources. National, spatially explicit information on the location, spatial extent, density and type of AIP species is needed. Their water use characteristics would be useful additional information. Eradication of AIP species is an ongoing effort in South Africa, so updates to spatial data on the extent, density and location of AIP species will be important. In future water resource accounts, it would be ideal to include AIP species into the hydrological modelling to estimate their impact on the catchment water balance.
- **Catchment recharge areas**: It is recommended that the use of data on catchment recharge areas, a methodology for which has been developed by SANBI and the University of Free State, together with the associated hydropedological characteristics be investigated further. This is to determine whether these can be used in hydrological modelling to potentially improve representation of groundwater/surface water interactions.
- **Reference evaporation data**: Evaporative demand is another critical variable for catchment scale water accounts as a large proportion of water entering a catchment is depleted through evaporation. The European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Satellite Application Facility for Land Surface Analysis (LSASAF) Reference Evapotranspiration (METREF) dataset needs additional verification for application in catchment scale hydrological modelling.

Advances in remote sensing technologies show promise for future application in addressing some of the above data gaps, however, these should be combined with in situ data and/or national expert input. Validation workshops with catchment or national experts highlighted the importance of their involvement in validation and interpretation of the data and accounts. Reporting on confidence in both measured and modelled data values should also be a future direction for work.

[16] Part 3 of the NWA (Act No. 36 of 1998) deals with the Reserve, which consists of two parts: (1) the basic human needs reserve, which provides for the essential needs (drinking, food preparation and personal hygiene) of individuals served by the water resource in question and (2) the ecological reserve, which relates to water required to protect aquatic ecosystems of the water resource. The Reserve will vary depending on the class of the resource and the catchment it is in.

5.3 Water quality

At this point, the methodology has focussed on quantifying water availability and use. Water quality accounts at a fine scale for the whole country would not be easy as (i) measurements are typically made at points of interest, and (ii) modelling water quality would require detailed time series data on sources and concentrations of point source pollution, and many assumptions about non-point source pollution. Including water quality into water resource accounts would add value to information available at catchment level and is an area that would require additional data and development for inclusion in future accounts.

6 REFERENCES

Anderson, A.J., Mahlangu, M.S., Cullis, J. and Swartz, S. 2008. Integrated monitoring of water allocation reform in South Africa. Water SA, 34 (6): 731-737.

Bailey, A.K. and Pitman, W.V. 2016. Water resources of South Africa 2012 study (WR2012) – Volume 1 Executive Summary. WRC Report No. TT 683/16. Water Research Commission (WRC), Pretoria, South Africa.

Clark, D.J. 2015. Development and Assessment of an Integrated Water Resources Accounting Methodology for South Africa. WRC Report 2205/1/15. Water Research Commission (WRC), Pretoria, South Africa.

Clark, D.J. 2019. Development and Assessment of an Integrated Water Resources Accounting Methodology for South Africa: Phase 2. WRC Report 2512/1/19. Water Research Commission (WRC), Pretoria, South Africa.

De Bruin, H., Trigo, I., Bosveld, F. and Meirink, J. 2016. A thermodynamically based model for actual evapotranspiration of an extensive grass field close to FAO Reference, suitable for remote sensing application. Journal of Hydrometeorology, 17 (5): 1373-1382.

Department of Environmental Affairs (DEA) and GeoTerraImage Pty Ltd (GTI). 2019. 73 Class GTI South African National Land Cover Dataset (2018). [Dataset]. Produced by GeoTerraImage Pty Ltd for the Department of Environmental Affairs, Pretoria, South Africa

Department of Rural Development and Land Reform (DRDLR). 2017. South African Land Cover Classes and Definitions. Department of Rural Development and Land Reform, Pretoria, South Africa.

Dam Safety Office (DSO). 2018. List of Registered Dams in South Africa, 2018. List of Registered Dams Feb 2018.xls available from https://www.dwa.gov.za/DSO/Publications.aspx. [Dataset]. Dam Safety Office, DoWaSD, Pretoria, South Africa.

Department of Water and Sanitation (DWS). 2018a. National Water and Sanitation Master Plan - Volume 1: Call To Action. Department of Water and Sanitation, Pretoria, South Africa.

Department of Water and Sanitation (DWS). 2018b. Quaternary Catchment Boundaries of South Africa. [Dataset]. Flood Studies Section, Department of Water and Sanitation, Pretoria, South Africa.

Department of Water and Sanitation (DWS). 2023. National Water Resource Strategy Third Edition (NWRS-3). The Department of Water and Sanitation, Pretoria, March 2023. Pages 130. Accessed 19 February 2024 at https://www.dws.gov.za/Documents/Gazettes/Approved%20National%20Water%20Resource%20Strategy%20Third%20Edition%20(NWRS3)%202023.pdf

Funk, C.C., Peterson, P.J., Landsfeld, M.F., Pedreros, D.H., Verdin, J.P., Rowland, J.D., Romero, B.E., Husak, G.J., Michaelsen, J.C. and Verdin, A.P. 2014. A quasi-global precipitation time series for drought monitoring. USGS Data Series 832. U.S. Geological Survey, Reston, Virginia, USA.

GEOTERRAIMAGE (GTI) 2015. 2013 - 2014 South African National Land-Cover Dataset. Data User Report and Metadata. March 2015. Version 05#2.

GEOTERRAIMAGE (GTI) 2019. South African National Land-Cover 2018: Report and Accuracy Assessment. DEA E1434 Land-Cover. Version 004, 25-09-2019.

International Water Management Institute (IWMI). 2013. Water Accounting for Integrated Water Resources Management. [Internet]. Available from: www.cglrc.cgiar.org/iwmi/perform_files/accounting.pdf. [Accessed: 05/03/2013].

Karimi, P., Bastiaanssen, W.G.M. and Molden, D. 2013. Water Accounting Plus (WA+) - a water accounting procedure for complex river basins based on satellite measurements. Hydrology and Earth System Sciences, 17 (7): 2459-2472.

Le Maitre, D.C., Seyler, H., Holland, M., Smith-Adao, L., Nel, J.L., Maherry, A. and Witthüser, K. 2018. Identification, Delineation and Importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for Surface Water and Groundwater. Report No. TT 743/1/18, Water Research Commission, Pretoria.

Maila, D., Crafford, J., Mathebula, V., Naidoo, N. and Visser, W. 2018. National Water Accounts for South Africa: Systems, Methods and Initial Results. WRC Report TT 774/18. Water Research Commission, Pretoria, South Africa.

Molden, D. 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. Earthscan, London, UK and International Water Management Institute, Colombo, Sri Lanka.

Nel, J.L. and Driver, A. 2015. National River Ecosystem Accounts for South Africa. Discussion document for Advancing SEEA Experimental Ecosystem Accounting Project, October 2015. South African National Biodiversity Institute, Pretoria.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A.M., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E. and Smith-Adao, L.B. 2011a. Atlas of freshwater ecosystem priority areas: Maps to support sustainable development of water resources. WRC Report No. TT 500/11. Water Research Commission, Pretoria, South Africa.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A.M., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E. and Smith-Adao, L.B. 2011b. FEPA Rivers Based on DWS 1:500,000 River Layer. NFEPA_Rivers.shp. [Dataset]. WRC Report No. TT 500/11, Water Research Commission, Pretoria, South Africa.

Nel, J.L., Le Maitre, D.C., Roux, D.J., Colvin, C., Smith, J.S., Smith-Adao, L. B., Maherry, A. and Sitas, N. 2017. Strategic water source areas for urban water security: Making the connection between protecting ecosystems and benefiting from their services. Ecosystem Services 28: 251-259.

Novella, N.S. and Thiaw, W.M. 2012. African Rainfall Climatology Version 2 for Famine Early Warning Systems. Journal of Applied Meteorology and Climatology, 52 (3): 588-606.

South African National Biodiversity Institute (SANBI). 2022. Ecological infrastructure for water security project: Demonstrating how healthy ecosystems can improve water security. South African National Biodiversity Institute (SANBI) Factsheet Series, South African National Biodiversity Institute, Pretoria.

South African National Space Agency (SANSA). 2018. Satellite Based Dams Volumes Calculator (Version 2). Version 2. [Dataset]. South African National Space Agency, Pretoria, South Africa.

Schulze, R.E. and Horan, M.J.C. 2008. Section 4.2: Soils Hydrological Attributes. In: ed. Schulze, RE, South African Atlas of Climatology and Agrohydrology. WRC Report 1489/1/06. Water Research Commission, Pretoria, South Africa.

Schulze, R.E. and Maharaj, M. 2008a. Section 6.5: Rainfall Seasonality. In: ed. Schulze, RE, South African Atlas of Climatology and Agrohydrology. WRC Report 1489/1/06. Water Research Commission, Pretoria, South Africa.

Schulze, R.E. and Maharaj, M. 2008b. Section 7.3: Daily Maximum Temperatures. In: ed. Schulze, RE, South African Atlas of Climatology and Agrohydrology. WRC Report 1489/1/06. Water Research Commission, Pretoria, South Africa.

Schulze, R.E. and Maharaj, M. 2008c. Section 7.3: Daily Minimum Temperatures. In: ed. Schulze, RE, South African Atlas of Climatology and Agrohydrology. WRC Report 1489/1/06. Water Research Commission, Pretoria, South Africa.

Schulze, R.E., Maharaj, M., Warburton, M.L., Gers, C.J., Horan, M.J.C., Kunz, R.P. and Clark, D.J. 2008. South African Atlas of Climatology and Agrohydrology. In: ed. Schulze, RE, South African Atlas of Climatology and Agrohydrology. WRC Report 1489/1/06, DVD-ROM accompanying the report. Water Research Commission, Pretoria, South Africa

Schulze, R.E. 1995. Hydrology and Agrohydrology: A Text to Accompany the ACRU 3.00 Agrohydrological Modelling System. Water Research Commission, Pretoria, South Africa.

Smithers, J.C. and Schulze, R.E. (eds.). 1995. ACRU Agrohydrological Modelling System: User Manual Version 3.00. WRC Report No. TT70/95. Water Research Commission, Pretoria, South Africa.

South African National Biodiversity Institute (SANBI). 2012. 2012 Vegetation Map of South Africa, Lesotho and Swaziland. NVM2012beta2_wgs84_Geo. [Dataset]. South African National Biodiversity Institute, Pretoria, South Africa.

Statistics South Africa (Stats SA). 2002. Natural resource accounting: Water accounts of the upper Vaal water management area, 1991-2000. Discussion document. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2004. Natural resource accounts – Water accounts for nineteen water management areas. Report No. 04-05-01 (2000). Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2005. Natural resource accounting: Water quality accounts for South Africa, 2000. Discussion document – April 2005. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2006. Update Water Accounts for South Africa: 2000. Discussion document D0405. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2009. Water Accounts for South Africa: 2000. Discussion document D0405.1. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2010. Water Management Areas in South Africa. Discussion document D0405.8. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2012. Census 2011: Statistical release (revised) P0301.4. Statistics South Africa (Stats SA). Pretoria. Released 30 October 2012.

Statistics South Africa (Stats SA). 2020. Natural Capital 1: Land and Terrestrial Ecosystem Accounts, 1990 to 2014. Discussion document D0401.1. Produced in collaboration with the South African National Biodiversity Institute and the Department of Environment, Forestry and Fisheries. Statistics South Africa, Pretoria, South Africa.

Statistics South Africa (Stats SA). 2021. Natural Capital Series 2: Accounts for Protected Areas, 1900 to 2020. Discussion document D0401.2. Produced in collaboration with the South African National Biodiversity Institute and the Department of Forestry, Fisheries and the Environment. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2023. Natural Capital Series 3: Accounts for Strategic Water Source Areas, 1990 to 2020. Discussion document D0401.3. Produced in collaboration with the South African National Biodiversity Institute and the Department of Forestry, Fisheries and the Environment. Statistics South Africa, Pretoria.

Thompson, M., Hiestermann, J., Eady, B. and Hallowes, J. 2018. Frankly my dear I give a dam! Or Using satellite observation to determine water resource availability in catchments. 19th SANCIAHS National Hydrology Symposium, Kruger National Park, South Africa.

Toucher, M.L., Ramjeawon, M., McNamara, M.A., Rouget, M., Bulcock, H., Kunz, R.P., Moonsamy, J., Mengistu, M., Naidoo, T., Vather, T. and Aldworth, T.A. 2019. Resetting The Baseline Land Cover Against Which Streamflow Reduction Activities And The Hydrological Impacts Of Land Use Change Are Assessed. WRC Report 2437/1/19. Water Research Commission (WRC), Pretoria, South Africa.

Trigo, I.F., Dacamara, C.C., Viterbo, P., Roujean, J-L., Olesen, F., Barroso, C., Camacho-de-Coca, F., Carrer, D., Freitas, S.C., García-Haro, J., Geiger, B., Gellens-Meulenberghs, F., Ghilain, N., Meliá, J., Pessanha, L., Siljamo, N. and Arboleda, A. 2011. The Satellite Application Facility for Land Surface Analysis. International Journal of Remote Sensing, 32 (10): 2725-2744.

Turpie, J.K., Letley, G., Schmidt, K., Weiss, J., O'Farrell and Jewitt, D. 2021. Towards a method for accounting for ecosystem services and asset value: Pilot accounts for KwaZulu-Natal, South Africa, 2005-2011. NCAVES project report: https://seea.un.org/content/knowledge-base

United Nations (UN). 2012. SEEA-Water: System of Environmental-Economic Accounting for Water. Department of Economic and Social Affairs: Statistics Division, United Nations, New York, USA.

United Nations (UN). 2014. System of Environmental-Economic Accounting 2012 – Central Framework. United Nations, New York, USA.

United Nations (UN). 2021. System of Environmental-Economic Accounting - Ecosystem Accounting (SEEA Ecosystem Accounting). White cover publication, pre-edited text subject to official editing. Department of Economic and Social Affairs, Statistics Division, United Nations, New York, USA.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. and Snaddon, K. 2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 October 2019. CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number http://hdl.handle.net/20.500.12143/5847. Council for Scientific and Industrial Research and South African National Biodiversity Institute, Pretoria, South Africa.

Weepener, H.L., van den Berg, H.M., Metz, M. and Hamandawana, H. 2011a. Flow direction raster based on SRTM 90m DEM. SRTM90m_Flowdir_sfd.tif. [Dataset]. WRC Report 1908/1/11, Water Research Commission, Pretoria, South Africa.

Weepener, H.L., van den Berg, H.M., Metz, M. and Hamandawana, H. 2011b. Flow accumulation raster based on SRTM 90m DEM. SRTM90m_Flowacc_sfd.tif. [Dataset]. WRC Report 1908/1/11, Water Research Commission, Pretoria, South Africa.

Weepener, H.L., van den Berg, H.M., Metz, M. and Hamandawana, H. 2011c. The development of a hydrologically improved Digital Elevation Model and derived products for South Africa based on the SRTM DEM. WRC Report 1908/1/11. Water Research Commission, Pretoria, South Africa.

World Wide Fund for Nature – South Africa (WWF-SA). 2017. Scenarios for the Future of Water in South Africa. World Wide Fund for Nature – South Africa and the Boston Consulting Group (BCG), Cape Town, South Africa.

APPENDIX 1: LAND COVER COMPOSITION OF SUB-ACCOUNTING AREAS

This appendix contains tables for each sub-accounting area of the area and proportion of the four broad land cover classes, namely natural or semi-natural, cultivated, built-up and waterbodies, per quaternary catchment. This is based on SANLC 2018 as described in Section 2.3. These values are referred to in Sections 3.1.2, 3.2.2 and 3.3.2.

Table 51 – Land cover composition (tier 1) per quaternary catchment in the Breede Catchment sub-accounting area, 2018, in hectares and as a proportion of the quaternary catchment

	Area (ha)					Percentage of total area (%)			
Quaternary catchment	**Total**	**Natural or semi-natural**	**Cultivated**	**Built-up**	**Waterbodies**	**Natural or semi-natural**	**Cultivated**	**Built-up**	**Waterbodies**
H10A	239,8	196,3	38,7	0,0	4,8	*81,9%*	*16,1%*	*0,0%*	*2,0%*
H10B	163,8	126,5	34,0	0,0	3,3	*77,2%*	*20,8%*	*0,0%*	*2,0%*
H10C	257,0	154,1	87,7	3,6	11,7	*59,9%*	*34,1%*	*1,4%*	*4,5%*
H10D	96,2	96,1	0,0	0,0	0,0	*100,0%*	*0,0%*	*0,0%*	*0,0%*
H10E	84,4	84,4	0,0	0,0	0,0	*100,0%*	*0,0%*	*0,0%*	*0,0%*
H10F	250,0	205,2	42,8	0,0	2,1	*82,1%*	*17,1%*	*0,0%*	*0,8%*
H10G	270,8	173,3	94,3	0,0	3,2	*64,0%*	*34,8%*	*0,0%*	*1,2%*
H10H	236,4	202,5	27,5	2,9	3,6	*85,6%*	*11,6%*	*1,2%*	*1,5%*
H10J	215,0	205,3	4,9	0,0	4,8	*95,5%*	*2,3%*	*0,0%*	*2,2%*
H10K	196,2	190,5	4,7	0,0	1,0	*97,1%*	*2,4%*	*0,0%*	*0,5%*
H10L	51,0	26,1	0,0	0,0	24,9	*51,2%*	*0,0%*	*0,0%*	*48,8%*
H20A	149,3	133,9	14,0	0,0	1,4	*89,7%*	*9,4%*	*0,0%*	*0,9%*
H20B	119,0	96,3	19,8	1,5	1,4	*81,0%*	*16,7%*	*1,2%*	*1,1%*
H20C	82,0	57,8	19,8	0,0	4,4	*70,5%*	*24,1%*	*0,0%*	*5,4%*
H20D	101,2	100,2	0,5	0,0	0,5	*99,0%*	*0,5%*	*0,0%*	*0,4%*
H20E	89,9	87,5	2,0	0,0	0,4	*97,3%*	*2,2%*	*0,0%*	*0,5%*
H20F	117,9	93,9	23,6	0,0	0,4	*79,6%*	*20,0%*	*0,0%*	*0,3%*
H20G	88,3	85,3	2,9	0,0	0,1	*96,6%*	*3,3%*	*0,0%*	*0,2%*
H20H	94,7	69,5	6,5	14,8	3,9	*73,4%*	*6,9%*	*15,6%*	*4,1%*
H30A	282,8	267,6	12,9	0,0	2,4	*94,6%*	*4,6%*	*0,0%*	*0,8%*
H30B	316,2	300,4	11,6	2,4	1,8	*95,0%*	*3,7%*	*0,7%*	*0,6%*
H30C	318,0	316,7	0,7	0,0	0,5	*99,6%*	*0,2%*	*0,0%*	*0,2%*
H30D	135,2	132,1	2,7	0,0	0,4	*97,7%*	*2,0%*	*0,0%*	*0,3%*
H30E	155,9	121,8	32,2	0,0	1,9	*78,1%*	*20,7%*	*0,0%*	*1,2%*
H40A	184,8	155,3	28,9	0,0	0,6	*84,0%*	*15,7%*	*0,0%*	*0,3%*
H40B	237,9	214,6	21,2	0,0	2,2	*90,2%*	*8,9%*	*0,0%*	*0,9%*
H40C	262,8	220,8	36,9	0,0	5,0	*84,0%*	*14,1%*	*0,0%*	*1,9%*
H40D	173,3	159,8	11,8	0,0	1,7	*92,2%*	*6,8%*	*0,0%*	*1,0%*
H40E	298,7	236,8	42,2	0,0	19,7	*79,3%*	*14,1%*	*0,0%*	*6,6%*

Table 51 – Land cover composition (tier 1) per quaternary catchment in the Breede Catchment sub-accounting area, 2018, in hectares and as a proportion of the quaternary catchment (concluded)

	Area (ha)					Percentage of total area (%)			
Quaternary catchment	Total	Natural or semi-natural	Cultivated	Built-up	Waterbodies	Natural or semi-natural	Cultivated	Built-up	Waterbodies
H40F	328,6	296,2	29,4	0,0	3,0	*90,1%*	*9,0%*	*0,0%*	*0,9%*
H40G	255,7	235,1	17,8	0,0	2,9	*91,9%*	*7,0%*	*0,0%*	*1,1%*
H40H	206,3	197,3	7,7	0,0	1,3	*95,6%*	*3,7%*	*0,0%*	*0,6%*
H40J	205,4	172,1	24,6	4,6	4,1	*83,8%*	*12,0%*	*2,2%*	*2,0%*
H40K	271,3	252,1	16,6	0,0	2,6	*92,9%*	*6,1%*	*0,0%*	*0,9%*
H40L	164,7	113,6	48,0	0,6	2,6	*68,9%*	*29,2%*	*0,3%*	*1,6%*
H50A	266,3	235,7	28,1	0,0	2,5	*88,5%*	*10,5%*	*0,0%*	*0,9%*
H50B	434,9	306,1	125,6	0,0	3,3	*70,4%*	*28,9%*	*0,0%*	*0,8%*
H60A_H60B_H60C	498,9	356,5	82,1	1,0	59,3	*71,5%*	*16,5%*	*0,2%*	*11,9%*
H60D	222,0	147,0	71,3	0,0	3,8	*66,2%*	*32,1%*	*0,0%*	*1,7%*
H60E	173,2	120,3	50,7	0,8	1,4	*69,5%*	*29,3%*	*0,5%*	*0,8%*
H60F	165,1	117,8	46,3	0,0	1,0	*71,4%*	*28,1%*	*0,0%*	*0,6%*
H60G	137,5	53,1	84,1	0,0	0,3	*38,6%*	*61,2%*	*0,0%*	*0,2%*
H60H	256,6	93,5	161,4	0,0	1,7	*36,4%*	*62,9%*	*0,0%*	*0,7%*
H60J	293,0	136,6	156,1	0,0	0,3	*46,6%*	*53,3%*	*0,0%*	*0,1%*
H60K	262,1	88,0	171,0	0,0	3,1	*33,6%*	*65,2%*	*0,0%*	*1,2%*
H60L	228,2	61,3	166,8	0,0	0,1	*26,9%*	*73,1%*	*0,0%*	*0,0%*
H70A	226,3	52,7	172,6	0,0	1,0	*23,3%*	*76,3%*	*0,0%*	*0,4%*
H70B	164,0	101,5	57,4	3,6	1,5	*61,9%*	*35,0%*	*2,2%*	*0,9%*
H70C	291,3	280,0	7,9	1,6	1,8	*96,1%*	*2,7%*	*0,6%*	*0,6%*
H70D	168,3	133,4	33,8	0,0	1,1	*79,3%*	*20,1%*	*0,0%*	*0,6%*
H70E	156,5	109,4	44,2	0,9	1,9	*69,9%*	*28,3%*	*0,6%*	*1,2%*
H70F	115,4	49,1	65,3	0,0	0,9	*42,6%*	*56,6%*	*0,0%*	*0,8%*
H70G	663,0	120,6	540,8	0,0	1,6	*18,2%*	*81,6%*	*0,0%*	*0,2%*
H70H	396,4	150,4	240,3	0,0	5,7	*37,9%*	*60,6%*	*0,0%*	*1,4%*
H70J	424,9	81,1	343,6	0,0	0,2	*19,1%*	*80,9%*	*0,0%*	*0,0%*
H70K	317,3	150,3	159,1	0,0	7,9	*47,4%*	*50,1%*	*0,0%*	*2,5%*
Breede Catchment	**12 562,0**	**8 721,5**	**3 577,8**	**38,2**	**224,6**	***69,4%***	***28,5%***	***0,3%***	***1,8%***

Table 52 – Land cover composition (tier 1) per quaternary catchment in the uMngeni Catchment sub-accounting area, 2018, in hectares and as a proportion of the quaternary catchment

	Area (ha)					Percentage of total (%)			
Quaternary catchment	Total	Natural or semi-natural	Cultivated	Built-up	Waterbodies	Natural or semi-natural	Cultivated	Built-up	Waterbodies
U20A	364,7	231,0	113,4	1,5	18,8	*63,3%*	*31,1%*	*0,4%*	*5,2%*
U20B	324,7	166,3	138,1	0,7	19,5	*51,2%*	*42,5%*	*0,2%*	*6,0%*
U20C	237,2	110,9	88,7	10,8	26,9	*46,7%*	*37,4%*	*4,5%*	*11,3%*
U20D	386,7	170,2	202,5	0,1	13,9	*44,0%*	*52,4%*	*0,0%*	*3,6%*
U20E	339,2	130,4	157,5	24,5	26,8	*38,4%*	*46,4%*	*7,2%*	*7,9%*
U20F	448,0	95,3	336,5	14,0	2,2	*21,3%*	*75,1%*	*3,1%*	*0,5%*
U20G	481,5	236,5	202,3	35,5	7,2	*49,1%*	*42,0%*	*7,4%*	*1,5%*
U20H	219,9	98,3	34,2	84,7	2,8	*44,7%*	*15,6%*	*38,5%*	*1,3%*
U20J	679,5	354,9	81,9	234,2	8,5	*52,2%*	*12,1%*	*34,5%*	*1,3%*
U20K	269,0	113,2	128,2	27,2	0,4	*42,1%*	*47,6%*	*10,1%*	*0,2%*
U20L	329,4	204,8	0,7	108,4	15,6	*62,2%*	*0,2%*	*32,9%*	*4,7%*
U20M	374,2	111,0	6,5	254,8	1,8	*29,7%*	*1,7%*	*68,1%*	*0,5%*
uMngeni Catchment	**4 454,1**	**2 022,6**	**1 490,5**	**796,4**	**144,6**	**45,4%**	**33,5%**	**17,9%**	**3,2%**

Table 53 – Land cover composition (tier 1) per quaternary catchment in the Mooi Catchment sub-accounting area, 2018, in hectares and as a proportion of the quaternary catchment

	Area (ha)					Percentage of total area (%)			
Quaternary catchment	Total	Natural or semi-natural	Cultivated	Built-up	Waterbodies	Natural or semi-natural	Cultivated	Built-up	Waterbodies
V20A	267,2	226,5	29,0	1,2	10,4	*84,8%*	*10,9%*	*0,5%*	*3,9%*
V20B	190,4	115,4	63,1	0,5	11,4	*60,6%*	*33,2%*	*0,3%*	*6,0%*
V20C	189,3	129,2	43,7	0,8	15,6	*68,3%*	*23,1%*	*0,4%*	*8,2%*
V20D	285,5	133,2	116,6	1,6	34,0	*46,7%*	*40,9%*	*0,6%*	*11,9%*
V20E	608,7	390,1	181,6	8,4	28,6	*64,1%*	*29,8%*	*1,4%*	*4,7%*
V20F	153,9	80,9	57,5	2,3	13,2	*52,6%*	*37,3%*	*1,5%*	*8,6%*
V20G	255,9	216,2	34,5	3,2	2,1	*84,5%*	*13,5%*	*1,2%*	*0,8%*
V20H	610,0	482,4	76,7	48,9	1,9	*79,1%*	*12,6%*	*8,0%*	*0,3%*
V20J	307,5	261,4	23,8	21,6	0,8	*85,0%*	*7,7%*	*7,0%*	*0,3%*
Mooi Catchment	**2 868,5**	**2 035,4**	**626,5**	**88,5**	**118,0**	***71,0%***	***21,8%***	***3,1%***	***4,1%***

APPENDIX 2: WATER RESOURCE INDICATORS FOR QUATERNARY CATCHMENTS

This appendix provides the values for water resource indicators per quaternary catchment reported in Section 4. The water resource indicator values are given per quaternary catchment for the whole accounting area, which is made up of three sub-accounting areas described in Section 1.5.1. The water resource indicators were calculated per accounting period. An average of the water resource indicator over the six accounting periods (hydrological years from 2015 to 2021) was calculated along with a coefficient of variation over time.

Table 54 – Evaporation ratio per quaternary catchment for the whole accounting area, given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	239,8	81,7%	101,1%	90,1%	104,5%	79,7%	66,0%	87,2%	0,2
H10B	163,8	78,3%	104,4%	79,8%	89,4%	65,2%	57,4%	79,1%	0,2
H10C	257,0	85,4%	126,0%	82,8%	104,4%	72,0%	73,8%	90,7%	0,2
H10D	96,2	66,6%	81,4%	69,9%	84,0%	58,0%	53,3%	68,9%	0,2
H10E	84,4	48,7%	70,4%	51,0%	53,8%	39,1%	31,3%	49,0%	0,3
H10F	250,0	75,3%	111,7%	73,9%	95,6%	62,4%	61,7%	80,1%	0,2
H10G	270,8	79,3%	112,8%	87,3%	98,6%	70,3%	69,1%	86,2%	0,2
H10H	236,4	63,2%	86,5%	83,5%	86,6%	64,2%	61,9%	74,3%	0,2
H10J	215,0	52,2%	75,9%	55,1%	61,1%	44,7%	35,3%	54,1%	0,3
H10K	196,2	44,0%	69,8%	63,2%	59,8%	44,4%	35,2%	52,7%	0,3
H10L	51,0	128,6%	255,1%	161,6%	179,7%	108,6%	99,4%	155,5%	0,4
H20A	149,3	85,0%	89,9%	95,0%	97,4%	80,4%	73,3%	86,8%	0,1
H20B	119,0	63,0%	68,2%	77,0%	84,3%	60,8%	57,4%	68,4%	0,2
H20C	82,0	92,4%	111,3%	88,2%	102,4%	73,2%	65,8%	88,9%	0,2
H20D	101,2	42,3%	52,0%	64,8%	57,4%	44,2%	34,9%	49,3%	0,2
H20E	89,9	36,4%	58,4%	57,5%	60,4%	41,6%	35,5%	48,3%	0,2
H20F	117,9	51,7%	71,1%	76,4%	75,5%	53,4%	46,6%	62,5%	0,2
H20G	88,3	64,6%	90,5%	94,7%	83,8%	73,3%	69,4%	79,4%	0,2
H20H	94,7	111,7%	160,3%	119,7%	131,2%	103,7%	100,5%	121,2%	0,2
H30A	282,8	96,3%	100,6%	95,0%	89,7%	94,0%	81,5%	92,9%	0,1
H30B	316,2	108,4%	99,2%	99,1%	96,5%	95,0%	94,2%	98,7%	0,1
H30C	318,0	95,0%	90,2%	96,7%	96,2%	92,5%	93,0%	93,9%	0,0
H30D	135,2	95,2%	104,0%	101,7%	102,3%	87,4%	86,1%	96,1%	0,1
H30E	155,9	96,4%	103,2%	99,9%	98,8%	92,4%	94,7%	97,5%	0,0
H40A	184,8	72,5%	64,3%	80,6%	89,0%	70,6%	56,1%	72,2%	0,2
H40B	237,9	50,9%	55,5%	76,2%	76,3%	56,7%	47,0%	60,4%	0,2
H40C	262,8	88,8%	123,3%	100,5%	97,0%	88,6%	88,8%	97,8%	0,1

Table 54 – Evaporation ratio per quaternary catchment for the whole accounting area, given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (continued)

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H40D	173,3	73,3%	83,3%	87,6%	94,8%	70,9%	65,5%	79,2%	0,1
H40E	298,7	79,7%	118,9%	107,3%	115,6%	79,0%	73,1%	95,6%	0,2
H40F	328,6	80,7%	85,5%	93,6%	93,0%	82,2%	75,9%	85,1%	0,1
H40G	255,7	86,9%	91,8%	92,3%	90,4%	84,9%	73,2%	86,6%	0,1
H40H	206,3	89,4%	99,8%	98,4%	93,7%	84,0%	81,7%	91,2%	0,1
H40J	205,4	96,9%	106,5%	99,7%	101,6%	90,4%	88,1%	97,2%	0,1
H40K	271,3	90,2%	91,0%	92,7%	94,1%	84,5%	72,5%	87,5%	0,1
H40L	164,7	108,2%	108,3%	105,3%	103,7%	100,5%	96,5%	103,8%	0,0
H50A	266,3	98,3%	99,6%	99,8%	97,0%	94,6%	83,9%	95,5%	0,1
H50B	434,9	106,0%	98,5%	100,9%	94,3%	94,8%	86,8%	96,9%	0,1
H60A_H60B_H60C	498,9	88,3%	99,7%	66,9%	80,1%	57,2%	61,1%	75,6%	0,2
H60D	222,0	84,4%	96,9%	88,9%	86,5%	86,3%	74,7%	86,3%	0,1
H60E	173,2	90,0%	96,3%	91,3%	91,9%	86,4%	78,6%	89,1%	0,1
H60F	165,1	79,4%	94,9%	90,2%	93,1%	77,3%	61,1%	82,7%	0,2
H60G	137,5	83,1%	95,0%	88,7%	95,7%	83,7%	65,2%	85,3%	0,1
H60H	256,6	88,8%	95,5%	89,3%	94,7%	87,3%	65,1%	86,8%	0,1
H60J	293,0	94,7%	101,6%	94,4%	100,3%	95,3%	76,3%	93,8%	0,1
H60K	262,1	100,6%	100,7%	97,5%	96,8%	98,6%	84,4%	96,4%	0,1
H60L	228,2	102,6%	104,2%	99,0%	97,1%	99,5%	82,1%	97,4%	0,1
H70A	226,3	97,4%	99,1%	88,0%	83,6%	75,1%	65,1%	84,7%	0,2
H70B	164,0	94,2%	103,6%	89,3%	85,3%	76,9%	63,1%	85,4%	0,2
H70C	291,3	85,0%	100,1%	95,9%	89,0%	89,6%	68,3%	88,0%	0,1
H70D	168,3	85,3%	97,6%	91,4%	81,4%	88,6%	65,6%	85,0%	0,1
H70E	156,5	86,2%	96,9%	92,1%	81,3%	83,6%	65,4%	84,2%	0,1
H70F	115,4	93,0%	100,0%	89,5%	80,2%	84,1%	70,5%	86,2%	0,1
H70G	663,0	95,7%	94,4%	91,8%	78,2%	84,6%	68,2%	85,5%	0,1
H70H	396,4	99,7%	96,2%	94,0%	78,7%	87,1%	68,7%	87,4%	0,1
H70J	424,9	90,9%	94,7%	92,6%	82,6%	96,8%	74,0%	88,6%	0,1
H70K	317,3	95,0%	96,1%	95,3%	86,8%	96,2%	75,7%	90,9%	0,1
U20A	364,7	91,0%	77,8%	72,8%	95,2%	82,5%	75,0%	82,4%	0,1
U20B	324,7	92,8%	79,5%	73,7%	95,2%	83,0%	75,1%	83,2%	0,1
U20C	237,2	96,5%	83,4%	77,1%	96,7%	89,2%	79,7%	87,1%	0,1
U20D	386,7	88,7%	83,7%	72,8%	82,5%	78,9%	81,4%	81,3%	0,1
U20E	339,2	90,1%	82,6%	72,3%	89,4%	81,9%	77,8%	82,3%	0,1
U20F	448,0	89,6%	87,7%	77,8%	85,5%	82,8%	85,6%	84,8%	0,0
U20G	481,5	85,5%	90,2%	87,0%	79,4%	89,5%	83,3%	85,8%	0,0
U20H	219,9	75,9%	65,6%	60,0%	77,7%	70,0%	63,0%	68,7%	0,1
U20J	679,5	73,3%	78,9%	73,2%	66,7%	74,0%	66,5%	72,1%	0,1

Table 54 – Evaporation ratio per quaternary catchment for the whole accounting area, given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
U20K	269,0	77,8%	84,6%	80,9%	79,0%	84,4%	76,1%	80,5%	0,0
U20L	329,4	70,2%	81,0%	79,9%	75,3%	76,3%	73,6%	76,1%	0,1
U20M	374,2	51,3%	64,8%	60,6%	61,7%	57,8%	51,3%	57,9%	0,1
V20A	267,2	75,3%	67,9%	72,0%	90,7%	79,7%	66,2%	75,3%	0,1
V20B	190,4	83,2%	75,3%	82,9%	87,8%	92,1%	71,2%	82,1%	0,1
V20C	189,3	85,0%	79,9%	89,2%	83,7%	100,5%	74,2%	85,4%	0,1
V20D	285,5	92,3%	87,6%	96,8%	90,5%	104,1%	79,2%	91,8%	0,1
V20E	608,7	76,5%	85,4%	83,2%	87,2%	100,4%	83,0%	86,0%	0,1
V20F	153,9	62,9%	77,6%	74,1%	78,8%	96,6%	73,1%	77,2%	0,1
V20G	255,9	66,9%	80,1%	78,2%	82,0%	96,8%	79,2%	80,5%	0,1
V20H	610,0	67,1%	78,4%	75,9%	81,4%	95,8%	78,4%	79,5%	0,1
V20J	307,5	60,5%	77,6%	76,9%	81,8%	95,1%	79,6%	78,6%	0,1

Table 55 – Surface runoff ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	239,8	1,6%	0,5%	0,2%	0,7%	0,7%	2,1%	1,0%	0,8
H10B	163,8	9,2%	7,0%	5,4%	9,0%	6,5%	11,2%	8,1%	0,3
H10C	257,0	2,0%	1,4%	1,0%	1,9%	1,5%	3,1%	1,8%	0,4
H10D	96,2	9,5%	9,1%	8,6%	9,6%	9,6%	10,4%	9,5%	0,1
H10E	84,4	20,2%	18,6%	14,6%	16,7%	26,1%	33,9%	21,7%	0,3
H10F	250,0	4,1%	3,6%	3,0%	5,2%	4,7%	9,0%	4,9%	0,4
H10G	270,8	4,7%	2,5%	0,9%	3,9%	2,1%	7,2%	3,5%	0,6
H10H	236,4	12,9%	7,9%	4,2%	12,1%	6,1%	10,8%	9,0%	0,4
H10J	215,0	16,5%	13,4%	12,2%	11,6%	17,9%	25,0%	16,1%	0,3
H10K	196,2	25,0%	13,6%	8,7%	9,0%	13,5%	21,6%	15,2%	0,4
H10L	51,0	13,8%	7,9%	7,2%	6,6%	7,8%	12,1%	9,2%	0,3
H20A	149,3	6,2%	0,7%	0,2%	0,1%	0,9%	1,5%	1,6%	1,4
H20B	119,0	9,6%	8,7%	5,0%	3,8%	4,8%	8,2%	6,7%	0,4
H20C	82,0	3,4%	1,9%	1,3%	1,0%	2,5%	5,5%	2,6%	0,6
H20D	101,2	22,9%	21,9%	14,7%	16,1%	19,1%	21,7%	19,4%	0,2
H20E	89,9	31,5%	19,6%	15,7%	22,2%	18,4%	24,6%	22,0%	0,3
H20F	117,9	13,6%	12,8%	6,7%	6,7%	9,9%	11,9%	10,3%	0,3
H20G	88,3	9,4%	3,5%	3,1%	3,3%	3,7%	5,1%	4,7%	0,5
H20H	94,7	3,6%	3,3%	3,3%	3,3%	3,5%	6,1%	3,9%	0,3
H30A	282,8	3,8%	2,9%	3,1%	4,0%	2,3%	5,3%	3,6%	0,3
H30B	316,2	0,2%	0,1%	0,1%	0,1%	0,1%	0,6%	0,2%	1,0
H30C	318,0	4,1%	4,0%	3,7%	3,8%	3,8%	3,9%	3,9%	0,0
H30D	135,2	2,5%	1,1%	1,0%	1,3%	1,0%	1,4%	1,4%	0,4
H30E	155,9	0,2%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	2,4
H40A	184,8	9,4%	6,1%	3,9%	2,3%	2,2%	7,4%	5,2%	0,6
H40B	237,9	19,1%	14,1%	7,3%	5,5%	9,2%	11,8%	11,2%	0,4
H40C	262,8	5,3%	0,2%	0,0%	0,4%	0,1%	1,2%	1,2%	1,7
H40D	173,3	9,0%	2,6%	0,6%	1,0%	1,0%	7,5%	3,6%	1,0
H40E	298,7	10,6%	4,8%	2,3%	2,1%	4,3%	9,5%	5,6%	0,7
H40F	328,6	8,3%	5,6%	4,4%	4,6%	4,9%	6,9%	5,8%	0,3
H40G	255,7	5,4%	3,9%	3,5%	3,6%	3,8%	5,4%	4,3%	0,2
H40H	206,3	3,4%	0,9%	0,6%	1,1%	1,0%	1,0%	1,3%	0,7
H40J	205,4	5,0%	3,2%	2,8%	2,6%	3,1%	3,3%	3,3%	0,3
H40K	271,3	5,2%	3,7%	3,6%	3,8%	4,1%	5,2%	4,3%	0,2
H40L	164,7	0,4%	0,1%	0,0%	0,1%	0,0%	0,1%	0,1%	1,2
H50A	266,3	2,4%	2,2%	2,0%	2,3%	2,0%	2,7%	2,3%	0,1
H50B	434,9	0,1%	0,0%	0,1%	0,4%	0,3%	0,7%	0,3%	1,0
H60A_H60B_H60C	498,9	13,7%	7,4%	5,0%	4,7%	8,0%	14,7%	8,9%	0,5

Table 55 – Surface runoff ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H60D	222,0	3,3%	1,6%	1,2%	1,8%	1,7%	3,1%	2,1%	0,4
H60E	173,2	3,0%	1,9%	1,5%	1,6%	2,1%	3,1%	2,2%	0,3
H60F	165,1	11,0%	1,2%	0,7%	0,5%	1,4%	9,2%	4,0%	1,2
H60G	137,5	4,6%	1,0%	0,3%	0,3%	0,4%	13,8%	3,4%	1,6
H60H	256,6	6,7%	1,1%	1,1%	0,7%	0,6%	9,1%	3,2%	1,2
H60J	293,0	4,6%	0,2%	0,3%	0,7%	0,4%	4,7%	1,8%	1,2
H60K	262,1	1,5%	0,0%	0,2%	0,9%	0,1%	1,3%	0,7%	1,0
H60L	228,2	0,6%	0,0%	0,8%	1,0%	0,8%	3,0%	1,0%	1,0
H70A	226,3	2,6%	0,6%	3,1%	5,3%	6,4%	10,5%	4,7%	0,7
H70B	164,0	4,3%	0,8%	3,4%	6,6%	1,6%	9,0%	4,3%	0,7
H70C	291,3	4,8%	0,9%	2,0%	2,4%	1,2%	7,2%	3,1%	0,8
H70D	168,3	4,0%	0,6%	1,0%	2,5%	0,6%	4,2%	2,1%	0,8
H70E	156,5	4,9%	0,4%	1,6%	2,4%	0,6%	4,6%	2,4%	0,8
H70F	115,4	4,1%	0,6%	3,2%	5,4%	1,0%	5,9%	3,4%	0,7
H70G	663,0	3,3%	1,1%	2,5%	5,8%	4,7%	10,8%	4,7%	0,7
H70H	396,4	2,6%	0,5%	1,8%	3,4%	4,9%	11,8%	4,2%	1,0
H70J	424,9	4,1%	0,5%	3,0%	1,9%	1,5%	6,0%	2,8%	0,7
H70K	317,3	2,0%	0,9%	1,8%	1,7%	1,4%	6,4%	2,4%	0,8
U20A	364,7	6,0%	15,4%	11,4%	5,6%	9,3%	10,9%	9,8%	0,4
U20B	324,7	6,5%	15,8%	12,1%	6,6%	10,1%	11,6%	10,5%	0,3
U20C	237,2	6,2%	13,9%	10,6%	6,4%	8,7%	9,9%	9,3%	0,3
U20D	386,7	5,6%	11,6%	10,1%	12,0%	8,2%	10,3%	9,6%	0,2
U20E	339,2	4,0%	10,8%	8,7%	6,6%	6,6%	8,5%	7,5%	0,3
U20F	448,0	1,6%	5,0%	4,0%	5,8%	3,3%	4,7%	4,1%	0,4
U20G	481,5	4,6%	5,1%	5,5%	11,2%	3,5%	6,6%	6,1%	0,4
U20H	219,9	8,7%	15,1%	12,5%	8,4%	10,8%	12,0%	11,3%	0,2
U20J	679,5	12,1%	10,8%	13,4%	18,4%	10,9%	15,2%	13,5%	0,2
U20K	269,0	6,3%	5,7%	6,2%	9,5%	4,3%	7,5%	6,6%	0,3
U20L	329,4	9,1%	5,9%	8,2%	11,0%	7,6%	8,5%	8,4%	0,2
U20M	374,2	20,7%	14,5%	16,9%	18,7%	17,6%	18,3%	17,8%	0,1
V20A	267,2	11,1%	12,8%	10,4%	7,5%	8,5%	11,1%	10,2%	0,2
V20B	190,4	9,3%	12,1%	7,8%	7,0%	5,7%	11,2%	8,8%	0,3
V20C	189,3	12,4%	15,9%	9,0%	9,2%	5,1%	14,8%	11,1%	0,4
V20D	285,5	10,0%	12,6%	7,6%	8,3%	6,2%	12,6%	9,6%	0,3
V20E	608,7	18,9%	15,9%	15,8%	12,6%	5,9%	13,3%	13,7%	0,3
V20F	153,9	30,7%	21,7%	20,9%	17,5%	8,0%	18,0%	19,5%	0,4
V20G	255,9	23,8%	16,0%	16,6%	12,9%	5,4%	13,7%	14,7%	0,4
V20H	610,0	22,3%	15,0%	16,2%	12,1%	5,6%	13,4%	14,1%	0,4
V20J	307,5	26,3%	13,0%	14,1%	10,1%	4,6%	11,6%	13,3%	0,5

Table 56 – Per capita net water resources per quaternary catchment for the whole accounting area given as annualised volume (m^3) from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Population	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	2 547,8	12 128,7	5 608,5	6 451,8	2 358,7	13 372,9	39 907,3	13 304,6	1,0
H10B	1 351,1	30 453,1	12 680,8	23 228,4	16 734,3	49 047,5	83 033,6	35 862,9	0,7
H10C	47 861,8	1 406,0	570,9	914,5	615,8	2 001,4	4 795,1	1 717,3	0,9
H10D	589,5	109 179,5	56 464,9	75 095,1	57 369,0	151 531,3	336 330,5	130 995,0	0,8
H10E	732,7	75 715,1	22 654,5	75 110,7	60 375,1	132 926,1	164 322,4	88 517,3	0,6
H10F	15 925,2	9 036,1	3 492,1	7 273,5	5 158,8	15 159,7	24 653,2	10 795,6	0,7
H10G	11 418,9	23 092,4	9 112,4	16 351,7	13 404,8	36 002,2	57 924,0	25 981,3	0,7
H10H	12 788,0	25 683,0	9 932,1	14 385,3	12 908,1	35 869,5	61 017,4	26 632,6	0,7
H10J	868,2	189 610,2	62 835,7	164 196,8	130 548,0	297 208,0	406 622,4	208 503,5	0,6
H10K	724,3	206 604,9	56 016,6	112 423,8	115 119,4	310 138,5	402 730,9	200 505,6	0,7
H10L	1 363,2	-11 511,7	-7 083,5	-6 226,6	-6 968,0	821,4	6 904,0	-4 010,7	-1,7
H20A	4 164,7	3 843,9	2 614,6	1 739,7	1 234,1	4 516,0	10 200,5	4 024,8	0,8
H20B	19 303,8	2 052,3	1 279,7	1 202,1	749,3	2 143,3	4 511,5	1 989,7	0,7
H20C	528,4	20 184,1	9 088,3	13 787,8	7 710,3	32 165,6	75 540,8	26 412,8	1,0
H20D	506,5	103 521,7	42 647,4	53 417,4	60 182,0	129 609,3	235 582,0	104 159,9	0,7
H20E	388,9	140 984,5	48 767,6	77 521,0	58 504,3	184 124,3	230 253,6	123 359,2	0,6
H20F	10 831,7	13 633,2	6 268,4	6 676,5	6 154,5	15 190,8	26 992,1	12 485,9	0,7
H20G	2 089,4	66 408,1	29 693,3	29 548,2	27 969,9	69 466,3	127 189,0	58 379,1	0,7
H20H	89 025,2	4 962,9	1 908,8	2 936,0	2 617,3	7 153,8	12 170,7	5 291,6	0,7
H30A	1 394,7	15 478,9	5 562,9	6 564,4	9 157,5	10 844,6	33 172,0	13 463,4	0,8
H30B	15 701,3	1 181,3	572,4	391,8	454,8	755,2	1 944,6	883,3	0,7
H30C	1 459,5	9 372,2	7 837,8	5 107,4	3 612,5	6 471,0	10 191,4	7 098,7	0,4
H30D	2 807,7	7 267,2	4 661,9	3 949,5	3 108,0	6 290,1	10 443,1	5 953,3	0,4
H30E	16 663,4	2 082,2	997,0	719,2	629,2	905,6	2 386,4	1 286,6	0,6
H40A	165,3	176 825,7	140 392,1	123 134,5	86 364,7	231 460,4	575 895,2	222 345,4	0,8
H40B	1 161,2	83 511,7	51 775,4	44 358,5	39 024,1	103 251,8	202 548,3	87 411,6	0,7
H40C	3 515,5	24 636,8	13 368,9	9 984,0	8 138,2	22 716,3	50 847,0	21 615,2	0,7
H40D	801,7	33 971,4	24 136,7	17 225,5	11 406,2	47 319,9	86 710,8	36 795,1	0,7
H40E	1 834,6	329 900,9	142 328,6	179 669,7	157 960,8	429 690,6	751 521,3	331 845,3	0,7
H40F	2 228,6	258 264,2	113 168,5	141 812,9	123 641,6	344 292,9	623 704,5	267 480,7	0,7
H40G	1 142,8	23 089,6	13 208,8	10 352,3	10 015,4	25 354,8	56 897,6	23 153,1	0,8
H40H	2 091,5	7 937,1	3 046,2	1 360,9	2 803,4	8 363,5	18 562,6	7 012,3	0,9
H40J	25 633,6	23 296,4	10 276,7	12 763,7	11 121,1	30 341,0	55 803,8	23 933,8	0,7
H40K	4 664,1	4 547,6	2 753,9	2 309,9	1 800,9	5 349,0	15 525,6	5 381,2	1,0
H40L	7 428,7	81 170,7	36 123,8	44 535,4	38 782,7	104 745,0	195 215,4	83 428,8	0,7
H50A	2 351,6	272 957,6	122 601,9	146 295,1	127 227,4	338 380,1	643 909,2	275 228,5	0,7
H50B	13 254,6	48 718,3	21 685,5	25 924,4	22 762,5	60 688,8	116 076,0	49 309,3	0,7
H60A	20 550,3	-3 812,3	-189,3	6 343,4	5 388,0	12 087,6	10 252,5	5 011,7	1,2
H60D	3 960,8	15 121,0	8 662,5	5 374,8	11 025,3	13 084,2	23 942,9	12 868,4	0,5

Table 56 – Per capita net water resources per quaternary catchment for the whole accounting area given as annualised volume (m3) from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Population	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H60E	5 103,8	11 664,8	7 267,9	4 095,6	9 018,7	9 987,6	19 312,3	10 224,5	0,5
H60F	4 763,3	16 356,9	9 160,4	5 202,0	10 344,9	14 751,8	32 601,8	14 736,3	0,7
H60G	433,7	41 021,2	17 225,1	20 203,0	11 273,3	37 123,0	127 566,1	42 401,9	1,0
H60H	998,1	104 051,6	57 607,4	37 352,7	55 759,0	83 498,3	250 221,6	98 081,7	0,8
H60J	6 122,7	18 821,2	10 666,1	7 151,5	10 122,3	13 747,1	44 786,8	17 549,1	0,8
H60K	878,5	125 693,4	67 906,5	39 798,7	65 082,6	80 912,0	303 377,7	113 795,2	0,9
H60L	630,5	188 720,2	104 139,7	62 975,9	100 925,0	123 013,0	452 686,8	172 076,8	0,8
H70A	938,7	837 591,6	384 755,6	428 421,8	410 886,0	998 004,5	2 036 706,3	849 394,3	0,7
H70B	17 891,4	45 056,3	20 565,2	22 924,6	22 252,9	53 854,1	110 441,3	45 849,1	0,8
H70C	5 417,7	7 516,5	2 204,8	1 907,4	1 769,7	5 930,7	23 162,8	7 082,0	1,2
H70D	538,2	96 061,1	30 460,6	34 489,5	41 523,9	66 970,1	297 111,9	94 436,2	1,1
H70E	2 607,5	26 257,3	8 549,0	8 561,7	12 427,9	22 055,4	79 745,3	26 266,1	1,0
H70F	2 185,9	33 331,9	10 849,9	12 015,2	17 319,5	27 997,1	102 040,7	33 925,7	1,0
H70G	1 830,4	501 888,3	226 473,8	253 890,7	275 513,0	597 060,4	1 335 873,5	531 783,3	0,8
H70H	993,6	923 808,8	415 009,3	463 217,1	516 701,7	1 096 270,0	2 497 444,3	985 408,5	0,8
H70J	3 849,3	8 785,3	3 940,7	5 834,4	8 187,5	7 985,8	36 672,1	11 901,0	1,0
H70K	867,3	1 087 888,0	482 839,6	535 638,9	591 254,5	1 254 261,2	2 957 952,3	1 151 639,1	0,8
U20A	4 722,6	9 125,7	21 304,3	35 034,8	6 986,9	19 868,7	27 515,6	19 972,7	0,5
U20B	12 520,7	11 617,2	13 810,6	20 129,6	12 411,4	16 341,1	16 906,0	15 202,6	0,2
U20C	36 570,5	3 313,5	5 299,3	8 454,2	3 670,1	5 477,1	6 743,0	5 492,8	0,3
U20D	7 386,3	6 975,2	16 146,3	27 359,1	14 045,0	17 290,1	15 702,1	16 253,0	0,4
U20E	35 963,1	4 627,6	9 379,6	15 294,8	6 984,4	9 660,6	11 177,6	9 520,8	0,4
U20F	30 222,7	1 366,6	3 590,3	6 013,2	2 918,1	3 596,3	3 023,6	3 418,0	0,4
U20G	37 965,2	3 157,0	10 411,2	15 015,0	8 493,5	9 165,5	11 298,4	9 590,1	0,4
U20H	105 526,0	266,3	502,8	821,3	267,2	449,2	615,7	487,1	0,4
U20J	566 912,8	293,9	345,9	437,1	441,2	371,7	477,1	394,5	0,2
U20K	28 296,6	2 044,3	2 572,1	2 445,2	2 164,7	1 808,5	2 478,3	2 252,2	0,1
U20L	125 200,8	1 729,3	4 060,9	5 770,2	3 799,3	3 661,5	4 781,2	3 967,1	0,3
U20M	1 139 829,0	348,3	575,2	775,5	543,9	541,7	713,9	583,1	0,3
V20A	1 695,2	47 799,1	94 477,1	63 468,3	18 049,6	41 913,5	87 493,1	58 866,8	0,5
V20B	1 407,3	29 021,4	51 194,8	32 744,6	23 520,0	20 427,4	52 317,5	34 870,9	0,4
V20C	1 234,3	25 783,9	36 948,2	19 461,1	30 274,6	7 974,3	40 157,8	26 766,6	0,4
V20D	3 334,4	12 452,4	44 760,5	11 778,2	-1 251,2	12 655,8	42 842,7	20 539,7	0,9
V20E	23 460,5	6 828,0	8 723,9	6 777,3	4 576,9	2 128,8	5 737,9	5 795,5	0,4
V20F	1 571,0	38 691,9	30 460,9	29 267,7	21 727,5	6 598,8	26 187,2	25 489,0	0,4
V20G	3 840,9	62 093,4	69 242,2	58 972,7	39 441,5	14 964,7	48 162,0	48 812,8	0,4
V20H	37 734,7	10 684,6	10 626,2	9 594,6	6 344,3	2 441,9	7 668,0	7 893,3	0,4
V20J	16 333,5	28 235,5	26 064,1	23 469,3	15 249,9	5 447,9	18 633,7	19 516,7	0,4

Table 57 – Water resource dependency ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	239,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10B	163,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10C	257,0	43,8%	62,7%	39,1%	55,8%	31,7%	45,7%	46,5%	0,2
H10D	96,2	62,6%	69,3%	52,2%	66,9%	48,9%	71,4%	61,9%	0,2
H10E	84,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10F	250,0	61,4%	78,0%	57,0%	70,3%	53,1%	64,7%	64,1%	0,1
H10G	270,8	77,5%	79,1%	85,0%	87,2%	77,8%	81,0%	81,3%	0,0
H10H	236,4	78,2%	77,4%	84,0%	85,8%	82,5%	86,6%	82,4%	0,0
H10J	215,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10K	196,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10L	51,0	17,4%	28,7%	30,8%	26,2%	22,3%	26,8%	25,4%	0,2
H20A	149,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20B	119,0	22,1%	19,8%	17,9%	22,2%	9,6%	22,6%	19,0%	0,3
H20C	82,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20D	101,2	6,5%	7,8%	10,5%	19,8%	2,0%	10,8%	9,6%	0,6
H20E	89,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20F	117,9	63,9%	64,5%	68,3%	68,9%	60,8%	63,7%	65,0%	0,0
H20G	88,3	87,4%	90,6%	96,0%	93,5%	90,4%	91,2%	91,5%	0,0
H20H	94,7	98,9%	98,6%	99,3%	99,5%	99,6%	99,5%	99,2%	0,0
H30A	282,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30B	316,2	77,5%	76,6%	86,1%	87,6%	51,0%	58,1%	72,8%	0,2
H30C	318,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30D	135,2	40,9%	42,9%	47,8%	42,0%	23,2%	23,2%	36,7%	0,3
H30E	155,9	87,6%	90,8%	96,3%	98,8%	84,0%	89,5%	91,1%	0,1
H40A	184,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40B	237,9	17,5%	21,4%	21,6%	18,6%	13,6%	21,9%	19,1%	0,2
H40C	262,8	75,1%	86,5%	96,3%	97,0%	88,8%	86,4%	88,3%	0,1
H40D	173,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40E	298,7	89,7%	88,8%	93,9%	94,8%	91,7%	92,5%	91,9%	0,0
H40F	328,6	94,3%	91,1%	96,3%	96,9%	95,7%	94,9%	94,9%	0,0
H40G	255,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40H	206,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40J	205,4	97,9%	98,1%	98,8%	98,9%	98,5%	98,0%	98,4%	0,0
H40K	271,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40L	164,7	99,6%	99,7%	99,8%	99,7%	99,9%	99,6%	99,7%	0,0
H50A	266,3	98,6%	98,1%	99,1%	99,2%	99,1%	97,7%	98,7%	0,0
H50B	434,9	98,5%	98,9%	99,6%	98,8%	98,2%	96,7%	98,4%	0,0
H60A_H60B_H60C	498,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60D	222,0	58,9%	65,2%	33,3%	67,7%	47,1%	35,8%	51,3%	0,3

Table 57 – Water resource dependency ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H60E	173,2	78,1%	79,4%	59,6%	77,9%	66,0%	62,4%	70,6%	0,1
H60F	165,1	67,1%	76,7%	63,1%	80,8%	56,5%	50,2%	65,7%	0,2
H60G	137,5	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60H	256,6	74,7%	79,8%	63,1%	86,2%	68,0%	61,5%	72,2%	0,1
H60J	293,0	80,7%	82,1%	67,6%	85,7%	77,1%	74,7%	78,0%	0,1
H60K	262,1	92,8%	95,0%	90,3%	96,1%	94,8%	88,0%	92,8%	0,0
H60L	228,2	91,0%	90,3%	83,6%	89,0%	88,3%	85,9%	88,0%	0,0
H70A	226,3	96,5%	96,5%	93,8%	92,4%	92,1%	92,4%	93,9%	0,0
H70B	164,0	95,9%	96,1%	94,3%	93,2%	93,1%	93,4%	94,3%	0,0
H70C	291,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70D	168,3	47,3%	52,8%	30,6%	22,4%	30,9%	41,3%	37,5%	0,3
H70E	156,5	59,7%	65,4%	50,9%	42,6%	37,1%	54,7%	51,7%	0,2
H70F	115,4	79,4%	82,1%	61,6%	60,8%	61,3%	73,0%	69,7%	0,1
H70G	663,0	92,9%	91,2%	88,6%	81,6%	88,4%	86,1%	88,1%	0,0
H70H	396,4	96,8%	95,6%	94,2%	89,2%	94,1%	92,4%	93,7%	0,0
H70J	424,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70K	317,3	98,2%	98,0%	98,0%	97,4%	98,7%	96,5%	97,8%	0,0
U20A	364,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20B	324,7	76,9%	50,7%	42,9%	78,2%	60,5%	45,6%	59,1%	0,3
U20C	237,2	90,1%	82,4%	80,1%	89,8%	86,7%	82,4%	85,2%	0,0
U20D	386,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20E	339,2	78,8%	74,9%	73,0%	76,8%	75,3%	75,8%	75,8%	0,0
U20F	448,0	2,3%	0,9%	0,5%	1,1%	0,9%	1,1%	1,1%	0,6
U20G	481,5	73,3%	83,8%	87,4%	73,5%	86,7%	85,3%	81,7%	0,1
U20H	219,9	19,3%	10,2%	6,3%	19,2%	11,5%	8,3%	12,5%	0,4
U20J	679,5	33,6%	37,1%	36,9%	22,7%	32,1%	29,2%	31,9%	0,2
U20K	269,0	2,2%	1,7%	1,8%	2,0%	2,4%	1,8%	2,0%	0,1
U20L	329,4	84,2%	92,2%	94,9%	91,2%	91,7%	94,0%	91,4%	0,0
U20M	374,2	64,0%	83,6%	86,6%	83,2%	80,6%	79,0%	79,5%	0,1
V20A	267,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20B	190,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20C	189,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20D	285,5	71,4%	74,2%	73,3%	51,4%	73,0%	69,2%	68,7%	0,1
V20E	608,7	21,0%	37,4%	35,4%	30,2%	47,3%	38,6%	35,0%	0,3
V20F	153,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20G	255,9	66,6%	76,2%	74,4%	73,7%	79,3%	75,0%	74,2%	0,1
V20H	610,0	54,5%	62,6%	59,3%	59,9%	60,6%	61,0%	59,7%	0,0
V20J	307,5	75,3%	83,1%	82,8%	83,7%	84,5%	84,5%	82,3%	0,0

Table 58 – Reserved outflow ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	239,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10B	163,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10C	257,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10D	96,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10E	84,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10F	250,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10G	270,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10H	236,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10J	215,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10K	196,2	4,6%	15,6%	8,1%	8,1%	3,0%	2,3%	7,0%	0,7
H10L	51,0	259,4%	330,4%	288,6%	311,5%	90,9%	49,4%	221,7%	0,5
H20A	149,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20B	119,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20C	82,0	1,8%	0,3%	2,2%	0,4%	2,4%	0,5%	1,3%	0,8
H20D	101,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20E	89,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20F	117,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20G	88,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20H	94,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30A	282,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30B	316,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30C	318,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30D	135,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H30E	155,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40A	184,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40B	237,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40C	262,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40D	173,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40E	298,7	0,3%	0,5%	0,4%	0,4%	0,3%	0,4%	0,4%	0,2
H40F	328,6	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40G	255,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40H	206,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40J	205,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40K	271,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40L	164,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H50A	266,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H50B	434,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60A_H60B_H60C	498,9	146,1%	105,2%	10,9%	22,1%	17,5%	41,6%	57,3%	1,0
H60D	222,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-

Table 58 – Reserved outflow ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H60E	173,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60F	165,1	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60G	137,5	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60H	256,6	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60J	293,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60K	262,1	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60L	228,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70A	226,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70B	164,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70C	291,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70D	168,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70E	156,5	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70F	115,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70G	663,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70H	396,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70J	424,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70K	317,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20A	364,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20B	324,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20C	237,2	34,4%	24,7%	17,0%	32,3%	24,4%	20,3%	25,5%	0,3
U20D	386,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20E	339,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20F	448,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20G	481,5	39,8%	16,8%	12,2%	19,9%	18,8%	15,5%	20,5%	0,5
U20H	219,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20J	679,5	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20K	269,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20L	329,4	29,5%	15,3%	11,4%	16,6%	17,3%	14,0%	17,3%	0,4
U20M	374,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20A	267,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20B	190,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20C	189,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20D	285,5	67,7%	36,0%	72,8%	103,9%	52,9%	37,0%	61,7%	0,4
V20E	608,7	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20F	153,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20G	255,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20H	610,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
V20J	307,5	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-

Table 59 – Incremental evaporation: total evaporation ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H10A	239,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10B	163,8	16,4%	23,8%	9,0%	13,6%	7,4%	14,3%	14,1%	0,4
H10C	257,0	11,1%	21,9%	3,9%	10,9%	3,6%	16,1%	11,3%	0,6
H10D	96,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10E	84,4	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H10F	250,0	5,7%	14,0%	2,1%	7,4%	1,7%	11,6%	7,1%	0,7
H10G	270,8	8,2%	16,5%	6,0%	8,3%	5,5%	11,1%	9,3%	0,4
H10H	236,4	4,4%	8,5%	3,7%	4,7%	3,0%	3,7%	4,7%	0,4
H10J	215,0	2,9%	4,5%	2,9%	3,0%	2,2%	2,4%	3,0%	0,3
H10K	196,2	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,5
H10L	51,0	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H20A	149,3	2,4%	5,2%	1,7%	1,5%	1,7%	1,3%	2,3%	0,6
H20B	119,0	7,7%	15,4%	4,2%	3,7%	3,5%	5,9%	6,7%	0,7
H20C	82,0	13,9%	17,7%	7,1%	8,3%	4,6%	12,5%	10,7%	0,5
H20D	101,2	0,5%	1,0%	0,2%	0,4%	0,3%	0,3%	0,5%	0,7
H20E	89,9	0,3%	1,0%	0,3%	0,3%	0,2%	0,9%	0,5%	0,7
H20F	117,9	10,6%	18,1%	5,7%	9,2%	6,1%	7,8%	9,6%	0,5
H20G	88,3	0,7%	1,6%	0,2%	0,1%	0,1%	0,7%	0,6%	1,0
H20H	94,7	18,2%	30,1%	20,4%	22,4%	14,5%	12,7%	19,7%	0,3
H30A	282,8	3,2%	4,1%	0,3%	0,9%	1,1%	1,6%	1,9%	0,8
H30B	316,2	4,9%	1,1%	0,0%	0,1%	0,2%	2,7%	1,5%	1,3
H30C	318,0	1,4%	1,9%	1,2%	1,2%	1,0%	0,9%	1,3%	0,3
H30D	135,2	6,7%	10,3%	4,9%	5,7%	4,1%	4,1%	6,0%	0,4
H30E	155,9	1,4%	0,7%	0,0%	0,0%	0,2%	0,3%	0,4%	1,3
H40A	184,8	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40B	237,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H40C	262,8	7,0%	12,9%	1,2%	0,6%	0,1%	3,7%	4,3%	1,2
H40D	173,3	5,3%	7,7%	2,7%	1,9%	0,8%	2,7%	3,5%	0,7
H40E	298,7	3,6%	4,9%	2,9%	2,3%	2,1%	1,9%	3,0%	0,4
H40F	328,6	0,4%	0,9%	0,3%	0,1%	0,1%	0,5%	0,4%	0,7
H40G	255,7	1,8%	1,8%	0,9%	0,7%	0,7%	0,9%	1,1%	0,5
H40H	206,3	1,0%	1,4%	0,4%	0,3%	0,2%	0,6%	0,6%	0,7
H40J	205,4	2,2%	3,2%	1,0%	0,8%	0,7%	1,2%	1,5%	0,6
H40K	271,3	0,8%	0,7%	0,4%	0,4%	0,4%	0,4%	0,5%	0,4
H40L	164,7	2,9%	2,0%	1,3%	1,5%	1,2%	0,9%	1,6%	0,4
H50A	266,3	0,7%	0,8%	0,4%	0,2%	0,1%	0,5%	0,4%	0,6
H50B	434,9	1,5%	0,3%	0,2%	0,3%	0,4%	0,9%	0,6%	0,8
H60A_H60B_H60C	498,9	25,9%	24,1%	6,3%	19,2%	12,6%	18,3%	17,7%	0,4
H60D	222,0	2,5%	3,1%	1,1%	1,5%	1,0%	1,8%	1,8%	0,5

Table 59 – Incremental evaporation: total evaporation ratio per quaternary catchment for the whole accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time (concluded)

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
H60E	173,2	2,3%	3,2%	1,5%	1,9%	1,5%	1,7%	2,0%	0,3
H60F	165,1	0,4%	0,9%	0,5%	0,2%	0,1%	0,2%	0,4%	0,8
H60G	137,5	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60H	256,6	1,1%	1,2%	0,5%	0,3%	0,3%	0,9%	0,7%	0,6
H60J	293,0	3,3%	5,2%	3,3%	3,2%	2,3%	2,0%	3,2%	0,3
H60K	262,1	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H60L	228,2	2,2%	3,7%	2,1%	2,4%	1,5%	1,3%	2,2%	0,4
H70A	226,3	0,8%	1,8%	1,0%	1,5%	0,6%	0,8%	1,1%	0,4
H70B	164,0	4,5%	7,6%	4,8%	6,0%	3,5%	3,6%	5,0%	0,3
H70C	291,3	0,2%	0,3%	0,2%	0,3%	0,1%	0,1%	0,2%	0,3
H70D	168,3	0,1%	0,2%	0,2%	0,4%	0,1%	0,1%	0,2%	0,6
H70E	156,5	0,1%	0,1%	0,1%	0,1%	0,0%	0,0%	0,1%	0,2
H70F	115,4	1,9%	1,9%	1,2%	1,9%	0,6%	2,2%	1,6%	0,4
H70G	663,0	0,7%	1,2%	0,8%	1,0%	0,6%	0,5%	0,8%	0,3
H70H	396,4	1,2%	2,0%	1,2%	1,5%	1,0%	0,8%	1,3%	0,3
H70J	424,9	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
H70K	317,3	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	-
U20A	364,7	0,2%	0,2%	0,2%	0,2%	0,1%	0,0%	0,2%	0,6
U20B	324,7	0,6%	1,4%	1,3%	1,1%	0,2%	0,1%	0,8%	0,7
U20C	237,2	1,2%	1,3%	1,0%	1,2%	0,9%	0,9%	1,1%	0,2
U20D	386,7	0,8%	0,7%	0,7%	1,2%	0,8%	0,6%	0,8%	0,3
U20E	339,2	0,5%	0,5%	0,4%	0,5%	0,4%	0,4%	0,5%	0,2
U20F	448,0	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1
U20G	481,5	0,6%	0,6%	0,5%	0,7%	0,6%	0,5%	0,6%	0,1
U20H	219,9	1,7%	1,9%	1,5%	1,7%	1,6%	1,6%	1,7%	0,1
U20J	679,5	3,8%	3,9%	3,4%	3,9%	3,7%	3,3%	3,7%	0,1
U20K	269,0	0,6%	0,7%	0,6%	0,8%	0,7%	0,6%	0,7%	0,1
U20L	329,4	1,5%	1,4%	1,3%	1,4%	1,5%	1,2%	1,4%	0,1
U20M	374,2	17,5%	16,9%	15,6%	16,8%	18,0%	12,9%	16,3%	0,1
V20A	267,2	0,1%	0,0%	0,1%	0,1%	0,0%	0,0%	0,1%	0,8
V20B	190,4	2,0%	0,6%	2,6%	3,4%	5,0%	1,6%	2,5%	0,6
V20C	189,3	0,7%	0,2%	0,8%	1,2%	1,7%	0,4%	0,8%	0,7
V20D	285,5	3,3%	4,8%	6,8%	6,9%	8,5%	6,0%	6,1%	0,3
V20E	608,7	3,9%	2,0%	2,2%	2,0%	3,4%	1,3%	2,5%	0,4
V20F	153,9	0,9%	0,5%	0,5%	0,4%	0,6%	0,3%	0,5%	0,4
V20G	255,9	0,3%	0,2%	0,2%	0,1%	0,3%	0,1%	0,2%	0,4
V20H	610,0	2,3%	2,2%	1,8%	1,9%	2,4%	1,4%	2,0%	0,2
V20J	307,5	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%	0,1

Table 60 – Exploitation index per quaternary catchment for the uMngeni Catchment sub-accounting area given as a percentage (%) annually from 2015-2021, averaged across all years and with a coefficient of variation over time

Quaternary catchment	Area (ha)	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	Average	Coefficient of variation
U20A	364,7	1,1%	0,6%	0,4%	1,7%	0,2%	0,1%	0,7%	0,9
U20B	324,7	1,0%	1,8%	1,5%	1,8%	0,3%	0,2%	1,1%	0,6
U20C	237,2	36,2%	26,0%	17,9%	33,9%	25,5%	21,2%	26,8%	0,3
U20D	386,7	6,6%	2,2%	1,4%	3,6%	2,4%	2,2%	3,1%	0,6
U20E	339,2	1,4%	0,7%	0,4%	1,0%	0,6%	0,5%	0,8%	0,5
U20F	448,0	2,4%	0,9%	0,6%	1,1%	0,9%	1,1%	1,2%	0,6
U20G	481,5	41,7%	17,5%	12,7%	20,8%	19,6%	16,2%	21,4%	0,5
U20H	219,9	19,3%	10,2%	6,3%	19,2%	11,5%	8,3%	12,5%	0,4
U20J	679,5	20,3%	17,3%	13,5%	13,6%	16,2%	12,4%	15,6%	0,2
U20K	269,0	4,7%	4,0%	4,0%	4,3%	5,3%	3,8%	4,4%	0,1
U20L	329,4	31,5%	16,3%	12,2%	17,7%	18,5%	14,9%	18,5%	0,4
U20M	374,2	16,1%	9,8%	7,1%	10,3%	10,4%	7,5%	10,2%	0,3

APPENDIX 3: WATER RESOURCE FLOW ACCOUNT DISAGGREGATED BY LAND COVER WITH REFERENCE STATE FOR TWO QUATERNARY CATCHMENTS

Water resource flow accounts disaggregated by land cover with reference state were compiled for all quaternary catchments. These are too numerous to present in the discussion document but are available in spreadsheets on Stats SA's website. This appendix provides the water resource flow accounts disaggregated by land cover with reference state for two quaternary catchments referred to in Section 4, namely for:

- Quaternary catchment U20M in the uMngeni Catchment sub-accounting area (discussed in Section 4.1) and provided in Table 61 to Table 66.
- Quaternary catchment is H70G in the Breede Catchment sub-accounting area (discussed in Section 4.3) and provided in Table 67 to Table 72.

Table 61 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment U20M in the uMngeni Catchment, for 2015-2016 (as volumes, depths and percentages)

Quaternary catchment U20M	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			Difference
Area		(km^2)	%[1]		(km^2)	%[2]		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%	
		374,2	*100,0*		111,0	*29,7*		6,5	*1,7*		254,8	*68,1*		1,8	*0,5*		374,2	*100,0*	
Water resource details 2015-2016	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	590,0	1 576,7														693,1	1 852,4		*-14,9*
Precipitation	335,8	897,4	*56,9*	95,1	254,2	*28,3*	6,0	16,1	*1,8*	232,5	621,4	*69,2*	2,1	5,6	*0,6*	335,8	897,4	*48,4*	*0,0*
Inflows	254,2	679,3	*43,1*													357,4	955,1	*51,6*	*-28,9*
$Q_{in\ SW}$	190,3	508,6	*32,3*													357,4	955,1	*60,6*	*-46,7*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	63,9	170,7	*10,8*													0,0	0,0	*0,0*	-
Total Out	491,4	1 313,4														671,0	1 793,2		*-26,8*
Total Evaporation (ET)	172,3	460,6	*35,1*	66,2	176,9	*38,4*	4,3	11,5	*2,5*	99,1	264,8	*57,5*	2,8	7,4	*1,6*	233,6	624,4	*34,8*	*-26,2*
Landscape ET	142,1	379,8	*82,5*	66,2	176,9	*46,6*	4,3	11,5	*3,0*	68,8	184,0	*48,4*	2,8	7,4	*2,0*	233,6	624,4	*100,0*	*-39,2*
Incremental ET	30,2	80,8	*17,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	30,2	80,8	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	43,1	115,1	*25,0*	20,5	54,8	*47,6*	0,9	2,4	*2,1*	21,6	57,6	*50,1*	0,1	0,3	*0,3*	75,5	201,9	*32,3*	*-43,0*
Transpiration ET	61,1	163,3	*35,5*	26,9	71,9	*44,0*	2,6	6,8	*4,2*	31,4	83,9	*51,4*	0,2	0,6	*0,4*	93,1	248,7	*39,8*	*-34,3*
Soil Water ET	54,5	145,7	*31,6*	18,8	50,2	*34,4*	0,8	2,3	*1,6*	34,8	93,1	*63,9*	0,1	0,1	*0,1*	62,3	166,6	*26,7*	*-12,6*
Open Water ET	13,6	36,4	*7,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	11,3	30,1	*82,6*	2,4	6,3	*17,4*	2,7	7,2	*1,1*	*408,0*
Outflows	319,1	852,8	*64,9*													437,4	1 168,8	*65,2*	*-27,0*
$Q_{out\ SW}$	319,1	852,8	*64,9*													437,4	1 168,8	*65,2*	*-27,0*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-98,5	-263,3		-8,0	-21,5		-0,5	-1,2		-90,0	-240,5		-0,1	-0,2		-22,2	-59,3		*344,4*
$DS_{f\ SW}$	-84,1	-224,7		0,0	0,0		0,0	0,0		-84,0	-224,6		-0,1	-0,2		0,0	0,0		*2 701 262,9*
$DS_{f\ SoilM}$	-5,0	-13,3		-3,0	-8,1		-0,2	-0,6		-1,8	-4,7		0,0	0,0		-12,4	-33,1		*-59,7*
$DS_{f\ GW}$	-9,5	-25,3		-5,0	-13,4		-0,2	-0,7		-4,2	-11,2		0,0	0,0		-9,8	-26,2		*-3,4*
Internal Flows																			
Interception	43,1	115,1		20,5	54,8	*47,6*	0,9	2,4	*2,1*	21,6	57,6	*50,1*	0,1	0,3	*0,3*	75,5	201,9		*-43,0*
Surface Runoff	69,4	185,5		13,9	37,2	*20,1*	1,0	2,6	*1,4*	54,0	144,4	*77,9*	0,5	1,2	*0,7*	58,3	155,8		*19,0*
Infiltration	159,3	425,6		60,7	162,2	*38,1*	4,2	11,1	*2,6*	94,4	252,2	*59,2*	0,1	0,1	*0,0*	201,1	537,5		*-20,8*
Pot. GW Recharge	38,9	103,9		12,0	32,1	*30,8*	0,5	1,4	*1,4*	26,4	70,4	*67,8*				33,5	89,6		*16,0*
Baseflow	34,5	92,2		7,8	20,7	*22,5*	0,5	1,2	*1,3*	26,1	69,8	*75,7*	0,2	0,4	*0,5*	23,7	63,4		*45,4*
Irrigation	0,0	0,0		0,0	0,0	*0,0*	0,0	0,0	-				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 62 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment U20M in the uMngeni Catchment, for 2016-2017 (as volumes, depths and percentages)

Quaternary catchment U20M	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			Difference
Area		(km^2)	%[1]		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%	
		374,2	*100,0*		111,0	*29,7*		6,5	*1,7*		254,8	*68,1*		1,8	*0,5*		374,2	*100,0*	
Water resource details 2016-2017	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	823,9	2 201,8														864,9	2 311,5		*-4,7*
Precipitation	275,8	737,1	*33,5*	79,3	212,0	*28,8*	4,9	13,1	*1,8*	190,0	507,7	*68,9*	1,6	4,2	*0,6*	275,8	737,1	*31,9*	*0,0*
Inflows	548,0	1 464,7	*66,5*													589,1	1 574,4	*68,1*	*-7,0*
$Q_{in\ SW}$	484,0	1 293,5	*58,7*													589,1	1 574,4	*71,5*	*-17,8*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	64,1	171,2	*7,8*													0,0	0,0	*0,0*	-
Total Out	766,4	2 048,1														880,4	2 352,9		*-13,0*
Total Evaporation (ET)	178,6	477,3	*23,3*	68,6	183,4	*38,4*	4,3	11,6	*2,4*	101,7	271,7	*56,9*	4,0	10,6	*2,2*	243,1	649,8	*27,6*	*-26,5*
Landscape ET	148,4	396,6	*83,1*	68,6	183,4	*46,3*	4,3	11,6	*2,9*	71,5	191,0	*48,2*	4,0	10,6	*2,7*	243,1	649,8	*100,0*	*-39,0*
Incremental ET	30,2	80,7	*16,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	30,2	80,7	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	46,4	124,1	*26,0*	22,7	60,7	*48,9*	1,0	2,6	*2,1*	22,6	60,5	*48,7*	0,1	0,3	*0,3*	82,8	221,2	*34,0*	*-43,9*
Transpiration ET	64,6	172,6	*36,2*	27,6	73,7	*42,7*	2,5	6,7	*3,9*	34,3	91,7	*53,1*	0,2	0,5	*0,3*	96,0	256,6	*39,5*	*-32,7*
Soil Water ET	52,7	140,8	*29,5*	18,3	49,0	*34,8*	0,9	2,3	*1,7*	33,4	89,4	*63,5*	0,0	0,1	*0,1*	60,9	162,7	*25,0*	*-13,4*
Open Water ET	14,9	39,8	*8,3*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	11,3	30,2	*75,9*	3,6	9,6	*24,1*	3,5	9,4	*1,4*	*322,7*
Outflows	587,8	1 570,8	*76,7*													637,3	1 703,1	*72,4*	*-7,8*
$Q_{out\ SW}$	587,8	1 570,8	*76,7*													637,3	1 703,1	*72,4*	*-7,8*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-57,5	-153,6		5,2	14,0		0,3	0,9		-63,1	-168,7		0,1	0,2		15,5	41,5		*-470,5*
$DS_{f\ SW}$	-66,3	-177,3		0,1	0,2		0,0	0,0		-66,5	-177,6		0,1	0,1		0,3	0,9		*-20 185,4*
$DS_{f\ SoilM}$	0,8	2,0		1,1	3,0		0,1	0,2		-0,4	-1,1		0,0	0,0		6,5	17,4		*-88,3*
$DS_{f\ GW}$	8,1	21,6		4,0	10,8		0,2	0,7		3,8	10,1		0,0	0,1		8,7	23,2		*-6,9*
Internal Flows																			
Interception	46,2	123,6		22,6	60,5	*49,0*	1,0	2,6	*2,1*	22,5	60,2	*48,7*	0,1	0,3	*0,3*	82,4	220,3		*-43,9*
Surface Runoff	40,1	107,1		4,3	11,5	*10,7*	0,3	0,8	*0,7*	35,2	94,0	*87,8*	0,3	0,8	*0,7*	19,6	52,3		*104,8*
Infiltration	143,5	383,5		52,4	140,0	*36,5*	3,7	9,8	*2,5*	87,4	233,6	*60,9*	0,0	0,1	*0,0*	173,2	462,9		*-17,1*
Pot. GW Recharge	27,2	72,7		7,6	20,3	*27,9*	0,3	0,9	*1,3*	19,3	51,5	*70,9*				23,0	61,4		*18,4*
Baseflow	40,3	107,8		8,1	21,6	*20,0*	0,5	1,2	*1,1*	31,7	84,7	*78,6*	0,1	0,3	*0,3*	31,6	84,6		*27,4*
Irrigation	0,0	0,0		0,0	0,0	*0,0*	0,0	0,0	-				0,0	0,0	*0,0*	0,0	0,0		-

1 Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

2 Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 63 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment U20M in the uMngeni Catchment, for 2017-2018 (as volumes, depths and percentages)

Quaternary catchment U20M	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			Difference
Area		(km²)	%[1]		(km²)	%		(km²)	%		(km²)	%		(km²)	%		(km²)	%	
		374,2	100,0		111,0	29,7		6,5	1,7		254,8	68,1		1,8	0,5		374,2	100,0	
Water resource details 2017-2018	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	%
Total In	1 072,4	2 866,0														1 132,0	3 025,4		-5,3
Precipitation	307,1	820,8	28,6	86,9	232,3	28,3	5,5	14,8	1,8	212,8	568,6	69,3	1,9	5,1	0,6	307,1	820,8	27,1	0,0
Inflows	765,3	2 045,2	71,4													824,9	2 204,6	72,9	-7,2
$Q_{in\ SW}$	702,6	1 877,7	65,5													824,9	2 204,6	76,9	-14,8
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	62,7	167,5	5,8													0,0	0,0	0,0	-
Total Out	1 000,2	2 673,0														1 139,7	3 045,8		-12,2
Total Evaporation (ET)	186,0	497,1	18,6	74,1	198,2	39,9	4,7	12,5	2,5	102,4	273,7	55,1	4,8	12,7	2,6	261,0	697,5	22,9	-28,7
Landscape ET	157,0	419,5	84,4	74,1	198,2	47,2	4,7	12,5	3,0	73,4	196,2	46,8	4,8	12,7	3,0	261,0	697,5	100,0	-39,9
Incremental ET	29,0	77,5	15,6	0,0	0,0	0,0	0,0	0,0	0,0	29,0	77,5	100,0	0,0	0,0	0,0	0,0	0,0	0,0	-
Interception ET	41,7	111,6	22,4	20,1	53,6	48,1	0,9	2,3	2,1	20,7	55,3	49,5	0,1	0,3	0,3	74,4	199,0	28,5	-43,9
Transpiration ET	74,7	199,6	40,2	34,8	93,1	46,6	2,9	7,8	3,9	36,8	98,2	49,2	0,2	0,6	0,3	119,1	318,3	45,6	-37,3
Soil Water ET	54,1	144,6	29,1	19,2	51,4	35,6	0,9	2,4	1,6	33,9	90,7	62,7	0,0	0,1	0,1	63,1	168,6	24,2	-14,2
Open Water ET	15,4	41,2	8,3	0,0	0,0	0,0	0,0	0,0	0,0	11,0	29,5	71,5	4,4	11,7	28,5	4,3	11,6	1,7	255,9
Outflows	814,2	2 175,9	81,4													878,7	2 348,3	77,1	-7,3
$Q_{out\ SW}$	814,2	2 175,9	81,4													878,7	2 348,3	77,1	-7,3
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	0,0													0,0	0,0	0,0	-
Total Change In Storage	-72,2	-193,0		1,7	4,6		0,1	0,3		-74,1	-198,0		0,0	0,0		7,6	20,4		-1 046,0
$DS_{f\ SW}$	-76,5	-204,6		0,0	0,0		0,0	0,0		-76,5	-204,6		0,0	0,0		0,0	0,0		17 921 339,8
$DS_{f\ SoilM}$	2,1	5,7		0,4	1,2		0,1	0,2		1,6	4,3		0,0	0,0		1,4	3,8		52,0
$DS_{f\ GW}$	2,2	5,8		1,3	3,4		0,0	0,1		0,8	2,3		0,0	0,0		6,2	16,7		-65,0
Internal Flows																			
Interception	41,7	111,6		20,1	53,6	48,1	0,9	2,3	2,1	20,7	55,3	49,5	0,1	0,3	0,3	74,4	199,0		-43,9
Surface Runoff	51,8	138,3		6,9	18,5	13,4	0,3	0,8	0,6	44,1	117,9	85,2	0,4	1,1	0,8	31,9	85,3		62,1
Infiltration	156,3	417,7		59,9	160,1	38,3	4,4	11,6	2,8	92,0	245,8	58,9	0,0	0,1	0,0	200,0	534,6		-21,9
Pot. GW Recharge	29,8	79,7		6,3	16,8	21,1	0,7	1,7	2,2	22,9	61,1	76,7				19,4	51,8		53,7
Baseflow	37,1	99,0		7,5	20,0	20,2	0,5	1,5	1,5	28,9	77,2	78,0	0,1	0,3	0,3	25,6	68,5		44,6
Irrigation	0,0	0,0		0,0	0,0	0,0	0,0	0,0	-				0,0	0,0	0,0	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 64 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment U20M in the uMngeni Catchment, for 2018-2019 (as volumes, depths and percentages)

Quaternary catchment U20M	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km^2)	%[1]		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%	
		374,2	*100,0*		111,0	*29,7*		6,5	*1,7*		254,8	*68,1*		1,8	*0,5*		374,2	*100,0*	
Water resource details 2018-2019	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	804,2	2 149,1														824,9	2 204,7		*-2,5*
Precipitation	288,1	770,0	*35,8*	81,7	218,4	*28,4*	5,2	13,9	*1,8*	199,4	532,9	*69,2*	1,8	4,7	*0,6*	288,1	770,0	*34,9*	*0,0*
Inflows	516,0	1 379,1	*64,2*													536,8	1 434,7	*65,1*	*-3,9*
$Q_{in\ SW}$	452,3	1 208,7	*56,2*													536,8	1 434,7	*66,8*	*-15,8*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	63,8	170,4	*7,9*													0,0	0,0	*0,0*	-
Total Out	735,5	1 965,6														830,7	2 220,1		*-11,5*
Total Evaporation (ET)	177,8	475,3	*24,2*	69,8	186,6	*39,3*	4,3	11,5	*2,4*	100,0	267,2	*56,2*	3,7	9,9	*2,1*	245,0	654,9	*29,5*	*-27,4*
Landscape ET	147,9	395,3	*83,2*	69,8	186,6	*47,2*	4,3	11,5	*2,9*	70,0	187,2	*47,4*	3,7	9,9	*2,5*	245,0	654,9	*100,0*	*-39,6*
Incremental ET	30,0	80,0	*16,8*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	30,0	80,0	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	42,8	114,3	*24,1*	21,6	57,7	*50,5*	0,9	2,3	*2,0*	20,2	54,1	*47,3*	0,1	0,3	*0,2*	78,5	209,7	*32,0*	*-45,5*
Transpiration ET	68,4	182,8	*38,5*	29,9	79,8	*43,7*	2,5	6,8	*3,7*	35,8	95,6	*52,3*	0,2	0,5	*0,3*	103,5	276,5	*42,2*	*-33,9*
Soil Water ET	52,1	139,2	*29,3*	18,4	49,1	*35,3*	0,9	2,5	*1,8*	32,8	87,6	*62,9*	0,0	0,1	*0,1*	59,9	160,0	*24,4*	*-13,0*
Open Water ET	14,6	39,0	*8,2*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	11,2	30,0	*76,9*	3,4	9,0	*23,1*	3,2	8,6	*1,3*	*354,5*
Outflows	557,6	1 490,3	*75,8*													585,7	1 565,2	*70,5*	*-4,8*
$Q_{out\ SW}$	557,6	1 490,3	*75,8*													585,7	1 565,2	*70,5*	*-4,8*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-68,7	-183,5		1,9	5,2		0,1	0,2		-70,7	-188,9		0,0	0,0		5,8	15,4		*-1 291,4*
$DS_{f\ SW}$	-71,7	-191,7		-0,2	-0,6		0,0	0,0		-71,5	-191,1		0,0	0,0		-0,8	-2,1		*9 190,8*
$DS_{f\ SoilM}$	2,6	6,9		2,0	5,3		0,1	0,1		0,5	1,4		0,0	0,0		6,7	17,9		*-61,5*
$DS_{f\ GW}$	0,5	1,4		0,2	0,5		0,0	0,1		0,3	0,8		0,0	0,0		-0,1	-0,4		*-451,9*
Internal Flows																			
Interception	43,2	115,6		21,8	58,3	*50,4*	0,9	2,3	*2,0*	20,5	54,7	*47,3*	0,1	0,3	*0,2*	79,3	211,8		*-45,4*
Surface Runoff	53,8	143,9		8,9	23,9	*16,6*	0,6	1,5	*1,0*	44,0	117,5	*81,7*	0,4	1,0	*0,7*	38,1	101,9		*41,2*
Infiltration	140,0	374,0		51,0	136,3	*36,4*	3,8	10,1	*2,7*	85,2	227,6	*60,9*	0,0	0,1	*0,0*	170,0	454,4		*-17,7*
Pot. GW Recharge	22,3	59,5		4,7	12,7	*21,3*	0,4	0,9	*1,6*	17,2	45,9	*77,1*				13,5	36,1		*65,0*
Baseflow	27,8	74,4		4,7	12,5	*16,9*	0,3	0,8	*1,1*	22,7	60,7	*81,6*	0,1	0,3	*0,4*	13,4	35,7		*108,4*
Irrigation	0,0	0,0		0,0	0,0	*0,0*	0,0	0,0	-				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 65 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment U20M in the uMngeni Catchment, for 2019-2020 (as volumes, depths and percentages)

Quaternary catchment U20M	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km^2)	*%*[1]		(km^2)	*%*		(km^2)	*%*		(km^2)	*%*		(km^2)	*%*		(km^2)	*%*	
		374,2	*100,0*		111,0	*29,7*		6,5	*1,7*		254,8	*68,1*		1,8	*0,5*		374,2	*100,0*	
Water resource details 2019-2020	Volume (Mm^3)	Depth (mm)	*%*	Volume (Mm^3)	Depth (mm)	*%*	Volume (Mm^3)	Depth (mm)	*%*	Volume (Mm^3)	Depth (mm)	*%*	Volume (Mm^3)	Depth (mm)	*%*	Volume (Mm^3)	Depth (mm)	*%*	*%*
Total In	788,9	2 108,3														806,7	2 156,0		*-2,2*
Precipitation	291,0	777,7	*36,9*	82,5	220,5	*28,3*	5,3	14,1	*1,8*	201,5	538,4	*69,2*	1,8	4,8	*0,6*	291,0	777,7	*36,1*	*0,0*
Inflows	497,9	1 330,6	*63,1*													515,7	1 378,3	*63,9*	*-3,5*
$Q_{in\ SW}$	433,9	1 159,6	*55,0*													515,7	1 378,3	*65,4*	*-15,9*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	64,0	171,0	*8,1*													0,0	0,0	*0,0*	-
Total Out	713,8	1 907,7														798,7	2 134,6		*-10,6*
Total Evaporation (ET)	168,3	449,8	*23,6*	63,6	169,9	*37,8*	4,1	11,0	*2,4*	96,5	258,0	*57,4*	4,1	10,9	*2,4*	227,6	608,2	*28,5*	*-26,0*
Landscape ET	138,0	368,7	*82,0*	63,6	169,9	*46,1*	4,1	11,0	*3,0*	66,2	176,9	*48,0*	4,1	10,9	*3,0*	227,6	608,2	*100,0*	*-39,4*
Incremental ET	30,3	81,1	*18,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	30,3	81,1	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	42,2	112,7	*25,0*	21,2	56,7	*50,3*	0,9	2,3	*2,1*	19,9	53,3	*47,3*	0,1	0,3	*0,3*	78,6	210,0	*34,5*	*-46,4*
Transpiration ET	62,6	167,3	*37,2*	25,8	69,1	*41,3*	2,4	6,4	*3,8*	34,2	91,3	*54,6*	0,2	0,5	*0,3*	92,2	246,3	*40,5*	*-32,1*
Soil Water ET	48,6	129,8	*28,8*	16,5	44,1	*34,0*	0,8	2,2	*1,7*	31,2	83,3	*64,2*	0,0	0,1	*0,1*	53,3	142,4	*23,4*	*-8,9*
Open Water ET	15,0	40,1	*8,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	11,3	30,1	*75,2*	3,7	10,0	*24,8*	3,5	9,4	*1,5*	*326,7*
Outflows	545,5	1 457,9	*76,4*													571,2	1 526,5	*71,5*	*-4,5*
$Q_{out\ SW}$	545,5	1 457,9	*76,4*													571,2	1 526,5	*71,5*	*-4,5*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-75,0	-200,5		-1,8	-4,9		-0,1	-0,2		-73,2	-195,5		0,0	0,0		-8,0	-21,4		*838,2*
$DS_{f\ SW}$	-72,0	-192,3		0,2	0,6		0,0	0,0		-72,2	-192,9		0,0	0,0		0,8	2,1		*-9 415,3*
$DS_{f\ SoilM}$	-3,7	-9,8		-2,3	-6,3		-0,1	-0,2		-1,2	-3,3		0,0	0,0		-7,9	-21,1		*-53,7*
$DS_{f\ GW}$	0,6	1,5		0,3	0,8		0,0	0,0		0,3	0,7		0,0	0,0		-0,9	-2,3		*-166,1*
Internal Flows																			
Interception	41,7	111,4		21,0	56,1	*50,4*	0,9	2,3	*2,1*	19,7	52,7	*47,3*	0,1	0,3	*0,3*	77,8	208,0		*-46,4*
Surface Runoff	51,2	137,0		7,9	21,0	*15,4*	0,5	1,3	*0,9*	42,5	113,7	*83,0*	0,4	0,9	*0,7*	35,0	93,5		*46,5*
Infiltration	145,9	390,0		53,6	143,3	*36,7*	3,9	10,5	*2,7*	88,3	236,1	*60,5*	0,0	0,1	*0,0*	177,5	474,4		*-17,8*
Pot. GW Recharge	31,3	83,7		8,9	23,8	*28,5*	0,6	1,6	*1,9*	21,8	58,3	*69,6*				24,3	64,9		*29,0*
Baseflow	37,0	98,8		7,4	19,7	*20,0*	0,5	1,3	*1,3*	29,0	77,5	*78,4*	0,1	0,3	*0,3*	23,4	62,6		*57,9*
Irrigation	0,0	0,0		0,0	0,0	*0,0*	0,0	0,0	-				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 66 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment U20M in the uMngeni Catchment, for 2020-2021 (as volumes, depths and percentages)

Quaternary catchment U20M	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km^2)	%[1]		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%	
		374,2	*100,0*		111,0	*29,7*		6,5	*1,7*		254,8	*68,1*		1,8	*0,5*		374,2	*100,0*	
Water resource details 2020-2021	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	1 055,9	2 821,9														1 103,5	2 949,2		*-4,3*
Precipitation	412,7	1 102,9	*39,1*	116,7	311,9	*28,3*	7,5	20,0	*1,8*	286,0	764,2	*69,3*	2,6	6,9	*0,6*	412,7	1 102,9	*37,4*	*0,0*
Inflows	643,2	1 719,0	*60,9*													690,8	1 846,3	*62,6*	*-6,9*
$Q_{in\ SW}$	582,3	1 556,1	*55,1*													690,8	1 846,3	*65,4*	*-15,7*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	60,9	162,9	*5,8*													0,0	0,0	*0,0*	-
Total Out	939,8	2 511,6														1 089,5	2 911,7		*-13,7*
Total Evaporation (ET)	211,6	565,6	*22,5*	91,4	244,3	*43,2*	5,8	15,6	*2,8*	109,7	293,3	*51,9*	4,7	12,5	*2,2*	318,1	850,1	*29,2*	*-33,5*
Landscape ET	184,3	492,6	*87,1*	91,4	244,3	*49,6*	5,8	15,6	*3,2*	82,4	220,2	*44,7*	4,7	12,5	*2,5*	318,1	850,1	*100,0*	*-42,1*
Incremental ET	27,3	73,0	*12,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	27,3	73,0	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	44,0	117,7	*20,8*	21,6	57,8	*49,1*	0,9	2,4	*2,1*	21,4	57,2	*48,6*	0,1	0,3	*0,3*	80,1	214,1	*25,2*	*-45,0*
Transpiration ET	93,6	250,3	*44,2*	47,4	126,7	*50,6*	4,0	10,6	*4,2*	42,1	112,5	*44,9*	0,2	0,5	*0,2*	161,2	430,7	*50,7*	*-41,9*
Soil Water ET	58,9	157,4	*27,8*	22,4	59,8	*38,0*	0,9	2,5	*1,6*	35,6	95,0	*60,4*	0,0	0,1	*0,0*	72,6	194,0	*22,8*	*-18,8*
Open Water ET	15,1	40,3	*7,1*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	10,7	28,6	*71,1*	4,4	11,6	*28,9*	4,2	11,3	*1,3*	*257,2*
Outflows	728,2	1 946,0	*77,5*													771,4	2 061,6	*70,8*	*-5,6*
$Q_{out\ SW}$	728,2	1 946,0	*77,5*													771,4	2 061,6	*70,8*	*-5,6*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-116,1	-310,3		-5,4	-14,4		-0,3	-0,8		-110,3	-294,9		-0,1	-0,2		-14,0	-37,5		*727,0*
$DS_{f\ SW}$	-106,1	-283,5		-0,2	-0,6		0,0	0,0		-105,8	-282,7		-0,1	-0,2		-0,8	-2,2		*12 803,3*
$DS_{f\ SoilM}$	-4,4	-11,8		-2,5	-6,6		-0,1	-0,3		-1,8	-4,8		0,0	0,0		-9,5	-25,4		*-53,6*
$DS_{f\ GW}$	-5,6	-15,0		-2,7	-7,1		-0,2	-0,5		-2,7	-7,3		0,0	-0,1		-3,7	-9,9		*51,4*
Internal Flows																			
Interception	44,5	118,9		21,8	58,4	*49,1*	0,9	2,5	*2,1*	21,6	57,8	*48,6*	0,1	0,3	*0,3*	80,9	216,3		*-45,0*
Surface Runoff	75,4	201,6		11,1	29,7	*14,7*	0,6	1,6	*0,8*	63,1	168,7	*83,7*	0,6	1,6	*0,8*	49,6	132,5		*52,1*
Infiltration	204,6	546,7		83,7	223,8	*40,9*	6,0	15,9	*2,9*	114,8	306,9	*56,1*	0,0	0,0	*0,0*	281,2	751,4		*-27,2*
Pot. GW Recharge	47,8	127,7		11,5	30,7	*24,0*	0,9	2,5	*1,9*	35,4	94,6	*74,1*				38,1	101,9		*25,4*
Baseflow	47,2	126,3		11,5	30,6	*24,2*	0,9	2,3	*1,8*	34,7	92,8	*73,5*	0,2	0,5	*0,4*	34,4	92,0		*37,3*
Irrigation	0,0	0,0		0,0	0,0	*0,0*	0,0	0,0	-				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 67 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment H70G in the Breede Catchment, for 2015-2016 (as volumes, depths and percentages)

Quaternary catchment H70G	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km²)	%[1]		(km²)	%		(km²)	%		(km²)	%		(km²)	%		(km²)	%	
		663,0	*100,0*		120,6	*18,2*		540,8	*81,6*		0,0	*0,0*		1,6	*0,2*		663,0	*100,0*	
Water resource details 2015-2016	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	%
Total In	1 159,7	1 749,1														1 375,8	2 075,1		*-15,7*
Precipitation	306,4	462,2	*26,4*	56,3	84,9	*18,4*	249,3	376,0	*81,4*	0,0	0,0	*0,0*	0,8	1,2	*0,3*	306,4	462,2	*22,3*	*0,0*
Inflows	853,3	1 287,0	*73,6*													1 069,4	1 612,9	*77,7*	*-20,2*
$Q_{in\ SW}$	853,3	1 287,0	*73,6*													1 069,4	1 612,9	*92,2*	*-20,2*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Out	1 182,2	1 783,1														1 405,5	2 119,8		*-15,9*
Total Evaporation (ET)	293,4	442,5	*24,8*	55,5	83,8	*18,9*	234,6	353,8	*80,0*	0,0	0,0	*0,0*	3,3	4,9	*1,1*	306,5	462,2	*21,8*	*-4,3*
Landscape ET	291,3	439,3	*99,3*	55,5	83,8	*19,1*	232,5	350,6	*79,8*	0,0	0,0	*0,0*	3,3	4,9	*1,1*	306,5	462,2	*100,0*	*-5,0*
Incremental ET	2,1	3,2	*0,7*	0,0	0,0	*0,0*	2,1	3,2	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	16,3	24,6	*5,5*	4,2	6,4	*26,0*	12,0	18,2	*74,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	23,4	35,2	*7,6*	*-30,3*
Transpiration ET	41,8	63,0	*14,2*	15,2	23,0	*36,5*	26,5	40,0	*63,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	84,2	127,1	*27,5*	*-50,4*
Soil Water ET	231,2	348,7	*78,8*	36,1	54,4	*15,6*	195,2	294,3	*84,4*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	195,4	294,7	*63,8*	*18,3*
Open Water ET	4,1	6,2	*1,4*	0,0	0,0	*0,0*	0,9	1,3	*20,9*	0,0	0,0	*0,0*	3,3	4,9	*79,1*	3,5	5,2	*1,1*	*19,2*
Outflows	888,8	1 340,6	*75,2*													1 099,0	1 657,6	*78,2*	*-19,1*
$Q_{out\ SW}$	888,8	1 340,6	*75,2*													1 099,0	1 657,6	*78,2*	*-19,1*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	22,5	33,9		4,8	7,2		17,7	26,7		0,0	0,0		0,0	0,0		29,6	44,7		*-24,1*
$DS_{f\ SW}$	0,0	0,0		0,0	0,0		0,0	0,0		0,0	0,0		0,0	0,0		0,0	0,0		*-31,6*
$DS_{f\ SoilM}$	12,6	19,0		3,0	4,5		9,6	14,5		0,0	0,0		0,0	0,0		16,4	24,7		*-23,2*
$DS_{f\ GW}$	9,9	14,9		1,8	2,7		8,1	12,2		0,0	0,0		0,0	0,0		13,2	20,0		*-25,2*
Internal Flows																			
Interception	16,3	24,6		4,2	6,4	*26,0*	12,0	18,2	*74,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	23,4	35,2		*-30,3*
Surface Runoff	10,0	15,1		0,8	1,2	*8,2*	9,2	13,8	*91,8*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	4,4	6,7		*125,7*
Infiltration	283,0	426,9		51,3	77,3	*18,1*	231,8	349,6	*81,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	277,9	419,1		*1,8*
Pot. GW Recharge	22,6	34,1		2,9	4,4	*12,9*	19,7	29,7	*87,1*	0,0	0,0	*0,0*				14,6	22,1		*54,7*
Baseflow	32,5	49,1		5,9	9,0	*18,3*	26,6	40,1	*81,7*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	27,9	42,0		*16,7*
Irrigation	3,7	5,5		0,0	0,0	*0,0*	3,7	5,5	*100,0*				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 68 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment H70G in the Breede Catchment, for 2016-2017 (as volumes, depths and percentages)

Quaternary catchment H70G	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			Difference
Area		(km²)	%[1]		(km²)	%		(km²)	%		(km²)	%		(km²)	%		(km²)	%	
		663,0	*100,0*		120,6	*18,2*		540,8	*81,6*		0,0	*0,0*		1,6	*0,2*		663,0	*100,0*	
Water resource details 2016-2017	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	589,5	889,0														716,8	1 081,1		*-17,8*
Precipitation	211,3	318,7	*35,8*	38,7	58,4	*18,3*	172,1	259,5	*81,4*	0,0	0,0	*0,0*	0,5	0,8	*0,3*	211,3	318,7	*29,5*	*0,0*
Inflows	378,1	570,3	*64,2*													505,5	762,4	*70,5*	*-25,2*
$Q_{in\ SW}$	378,1	570,3	*64,2*													505,5	762,4	*85,8*	*-25,2*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Out	593,9	895,8														723,9	1 091,8		*-18,0*
Total Evaporation (ET)	199,5	300,9	*33,6*	37,1	55,9	*18,6*	160,0	241,3	*80,2*	0,0	0,0	*0,0*	2,4	3,7	*1,2*	205,1	309,4	*28,3*	*-2,7*
Landscape ET	197,0	297,2	*98,8*	37,1	55,9	*18,8*	157,5	237,6	*80,0*	0,0	0,0	*0,0*	2,4	3,7	*1,2*	205,1	309,4	*100,0*	*-3,9*
Incremental ET	2,5	3,7	*1,2*	0,0	0,0	*0,0*	2,5	3,7	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	12,7	19,1	*6,4*	3,2	4,9	*25,5*	9,4	14,2	*74,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	18,2	27,5	*8,9*	*-30,4*
Transpiration ET	23,6	35,6	*11,8*	9,3	14,1	*39,6*	14,2	21,5	*60,4*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	51,3	77,3	*25,0*	*-54,0*
Soil Water ET	159,9	241,1	*80,1*	24,5	37,0	*15,3*	135,4	204,2	*84,7*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	133,0	200,6	*64,9*	*20,2*
Open Water ET	3,4	5,1	*1,7*	0,0	0,0	*0,0*	0,9	1,4	*27,7*	0,0	0,0	*0,0*	2,4	3,7	*72,3*	2,6	3,9	*1,3*	*28,6*
Outflows	394,4	594,9	*66,4*													518,8	782,4	*71,7*	*-24,0*
$Q_{out\ SW}$	394,4	594,9	*66,4*													518,8	782,4	*71,7*	*-24,0*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	4,5	6,7		0,9	1,4		3,5	5,3		0,0	0,0		0,0	0,0		7,1	10,7		*-36,9*
$DS_{f\ SW}$	0,1	0,1		0,0	0,0		0,1	0,1		0,0	0,0		0,0	0,0		0,0	0,0		-
$DS_{f\ SoilM}$	-3,1	-4,6		-0,4	-0,7		-2,6	-4,0		0,0	0,0		0,0	0,0		-2,4	-3,6		*29,8*
$DS_{f\ GW}$	7,5	11,3		1,4	2,1		6,1	9,2		0,0	0,0		0,0	0,0		9,4	14,2		*-20,9*
Internal Flows																			
Interception	12,7	19,1		3,2	4,9	*25,5*	9,4	14,2	*74,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	18,2	27,5		*-30,4*
Surface Runoff	2,3	3,4		0,1	0,1	*3,2*	2,2	3,3	*96,8*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	0,4	0,7		*404,3*
Infiltration	199,8	301,3		35,4	53,4	*17,7*	164,4	248,0	*82,3*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	192,1	289,8		*4,0*
Pot. GW Recharge	13,3	20,0		1,1	1,7	*8,5*	12,2	18,3	*91,5*	0,0	0,0	*0,0*				5,5	8,3		*141,6*
Baseflow	20,8	31,3		3,7	5,6	*18,0*	17,0	25,7	*82,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	14,9	22,5		*38,9*
Irrigation	4,0	6,0		0,0	0,0	*0,0*	4,0	6,0	*100,0*				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 69 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment H70G in the Breede Catchment, for 2017-2018 (as volumes, depths and percentages)

Quaternary catchment H70G	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km²)	%[1]		(km²)	%		(km²)	%		(km²)	%		(km²)	%		(km²)	%	
		663,0	*100,0*		120,6	*18,2*		540,8	*81,6*		0,0	*0,0*		1,6	*0,2*		663,0	*100,0*	
Water resource details 2017-2018	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	%
Total In	727,4	1 097,1														874,0	1 318,2		*-16,8*
Precipitation	315,6	476,0	*43,4*	58,0	87,5	*18,4*	256,8	387,3	*81,4*	0,0	0,0	*0,0*	0,8	1,3	*0,3*	315,6	476,0	*36,1*	*0,0*
Inflows	411,8	621,1	*56,6*													558,4	842,2	*63,9*	*-26,2*
$Q_{in\ SW}$	411,8	621,1	*56,6*													558,4	842,2	*76,8*	*-26,2*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Out	723,4	1 091,1														869,0	1 310,6		*-16,8*
Total Evaporation (ET)	289,8	437,0	*40,1*	54,2	81,8	*18,7*	233,3	351,9	*80,5*	0,0	0,0	*0,0*	2,2	3,3	*0,8*	297,6	448,8	*34,2*	*-2,6*
Landscape ET	287,5	433,7	*99,2*	54,2	81,8	*18,9*	231,1	348,5	*80,4*	0,0	0,0	*0,0*	2,2	3,3	*0,8*	297,6	448,8	*100,0*	*-3,4*
Incremental ET	2,2	3,4	*0,8*	0,0	0,0	*0,0*	2,2	3,4	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	18,6	28,0	*6,4*	4,6	7,0	*24,9*	14,0	21,1	*75,1*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	25,7	38,8	*8,6*	*-27,7*
Transpiration ET	40,0	60,3	*13,8*	14,8	22,4	*37,1*	25,1	37,9	*62,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	81,3	122,6	*27,3*	*-50,9*
Soil Water ET	228,1	344,1	*78,7*	34,7	52,4	*15,2*	193,4	291,7	*84,8*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	188,1	283,7	*63,2*	*21,3*
Open Water ET	3,1	4,7	*1,1*	0,0	0,0	*0,0*	0,9	1,3	*28,3*	0,0	0,0	*0,0*	2,2	3,3	*71,7*	2,4	3,7	*0,8*	*26,5*
Outflows	433,6	654,0	*59,9*													571,4	861,8	*65,8*	*-24,1*
$Q_{out\ SW}$	433,6	654,0	*59,9*													571,4	861,8	*65,8*	*-24,1*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-4,0	-6,1		-0,8	-1,2		-3,2	-4,8		0,0	0,0		0,0	0,0		-5,0	-7,6		*-20,2*
$DS_{f\ SW}$	-0,1	-0,2		0,0	0,0		-0,1	-0,2		0,0	0,0		0,0	0,0		0,0	0,0		*10 722,6*
$DS_{f\ SoilM}$	1,1	1,6		0,1	0,2		1,0	1,5		0,0	0,0		0,0	0,0		0,4	0,6		*185,3*
$DS_{f\ GW}$	-5,0	-7,5		-0,9	-1,4		-4,1	-6,1		0,0	0,0		0,0	0,0		-5,4	-8,2		*-8,0*
Internal Flows																			
Interception	18,6	28,0		4,6	7,0	*24,9*	14,0	21,1	*75,1*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	25,7	38,8		*-27,7*
Surface Runoff	8,0	12,1		0,5	0,7	*5,8*	7,6	11,4	*94,2*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	2,8	4,2		*189,4*
Infiltration	291,9	440,2		52,9	79,8	*18,1*	239,0	360,4	*81,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	286,4	431,9		*1,9*
Pot. GW Recharge	24,9	37,5		3,4	5,1	*13,7*	21,5	32,4	*86,3*	0,0	0,0	*0,0*				17,3	26,1		*43,6*
Baseflow	19,9	30,0		3,7	5,5	*18,4*	16,2	24,5	*81,6*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	11,9	17,9		*67,1*
Irrigation	3,7	5,6		0,0	0,0	*0,0*	3,7	5,6	*100,0*				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).
[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 70 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment H70G in the Breede Catchment, for 2018-2019 (as volumes, depths and percentages)

Quaternary catchment H70G	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			Difference
Area		(km²)	%[1]		(km²)	%		(km²)	%		(km²)	%		(km²)	%		(km²)	%	
		663,0	100,0		120,6	18,2		540,8	81,6		0,0	0,0		1,6	0,2		663,0	100,0	
Water resource details 2018-2019	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	Volume (Mm³)	Depth (mm)	%	%
Total In	719,6	1 085,3														838,2	1 264,2		-14,2
Precipitation	308,2	464,9	42,8	56,6	85,3	18,4	250,8	378,3	81,4	0,0	0,0	0,0	0,8	1,2	0,3	308,2	464,9	36,8	0,0
Inflows	411,4	620,4	57,2													530,0	799,4	63,2	-22,4
$Q_{in\ SW}$	411,4	620,4	57,2													530,0	799,4	73,7	-22,4
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	0,0	0,0	0,0													0,0	0,0	0,0	-
Total Out	699,5	1 055,1														816,0	1 230,7		-14,3
Total Evaporation (ET)	241,2	363,7	34,5	45,1	68,0	18,7	193,7	292,1	80,3	0,0	0,0	0,0	2,4	3,6	1,0	249,9	376,8	30,6	-3,5
Landscape ET	238,8	360,2	99,0	45,1	68,0	18,9	191,3	288,5	80,1	0,0	0,0	0,0	2,4	3,6	1,0	249,9	376,8	100,0	-4,4
Incremental ET	2,4	3,6	1,0	0,0	0,0	0,0	2,4	3,6	100,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-
Interception ET	15,1	22,7	6,2	3,9	5,9	25,8	11,2	16,9	74,2	0,0	0,0	0,0	0,0	0,0	0,0	21,8	32,9	8,7	-30,9
Transpiration ET	24,5	36,9	10,1	11,4	17,2	46,6	13,1	19,7	53,4	0,0	0,0	0,0	0,0	0,0	0,0	62,6	94,4	25,0	-60,9
Soil Water ET	198,3	299,2	82,2	29,8	45,0	15,0	168,5	254,2	85,0	0,0	0,0	0,0	0,0	0,0	0,0	163,0	245,8	65,2	21,7
Open Water ET	3,3	5,0	1,4	0,0	0,0	0,0	0,9	1,4	27,9	0,0	0,0	0,0	2,4	3,6	72,1	2,5	3,7	1,0	33,2
Outflows	458,4	691,3	65,5													566,2	853,9	69,4	-19,0
$Q_{out\ SW}$	458,4	691,3	65,5													566,2	853,9	69,4	-19,0
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	0,0													0,0	0,0	0,0	-
Total Change In Storage	-20,0	-30,2		-3,8	-5,7		-16,2	-24,5		0,0	0,0		0,0	0,0		-22,2	-33,5		-9,8
$DS_{f\ SW}$	-0,4	-0,7		0,0	0,0		-0,4	-0,6		0,0	0,0		0,0	0,0		-0,1	-0,2		267,4
$DS_{f\ SoilM}$	-16,5	-24,9		-3,3	-4,9		-13,2	-20,0		0,0	0,0		0,0	0,0		-17,6	-26,6		-6,3
$DS_{f\ GW}$	-3,1	-4,7		-0,5	-0,8		-2,6	-3,9		0,0	0,0		0,0	0,0		-4,5	-6,7		-30,8
Internal Flows																			
Interception	15,1	22,7		3,9	5,9	25,8	11,2	16,9	74,2	0,0	0,0	0,0	0,0	0,0	0,0	21,8	32,9		-30,9
Surface Runoff	18,0	27,1		2,2	3,4	12,5	15,7	23,7	87,5	0,0	0,0	0,0	0,0	0,0	0,0	11,7	17,6		54,0
Infiltration	278,3	419,7		50,5	76,1	18,1	227,8	343,6	81,9	0,0	0,0	0,0	0,0	0,0	0,0	274,0	413,3		1,6
Pot. GW Recharge	39,0	58,8		6,0	9,0	15,3	33,0	49,8	84,7	0,0	0,0	0,0				30,8	46,4		26,6
Baseflow	35,9	54,1		6,5	9,8	18,2	29,4	44,3	81,8	0,0	0,0	0,0	0,0	0,0	0,0	26,3	39,7		36,3
Irrigation	3,9	5,9		0,0	0,0	0,0	3,9	5,9	100,0				0,0	0,0	0,0	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 71 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment H70G in the Breede Catchment, for 2019-2020 (as volumes, depths and percentages)

Quaternary catchment H70G	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km^2)	%[1]		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%	
		663,0	*100,0*		120,6	*18,2*		540,8	*81,6*		0,0	*0,0*		1,6	*0,2*		663,0	*100,0*	
Water resource details 2019-2020	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	1 382,2	2 084,7														1 640,1	2 473,6		*-15,7*
Precipitation	416,0	627,4	*30,1*	76,1	114,8	*18,3*	338,8	511,0	*81,4*	0,0	0,0	*0,0*	1,1	1,6	*0,3*	416,0	627,4	*25,4*	*0,0*
Inflows	966,2	1 457,3	*69,9*													1 224,1	1 846,2	*74,6*	*-21,1*
$Q_{in\ SW}$	966,2	1 457,3	*69,9*													1 224,1	1 846,2	*88,6*	*-21,1*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Out	1 377,4	2 077,4														1 627,5	2 454,7		*-15,4*
Total Evaporation (ET)	351,8	530,5	*25,5*	64,1	96,7	*18,2*	284,5	429,1	*80,9*	0,0	0,0	*0,0*	3,1	4,7	*0,9*	355,3	535,9	*21,8*	*-1,0*
Landscape ET	349,7	527,4	*99,4*	64,1	96,7	*18,3*	282,4	425,9	*80,8*	0,0	0,0	*0,0*	3,1	4,7	*0,9*	355,3	535,9	*100,0*	*-1,6*
Incremental ET	2,1	3,1	*0,6*	0,0	0,0	*0,0*	2,1	3,1	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	21,2	31,9	*6,0*	5,7	8,5	*26,7*	15,5	23,4	*73,3*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	31,4	47,4	*8,8*	*-32,6*
Transpiration ET	55,4	83,5	*15,7*	19,0	28,6	*34,3*	36,4	54,9	*65,7*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	105,0	158,4	*29,6*	*-47,3*
Soil Water ET	271,2	409,0	*77,1*	39,5	59,6	*14,6*	231,7	349,4	*85,4*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	215,4	324,9	*60,6*	*25,9*
Open Water ET	4,0	6,1	*1,1*	0,0	0,0	*0,0*	0,9	1,3	*22,1*	0,0	0,0	*0,0*	3,1	4,7	*77,9*	3,5	5,2	*1,0*	*16,3*
Outflows	1 025,6	1 546,9	*74,5*													1 272,2	1 918,8	*78,2*	*-19,4*
$Q_{out\ SW}$	1 025,6	1 546,9	*74,5*													1 272,2	1 918,8	*78,2*	*-19,4*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-4,8	-7,3		-1,4	-2,2		-3,4	-5,1		0,0	0,0		0,0	0,0		-12,5	-18,9		*-61,4*
$DS_{f\ SW}$	0,0	0,0		-0,1	-0,2		0,1	0,1		0,0	0,0		0,0	0,0		-0,7	-1,0		*-95,1*
$DS_{f\ SoilM}$	9,8	14,7		1,4	2,1		8,4	12,7		0,0	0,0		0,0	0,0		7,4	11,2		*31,8*
$DS_{f\ GW}$	-14,6	-22,0		-2,7	-4,0		-11,9	-17,9		0,0	0,0		0,0	0,0		-19,3	-29,1		*-24,4*
Internal Flows																			
Interception	21,7	32,7		5,8	8,8	*26,8*	15,9	24,0	*73,2*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	32,2	48,5		*-32,6*
Surface Runoff	19,5	29,5		2,1	3,1	*10,5*	17,5	26,4	*89,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	11,4	17,2		*71,0*
Infiltration	377,5	569,3		68,3	103,0	*18,1*	309,2	466,4	*81,9*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	371,4	560,1		*1,6*
Pot. GW Recharge	60,7	91,6		11,2	16,9	*18,4*	49,5	74,7	*81,6*	0,0	0,0	*0,0*				58,3	88,0		*4,1*
Baseflow	46,1	69,6		8,5	12,8	*18,4*	37,6	56,8	*81,6*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	39,1	58,9		*18,1*
Irrigation	3,8	5,7		0,0	0,0	*0,0*	3,8	5,7	*100,0*				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

Table 72 – Water resource flow account disaggregated by land cover with reference state for quaternary catchment H70G in the Breede Catchment, for 2020-2021 (as volumes, depths and percentages)

Quaternary catchment H70G	Total			Natural or semi-natural			Cultivated			Built-up			Waterbodies			Reference			*Difference*
Area		(km^2)	%[1]		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%		(km^2)	%	
		663,0	*100,0*		120,6	*18,2*		540,8	*81,6*		0,0	*0,0*		1,6	*0,2*		663,0	*100,0*	
Water resource details 2020-2021	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	Volume (Mm^3)	Depth (mm)	%	%
Total In	2 706,0	4 081,2														3 050,6	4 601,0		*-11,3*
Precipitation	601,3	907,0	*22,2*	109,7	165,5	*18,2*	490,1	739,2	*81,5*	0,0	0,0	*0,0*	1,5	2,3	*0,3*	601,3	907,0	*19,7*	*0,0*
Inflows	2 104,6	3 174,3	*77,8*													2 449,2	3 694,0	*80,3*	*-14,1*
$Q_{in\ SW}$	2 104,6	3 174,3	*77,8*													2 449,2	3 694,0	*90,5*	*-14,1*
$Q_{in\ GW}$																			
$Q_{in\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Out	2 703,8	4 077,9														3 051,7	4 602,8		*-11,4*
Total Evaporation (ET)	410,3	618,8	*15,2*	74,3	112,0	*18,1*	330,7	498,8	*80,6*	0,0	0,0	*0,0*	5,3	8,0	*1,3*	412,9	622,8	*13,5*	*-0,6*
Landscape ET	408,4	615,9	*99,5*	74,3	112,0	*18,2*	328,8	495,9	*80,5*	0,0	0,0	*0,0*	5,3	8,0	*1,3*	412,9	622,8	*100,0*	*-1,1*
Incremental ET	1,9	2,9	*0,5*	0,0	0,0	*0,0*	1,9	2,9	*100,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	-
Interception ET	27,7	41,7	*6,7*	7,0	10,6	*25,5*	20,6	31,1	*74,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	39,2	59,1	*9,5*	*-29,4*
Transpiration ET	56,9	85,9	*13,9*	19,7	29,6	*34,5*	37,3	56,2	*65,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	108,9	164,3	*26,4*	*-47,7*
Soil Water ET	319,6	482,0	*77,9*	47,6	71,8	*14,9*	272,0	410,2	*85,1*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	259,1	390,8	*62,7*	*23,3*
Open Water ET	6,2	9,3	*1,5*	0,0	0,0	*0,0*	0,9	1,3	*13,9*	0,0	0,0	*0,0*	5,3	8,0	*86,1*	5,7	8,7	*1,4*	*7,1*
Outflows	2 293,5	3 459,1	*84,8*													2 638,8	3 980,0	*86,5*	*-13,1*
$Q_{out\ SW}$	2 293,5	3 459,1	*84,8*													2 638,8	3 980,0	*86,5*	*-13,1*
$Q_{out\ GW}$																			
$Q_{out\ Transfers}$	0,0	0,0	*0,0*													0,0	0,0	*0,0*	-
Total Change In Storage	-2,2	-3,3		0,4	0,6		-2,6	-3,9		0,0	0,0		0,0	0,0		1,2	1,8		*-288,9*
$DS_{f\ SW}$	0,5	0,7		0,1	0,2		0,3	0,5		0,0	0,0		0,0	0,0		0,8	1,2		*-41,2*
$DS_{f\ SoilM}$	8,0	12,1		2,1	3,2		5,9	8,9		0,0	0,0		0,0	0,0		11,6	17,5		*-31,1*
$DS_{f\ GW}$	-10,7	-16,1		-1,9	-2,8		-8,8	-13,3		0,0	0,0		0,0	0,0		-11,2	-17,0		*-5,2*
Internal Flows																			
Interception	27,1	40,9		6,9	10,4	*25,4*	20,2	30,5	*74,6*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	38,4	57,9		*-29,3*
Surface Runoff	64,9	98,0		9,4	14,2	*14,5*	55,5	83,8	*85,5*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	53,6	80,9		*21,2*
Infiltration	511,4	771,3		93,4	140,9	*18,3*	417,9	630,3	*81,7*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	507,9	766,1		*0,7*
Pot. GW Recharge	142,9	215,5		28,3	42,7	*19,8*	114,6	172,8	*80,2*	0,0	0,0	*0,0*				151,5	228,6		*-5,7*
Baseflow	132,2	199,4		24,4	36,7	*18,4*	107,9	162,7	*81,6*	0,0	0,0	*0,0*	0,0	0,0	*0,0*	140,3	211,6		*-5,8*
Irrigation	3,6	5,5		0,0	0,0	*0,0*	3,6	5,5	*100,0*				0,0	0,0	*0,0*	0,0	0,0		-

[1] Percentages in this column are the proportion of the total in the next higher level of aggregation, except for surface water and transfer inflows and outflows which are a proportion of Total In and Total Out (refer to Table 2).

[2] Percentages in these columns are summed horizontally across the broad land cover classes, enabling comparison of variables across classes relative to the proportion of area extent per class.

PREVIOUS PUBLICATIONS IN THE NATURAL CAPITAL SERIES

Statistics South Africa (Stats SA). 2020. Natural Capital Series 1: Land and Terrestrial Ecosystem Accounts, 1990 to 2014. Discussion document D0401.1. Produced in collaboration with the South African National Biodiversity Institute and the Department of Forestry, Fisheries and the Environment. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2021. Natural Capital Series 2: Accounts for Protected Areas, 1900 to 2020. Discussion document D0401.2. Produced in collaboration with the South African National Biodiversity Institute and the Department of Forestry, Fisheries and the Environment. Statistics South Africa, Pretoria.

Statistics South Africa (Stats SA). 2023. Natural Capital Series 3: Accounts for Strategic Water Source Areas, 1990 to 2020. Discussion document D0401.3. Produced in collaboration with the South African National Biodiversity Institute and the Department of Forestry, Fisheries and the Environment. Statistics South Africa, Pretoria.

D0401.4