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Summary

This supporting information provides details of the different methods and coefficient tables used to calculate (1) runoff (Supplementary tables 1–5) and (2) the mass balance analysis (Supplementary table 7).

1. Runoff

Three different methods were employed to calculate runoff rates within the City of Cape Town metropolitan boundary: (1) The rational method following the *Road Drainage Manual* from SANRAL[1], (2) the rational method and coefficients used in Paul et al.[2] and (3) the mean annual runoff values published by Bailey and Pitman[3] in the *Water Resources 2012 Book of Maps*.

1.1. Runoff using the rational method (SANRAL[1])

The rational method applies a coefficient (C) to mean annual precipitation (MAP, mm/year) to determine the ratio of runoff (Rs, mm/year):

$$Rs = MAP*C$$

Runoff coefficients were determined as per Table 3.7 (p. 3–18) of the SANRAL *Road Drainage Manual*[1]. The runoff coefficient is an integrated value representing soil, slope, and land and vegetation cover. Soil cover factors (Supplementary table 1) are defined per hydrological soil group. Soils in the region are predominantly A/B, consisting of well- to moderately well drained sandy/loamy soils.[4] The assumption is made that all soils within the hydrological boundary are 'Sandy soils, fairly permeable deep soils' and all paved areas are considered as man-made impermeable cover. Slope was defined using a 10-m Digital Elevation Bare Earth model (Supplementary table 2). South African landcover was obtained from the 2014 Western Cape Province data portal. The 72 different landcover classes were re-classified according to SANRAL[1(p.3-18)] and detailed here in Supplementary table 3.

Supplementary table 1: Soil cover categories and assigned factors

Soil cover	SANRAL[1] (<600 mm/year)
Deep sand, very permeable	0.03
Sandy soils, fairly permeable deep soils	0.06
Shallow soils with some clay and silt	0.12
Impermeable clay, rock and man-made impermeable cover	0.21

Supplementary table 2: Slope (%) and assigned factors. Slope was calculated as a percentage using the 10-m Digital Elevation model for the City of Cape Town

Slope (%)	SANRAL[1] (<600 mm/year)
Vleis and pans (0–3%)	0.01
Flat areas (3–10%)	0.06
Hilly (10–20%)	0.12
Steep areas (>20%)	0.22

Supplementary table 3: Landcover protection categories and assigned factors adapted from categories stipulated in SANRAL[1]

Vegetation/urban	SANRAL[1] (<600 mm/year)
Thick bush and plantation	0.03
Urban high vegetation: residential, smallholding, sports and golf, informal settlement	0.5
Light bush and farmlands, cultivated commercial fields, vineyards, grassland, low shrubland, shrubland fynbos, urban low vegetation	0.07
Urban industrial	0.8
Urban no vegetation, bare ground, mines, water bodies	0.95

1.2. Historical estimates of runoff

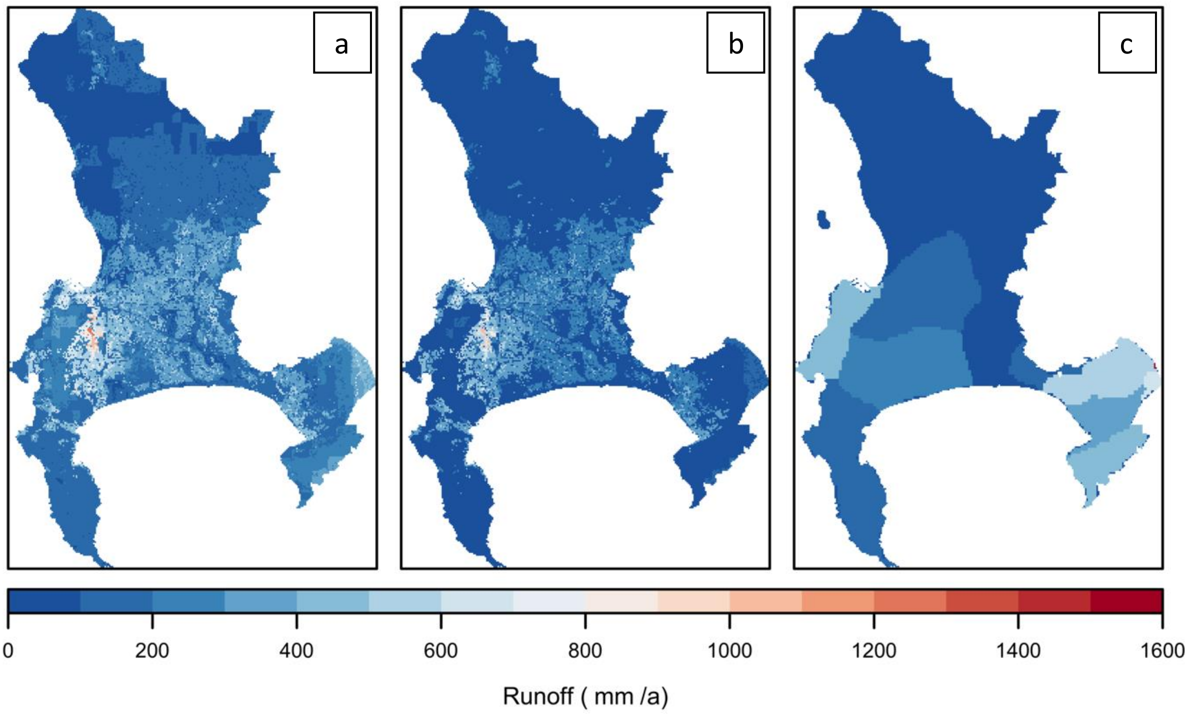
Supplementary table 4: Classification for historical runoff coefficients for a pre-urbanised landscape. Urban areas have been masked over.

Vegetation/urban	SANRAL1 (<600 mm/year)
Thick bush and plantation	0.03
Riparian vegetation and wetlands	0.01
Light bush, grassland, low shrubland, shrubland fynbos, low vegetation.	0.07

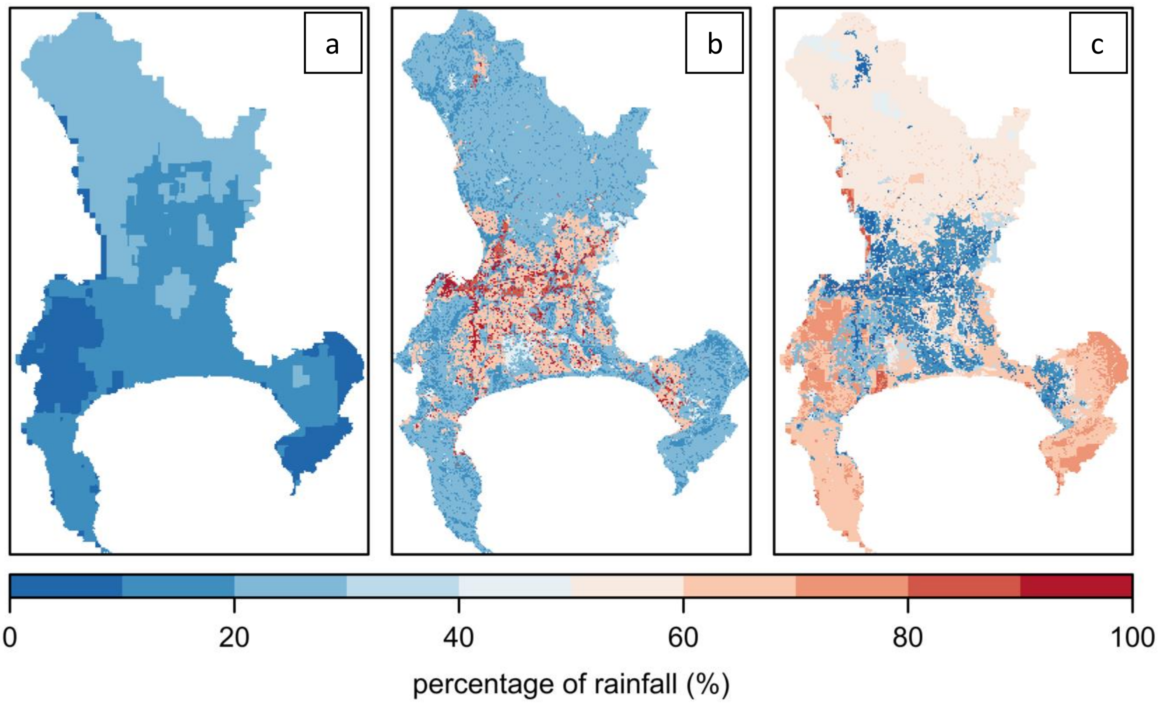
1.3. Runoff as per Paul et al.[2]

Supplementary table 5: Runoff coefficients used in Paul et al.[2] were applied to the various landcover categories found within the hydrological boundary. Values used in Paul et al.[2] were taken from the original Butler and Davies[5].

Land type	Runoff coefficient
Residential	0.5
Commercial	0.8
Industrial	0.7
Open Space and garden/park	0.2
Transport (concrete paving and asphalt)	0.9
Agriculture and vacant land	0.07



Supplementary figure 1: Differences in the spatial distribution of runoff estimates calculated using (a) SANRAL[1], (b) Paul et al.[2] and (c) Water Resource 2012 (WR2012)[3].



Supplementary figure 2: Differences in the spatial distribution of percentage of rainfall for (a) evapotranspiration[6,7], (b) runoff[1] and (c) recharge (water balance).

2. Mass balance analysis

Supplementary table 6: Summaries of the spatial distribution of hydrological parameters in m^3/year. Sums have been expressed in gigalitres/year (1 million m^3/year = 1 gigalitre/year)

Parameter	Mean (m^3/year)	s.d. (m^3/year)	Median (m^3/year)	Minimum (m^3/year)	Maximum (m^3/year)	Sum (GL/year)
MAP[3]	3381.85	1391.54	2957.53	1706.03	10337.33	1471.36
Evapotranspiration[6]	513.24	101.71	534.54	0.00	646.78	218.60
Runoff[3]	828.66	878.53	419.22	0.00	8617.80	361.22
Runoff[1]	1131.61	825.19	721.62	311.02	6976.85	492.33
Recharge[1]	1744.23	1270.54	1481.33	0.00	7848.04	741.74
Runoff (historical)	753.15	307.38	669.91	311.02	2377.58	327.68
Recharge (historical)	2111.56	1109.34	1734.52	835.16	7848.04	897.94
Runoff[2]	595.66	760.83	208.60	0.00	5814.04	259.16
Recharge[2]	2264.83	1480.37	1918.76	0.00	9605.39	963.12

3. Performance indicators: Sensitivity test of hydrological performance

Owing to the variability in runoff products and the difficulty in finding appropriate reference evapotranspiration products, the sensitivity of hydrological performance (recharge and runoff) to the various data products was assessed. For hydrological performance of recharge, this involved calculating three separate recharge distribution maps using (1) evapotranspiration[6] with an upper (ETo +10%) and a lower (ETo -10%) range, and (2) runoff[1] also with an upper (runoff +10%) and a lower (runoff -10%) range. For hydrological performance of runoff, this just involved using runoff[1] and its upper/lower ranges (runoff ±10%).

Supplementary table 7: Sensitivity of hydrological performance indicators (recharge and runoff) to evapotranspiration and runoff

Performance indicator		**2008–2012**		**New Water Programme**	
Hydrological performance	**Parameter**	**Mean**	**s.d.**	**Mean**	**s.d.**
Recharge	ETo (±10%)	0.83	0.02	0.84	0.02
Recharge	Runoff (±10%)	0.84	0.03	0.85	0.03
Runoff	Runoff (±10%)	1.50	<0.001	1.50	0.08

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