Global, Composite Runoff Fields Based on Observed River Discharge and Simulated Water Balances

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Abstract

The present report demonstrates the potential of combining observed river discharge information with a climate-driven Water Balance Model in order to develop composite runoff fields which are consistent with observed discharges. Such combined runoff fields preserve the accuracy of the discharge measurements and simultaneously the spatial and temporal distribution of simulated runoff, thereby providing the "best estimate" of terrestrial runoff over large domains.

The method applied in this study utilizes a gridded river network at 30-minute spatial resolution to represent the riverine flow pathways and to link the continental land mass to oceans through river channels. Selected gauging stations from the Global Runoff Data Centre data archive were co-registered to a simulated topological network (STN–30p) developed at University of New Hampshire. Inter-station regions between gauging stations along STN–30p network were identified. Inter-station discharge and runoff were calculated to compare observed runoff with outputs from water balance model (WBM) simulation. Correction coefficients based on the ratio of observed and simulated runoff for inter-station areas were calculated and applied against simulated runoff to create composite runoff fields.

The resulting composite runoff fields (UNH-GRDC Composite Runoff Fields V1.0) are released along with the present report to the scientific community. Besides the final product, intermediate data sets, such as station attributes and long-term monthly regimes of the selected gauging stations, the simulated topological network (STN–30p), STN–30p derived attributes for the selected stations and gridded fields of the inter-station regions along STN–30p are also released.

The present study also demonstrates some applications of the composite runoff fields. Besides calculating regional statistics of the continental runoff distribution, the study assessed the monitored portion of the continental land mass and discharge. A potential approach in using the composite runoff fields to develop corrected precipitation fields is also presented.

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Introduction

Spatially-distributed runoff estimates are normally based on water balances using climate data such as precipitation, air temperature, vapor pressure, wind speed, etc. (depending on the complexity of the evaporation function used in the water balance model). The potential errors in the observed precipitation - widely recognized in the climate research community [33] - considerably limit the expected accuracy of the runoff estimates based on climate variables.

The rational to validate components of the hydrological cycle against observed runoff is discharge can be measured more accurately than other components of the land-based energy and water cycles with perhaps the exemption of temperature [13]. The accuracy of river discharge measurements are in the range of 10-20 % which is much higher than what can be achieved in measuring precipitation [10]. Climate models at present do not adequately recognize drainage basin processes and the lateral runoff at the continental scale. Available observed runoff data sets have not yet been adequately used in model calibration and validation, which is one of the reasons, why present climate models show marked discrepancies between observed and modeled runoff [7]. More recently, atmospheric scientists have realized the value of river discharge data as a source of information for calibrating and validating climate models [9], [22].

Even though, discharge is an accurate measure of the integrated terrestrial runoff, it does not give information on the spatial distribution of the runoff within the watershed. Disaggregation of the river discharge signal is necessary when spatially distributed runoff information is needed. Early works of Baumgartner and Reichel (1975) and Korzoun et. al. (1977) estimated global runoff using manual techniques to develop spatially distributed runoff fields on the annual basis [1], [12].

The Global Runoff Data Centre[1] (GRDC) and Institute for the Study of Earth Ocean and Space, University of New Hampshire, Durham, USA have teamed to develop methods and data products allowing for the re-distribution of observed global river discharge data from GRDC data archives along grid-based, simulated river network at 30-minute ($\sim 50\,km$ at the equator) spatial resolution developed at UNH. The products of this initial joint effort are gridded monthly mean composite runoff fields (UNH-GRDC Composite Runoff Fields V1.0) on a 30-minute global grid, but the intermediate data sets, such as the simulated river network and the co-registered discharge gauging stations data, will also be released to the global research community.

The disaggregation techniques implemented within the present report distribute observed discharge data over a simulated river network by incorporating global water balance model runoff estimates developed at UNH [29], [26], [32], [31] to provide information on the spatial and temporal distribution of runoff. The merging of water balance model runoff with re-distributed observed discharge offers at present the best estimate of the geography of terrestrial runoff where the amount of runoff is constrained by observed discharge while at the same time the spatial distribution of water balance is preserved.

[1] GRDC operates under the auspices of the World Meteorological Organization (WMO) and is hosted by the Federal Institute of Hydrology (BfG) in Koblenz, Germany.

1 Geographic Co-Registration of Simulated River Network and Gauged River Flows

The key element to re-distribute gauge-based discharge data across the terrestrial surface is to co-register individual discharge observation stations to a simulated river network . The Global Simulated Topological Network at 30-minute spatial resolution (STN–30p) [29] and allied river-based geographical information system (Global Hydrological Archive and Analysis System, GHAAS) developed at UNH were used in the present context.

1.1 Key features of the Global Simulated Topological Network

The Simulated Topological Network (*Figure 1*) at a 30-minute grid cell resolution organizes the ~60,000 half degree continental land cells into 6152 river basins with sizes ranging from a few hundred km^2 to 5.8 $\times 10^6 km^2$. Out of the 6152 river basins represented in STN–30p, 1123 have more than 10,000 km^2 catchment area (~5 cells) which could be considered as the smallest catchment area that a 50 km network potentially can represent. Our experience with STN–30p [29] shows, that typically river basins with $\geq$25,000 km^2 can be represented accurately with STN–30p.

The Simulated Topological Network is not simply a flow direction grid at 30-minute resolution, but a set of derived data sets, which makes the representation of river systems more comprehensive. First, every river segment (grid cell with flow direction) has a set of attributes such as basin identifier, upstream catchment area, main-stem length, distance to receiving end-point downstream, stream order using Strahler's system [23], etc. Furthermore, the attribute table associated with individual river segments is sorted by basin identifier and catchment area. The management of the river segment attributes adds significant overhead compared to simply managing the flow directions, but offers substantial improvement in network analysis, since the attribute information is stored instead of being re-generated every time when needed. Sorting the attribute information is particularly useful in flow accumulation procedures. A detailed description of STN–30p data structures is given in Appendix A.

Beside the river segment attributes, STN–30p maintains information at the river basin level (e.g. basin name, basin area, main-stem length, Strahler stream order, etc.). A total of 397 basins (out of the 1123 basins with more than 10,000 km^2 catchment area) were named by co-registering STN–30p to the GEMS/GLORI (Global Register of River Inputs) data base [18]. Appendix B gives the list of named STN–30p basins with STN–30p derived attributes.

1.2 GRDC Discharge Gauging Station Data Set

GRDC collects and maintains a large set of river discharge data with global coverage. A WWWeb-based catalog of available data and a user desk assist users to select discharge data for a variety of research purposes. Access to the database is regulated by GRDC's Policy Guidelines for the Dissemination of Data and Costing of Services [6]. The GRDC's discharge

Potential Simulated Topological Networks (STN-30p)

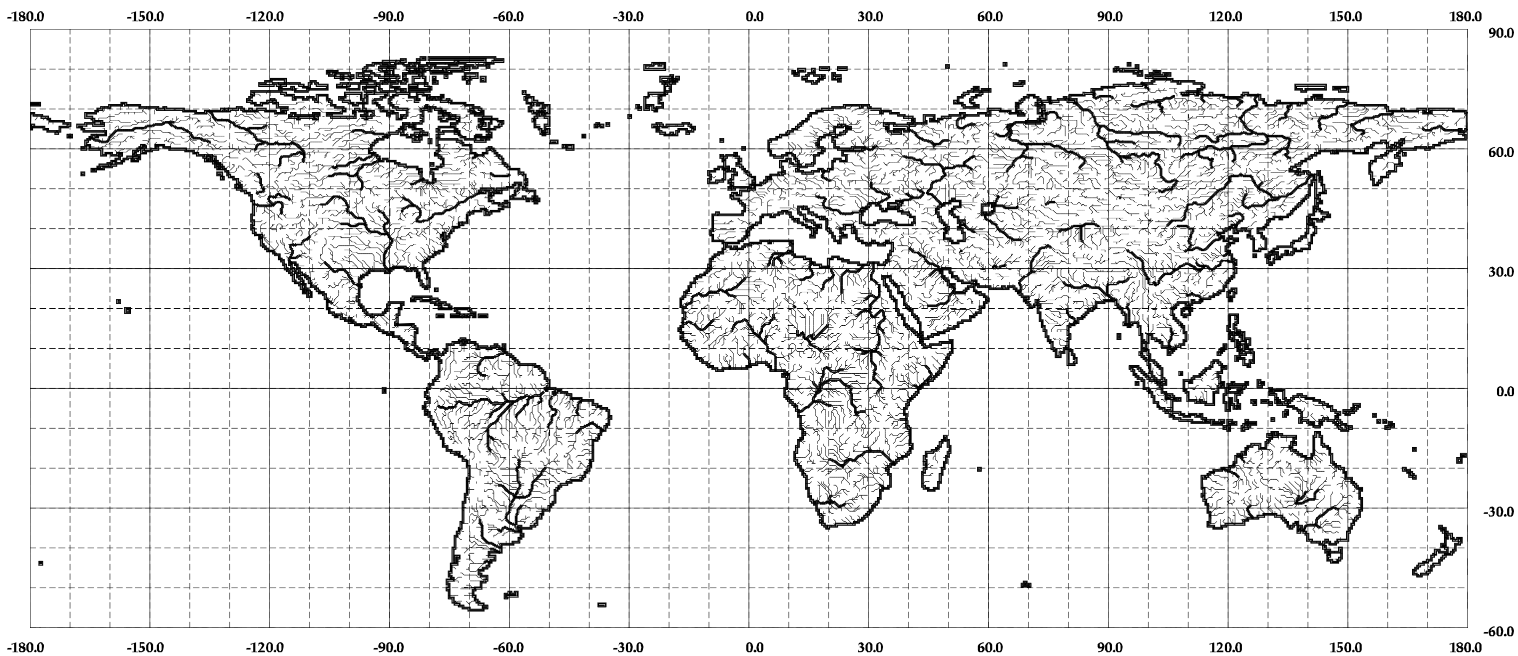

Figure 1: Simulated Topological Networks at 30-minute resolution. A partial inventory is given representing only second or higher order STN–30p rivers segments (using Strahler system).

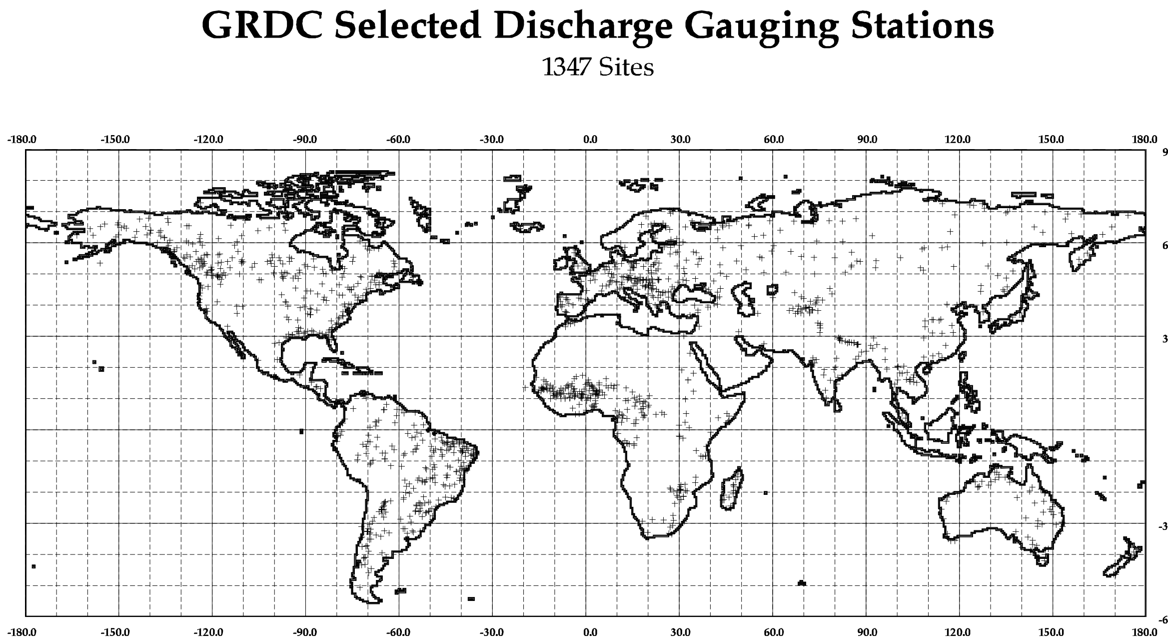

Figure 2: GRDC selected discharge gauging stations.

data set has the advantage over publicly available global data sets (such as UNESCO/UNH RivDIS [30], [27], [28]) of having continuous updates for many of its stations.

As an important part of its activities, GRDC is providing analyses and data products for release to the global research community. The release of two datasets on CD-ROM is planned for March 1999. The CD-ROM provides long-term monthly discharge of 198 gauging stations close to mouth of rivers draining into the world oceans in addition to percentile graphs and flow accumulation curves; another data set consists of long term monthly discharge from 1,348 gauging stations with tributaries larger than 2500 km^2 and time series exceeding 12 years with less the 10 % missing data (*Figure 2*). Both data sets also contain maximum and minimum values from these stations.

Figure 3 shows the number of operating stations throughout the observational record in a similar subset ($\geq$12 years of record, $\geq$2500 km^2 catchment area) of UNESCO/UNH RivDIS data set vs. the GRDC 1348 selected sites. This demonstrates the improvement in time series coverage in the GRDC data set compared to publicly available data sets.

Since the average grid cell area in STN–30p is around 2250 km^2 and a single grid cell cannot be expected to represent basin catchment areas realistically, the 1348 GRDC stations were further reduced in number for the present study by selecting 861 candidate stations with more than 10,000 km^2 catchment area. This catchment size is still below the 25,000 km^2 limit that STN–30p can resolve reliably, but retains some smaller sites, which may still work well for predicting spatially distributed runoff within our 30-minute resolution framework.

Since the aim of the present study was to develop climatologically-averaged monthly runoff

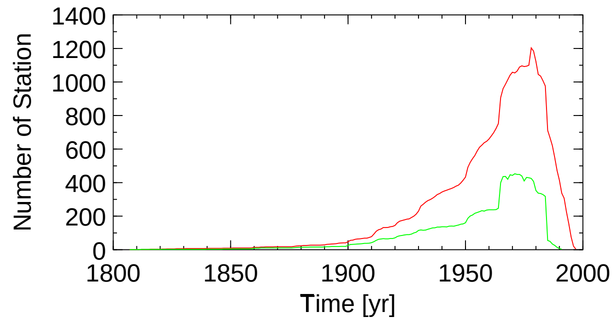

Figure 3: Number of operating stations over time in GRDC and UNESCO/UNH RivDIS V1.0 data sets.

fields, the mean monthly discharge time series associated with the discharge gauging stations were averaged over the time period of the observation records. Unfortunately, the time period of the observation varies station by station [8], therefore the resulting monthly discharge regimes are not fully consistent.

1.3 Co-registering Discharge Gauging Stations to STN–30p

The most important step in the development of disaggregated runoff fields is the proper co-registration of discharge gauging sites to a simulated river network which allows the inter-comparison of simulated to reported catchment area associated with each station. STN–30p (V5.12), documented in Vörösmarty et al [29] was used in the present work. This data set has been validated against several independent atlases and station-based attribute sources, such as the UNH edition of the UNESCO global selected discharge series [30], and R-ArcticNet, a pan-Arctic discharge data set including station data from Russian, Canadian and US monitoring archives representing the Arctic region [14]. The GRDC stations were geo-registered to locations on STN–30p which maintained consistent catchment area attributes.

Considering STN–30p simulated vs. GRDC-reported catchment areas at the gauging stations, we note STN–30p's tendency to overestimate catchment areas [29]. This is due to the fact that STN–30p represents potential routing (i.e. the river networks that would be formed if sufficient runoff were available to produce discharge everywhere), while GRDC-reported catchment area represent the contributing upstream area only.

In addition to displaying and visually inspecting the one-to-one correspondence between reported and simulated catchment areas, normalized errors were computed for each station. One common approach to computing normalized error is

$$\varepsilon_c = \frac{X_{sim} - X_{obs}}{X_{obs}} 100\,\% \tag{1}$$

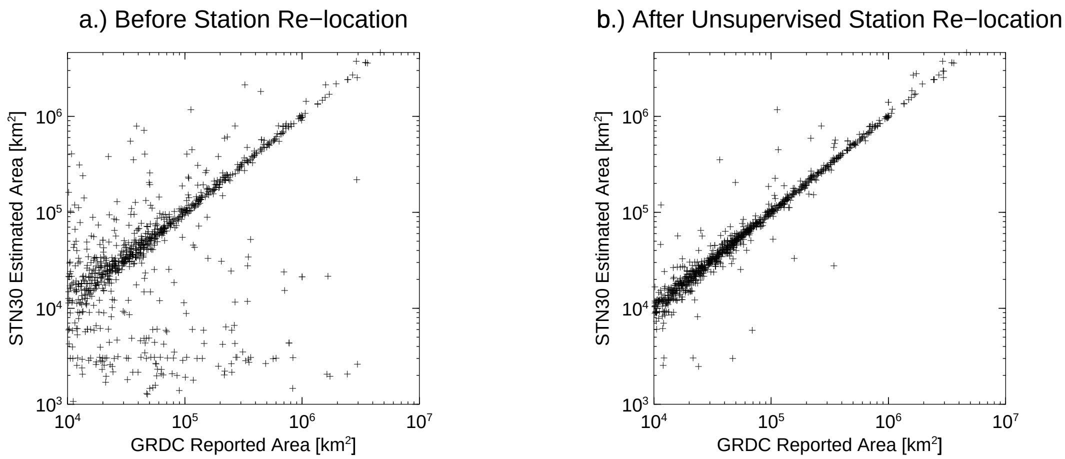

Figure 4: Comparison of GRDC reported catchment areas to STN–30p simulated subbasin areas at the Original and Re-located GRDC gauging sites (using automated unsupervised re-location.

ε_c	- classic normalized error [%]
X_{sim}	- simulated value
X_{obs}	- observed value

However, equation 1 has the disadvantage of being asymmetric, since its lower limit is -100 % while its upper limit is $+\infty$ %. A symmetric normalized error term was introduced and given as

$$\varepsilon_{sym} = \frac{X_{sim} - X_{obs}}{\max(X_{obs}, X_{sim})} 100\,\% \tag{2}$$

The first step in co-registering gauging stations to the STN–30p simulated network was to assign STN–30p grid cells to GRDC gauging stations. This yielded many inconsistencies in terms of reported and STN–30p derived catchment area (*Figure 4a*). We then applied an automated search algorithm that positioned sites within neighboring STN–30p grids that yielded a best match to GRDC-reported catchment area (*Figure 4b*). This apparent improvement proves the good performance of the STN–30p network and robustness of the unsupervised relocation procedure.

After automatic re-location, every site with symmetric error $\varepsilon_{sym} > 15\,\%$ was individually inspected to identify whether the significant difference in reported area and the STN–30p area was due to station positioning error, STN–30p routing error or error in the GRDC-reported longitude/latitude or catchment area. Sites where the reported and simulated area differences could not be resolved were removed from the selection when a sufficient number of stations in the neighborhood was available. Some stations, which had substantially different reported and STN–30p areas were kept in the data set when their observed long term mean annual discharges were consistent with the neighboring stations. For example, Upington (Zaire) on the Orange River has ~10 times larger area in STN–30p than recorded by GRDC, but its discharge is consistent with upstream and downstream neighboring stations.

Co-registration of gauging stations to STN–30p is not only important as an opportunity to validate STN–30p performance and identify potential errors in the discharge station attributes but allows the derivation of a station network topology. The station network topology is defined by a single attribute specifying the next nearest downstream gauging station. The use of a 30-minute gridded network has some limitation in defining station topology since the terms "upstream" and "downstream" are ambiguous when more than one station shares the same grid-cell. The station data set was screened for multiple stations falling into the same STN–30p grid cell. Stations sharing the same STN–30p cell were either moved to a neighboring grid cell or removed from the analysis. In such situations, the station with the longer and more complete time series was kept. When the length and the quality of the time series were identical, the one with the more contemporary time series was retained. Furthermore, the correspondence of GRDC-recorded and simulated catchment areas was also considered when rejecting or retaining stations.

The co-registered station network and the STN–30p define inter-station regions between gauging stations (*Figure 5*). The station network topology allows the calculation of inter-station areas between gauging stations. The inter-station areas can be calculated both from the GRDC-recorded and the STN–30p estimated catchment areas. As stated earlier STN–30p can reliably represent catchment areas $\geq$25,000 km^2 [29] and occasionally 10,000 km^2- 25,000 km^2. This is true for inter-station areas as well. Further screening of the gauging station subset was necessary to identify sites which were too close to each other based on the 10,000 km^2 criterion. Similar criteria (better discharge record, better match with simulated catchment area, etc.) to resolve multiple instances of stations falling into the same grid cells were applied here as well. We also considered if improvements could be made by moving sites up or down along the STN–30p network. In such cases the station locations were re-assigned manually.

Further sub-setting of the discharge gauging stations was based on calculated inter-station runoff. Inter-station runoff was calculated based on the long-term mean annual discharge (long-term mean inter-station discharge divided by the inter-station area). Inter-station runoff values were checked for extreme values. One typical extreme situation was the occurrence of negative inter-station runoff (as a result of decreasing observed discharge in the downstream direction). This situation is not without precedent especially in arid regions (e.g. Nile, Niger, etc.). However, it can also reflect errors in the observed discharge database. For instance, there is decreasing discharge between Mohács (the last Danubian station in Hungary) and Bogojevo, the next downstream gauging station on the Danube in the former Yugoslavia. Hydrologists at the Vízgazdálkodási Tudományos Kutató Központ (Water Resources Research Center, VITUKI), Budapest, Hungary, recognize that their discharge rating curves consistently yield higher discharge than those used by the hydrological services of the former Yugoslavia. According to GRDC, a similar situation exists on the Rhein River, where German and Dutch discharge measurements are not fully consistent.

Consistency of the inter-station and the upstream runoff was also checked. For example,

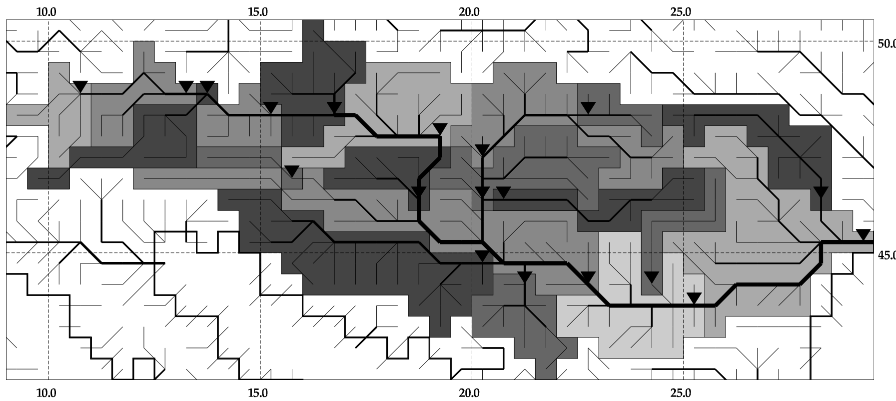

Figure 5: Inter-station areas in the Danube basin.

two major Brazilian stations (Ipiranga Velho on the Rio Ica, ~13,000 mm/yr runoff, Manicore, on Rio Madeira ~6000 mm/yr runoff) were removed from the discharge station data set because of unrealistically high discharge values. Assuming river basins are exposed to similar climate, wide differences between the inter-station and sub-basin-wide runoff could be indication of errors in the discharge data set, but it is often difficult to judge whether the dramatic difference is in fact unrealistic.

This sub-setting and screening were done manually, with the help of special software called RiverGIS which is part of the Global Hydrological Archive and Analysis System (GHAAS) developed at UNH. RiverGIS is GIS software specially designed for processing river-based spatial data sets. It is a complement to other general purpose GIS software such as ARC/INFO. RiverGIS has some unique functionality geared toward reducing the time-consuming tasks such as manual editing of gridded river networks, comparison of gauging station attributes to STN–30p and delineating inter-station areas. RiverGIS can handle various types of spatial data sets (point, arc, polygon, discrete/continuous grids) both on Cartesian coordinate systems and Geographical (spherical) coordinate systems.

The final selection yielded 663 sites (*Figure* 6 and 7). Appendix D gives the list of the selected stations with GRDC catalog and STN–30p derived attributes. *Figure* 8 demonstrates the highly consistent correspondence between GRDC-reported and simulated catchment and inter-station areas. The catchment and inter-station area comparisons show 7.5 and 11 % absolute error with 2 % and 3 % bias respectively. The positive bias is due to the STN–30p tendency mentioned earlier to overestimate catchment areas. *Figure* 9 shows the frequency distribution of the symmetric error in comparing reported and STN–30p estimated catchment and inter-station areas.

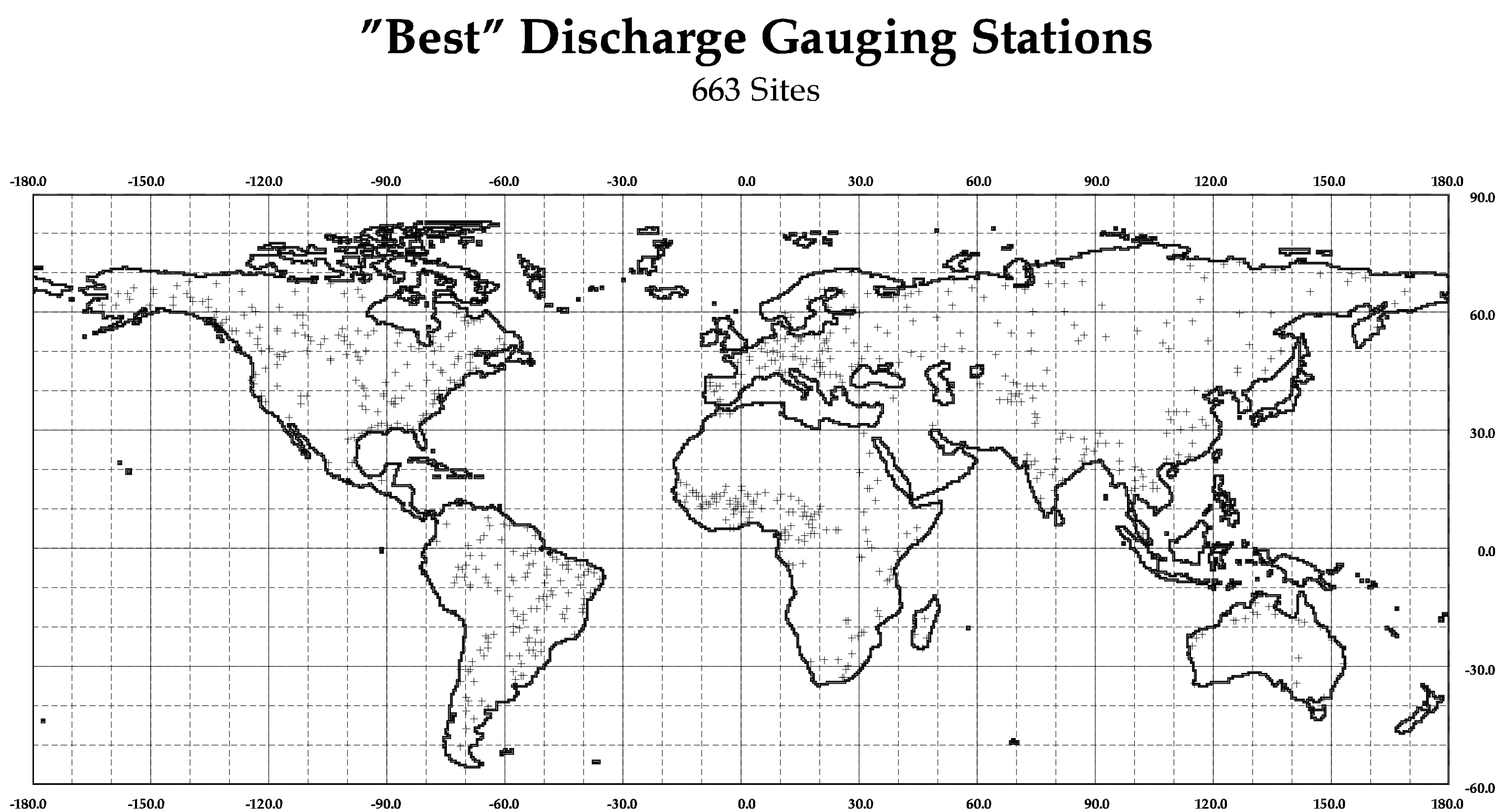

Figure 6: The 663 "Best" discharge gauging stations used in the present study.

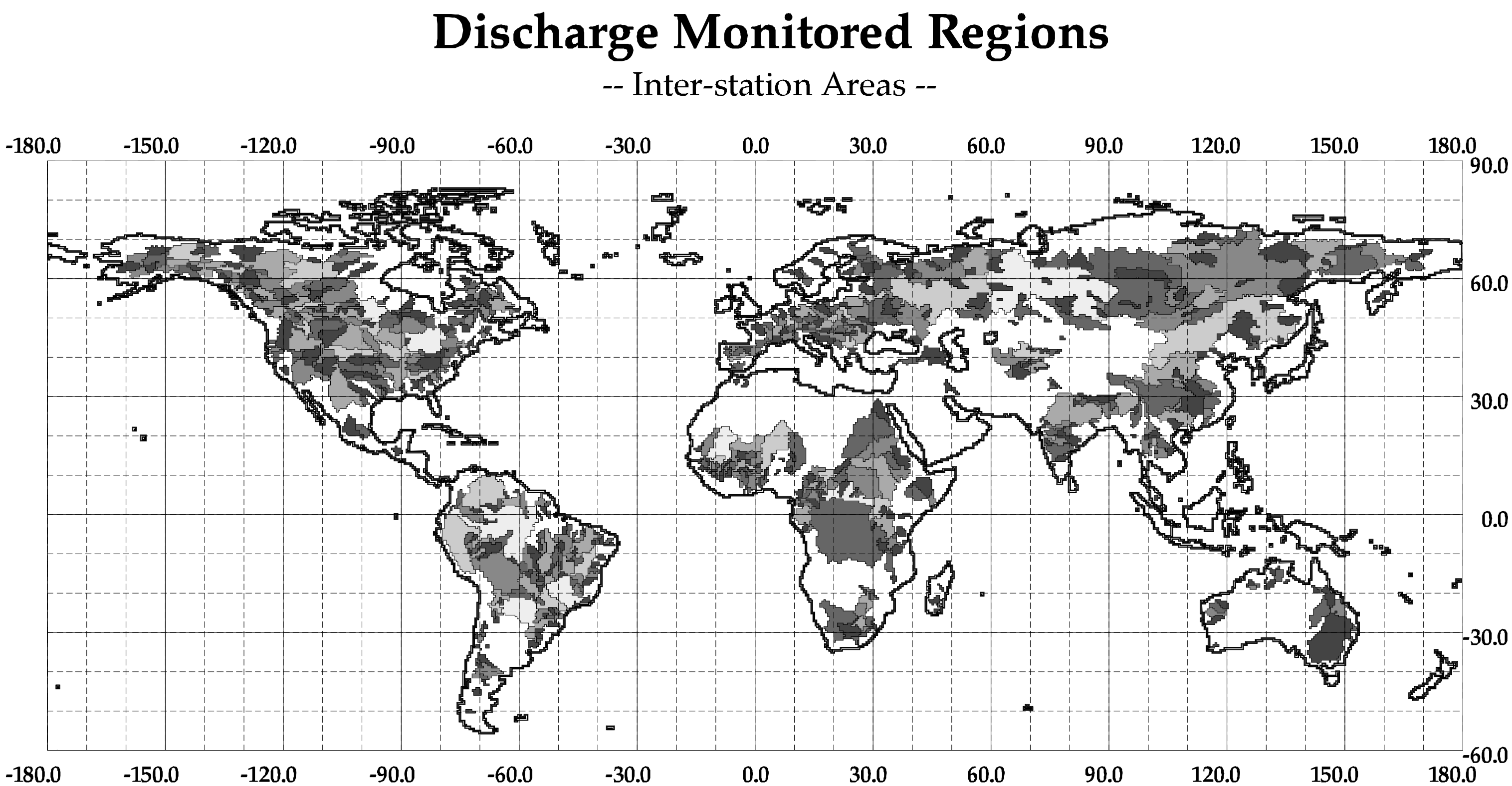

Figure 7: Continental land mass monitored by the selected GRDC stations.

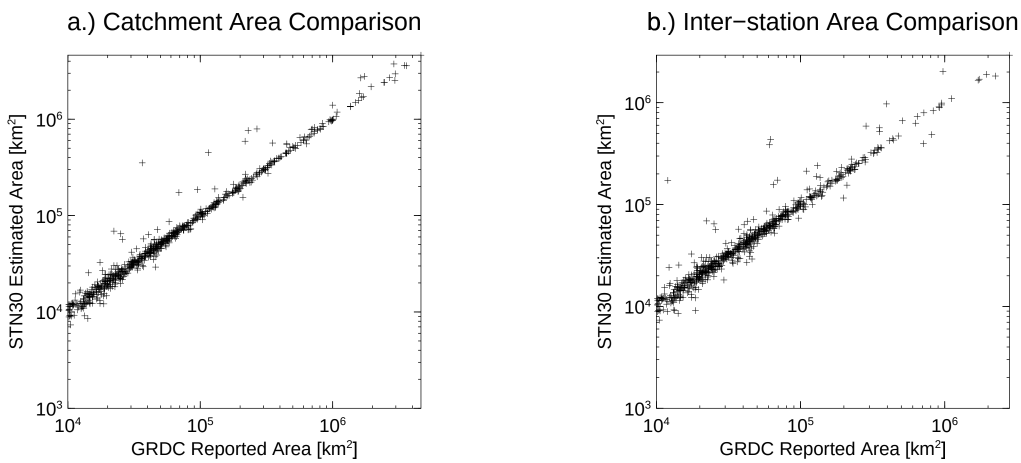

Figure 8: Comparison of GRDC-reported catchment and inter-station areas to those represented by STN–30p.

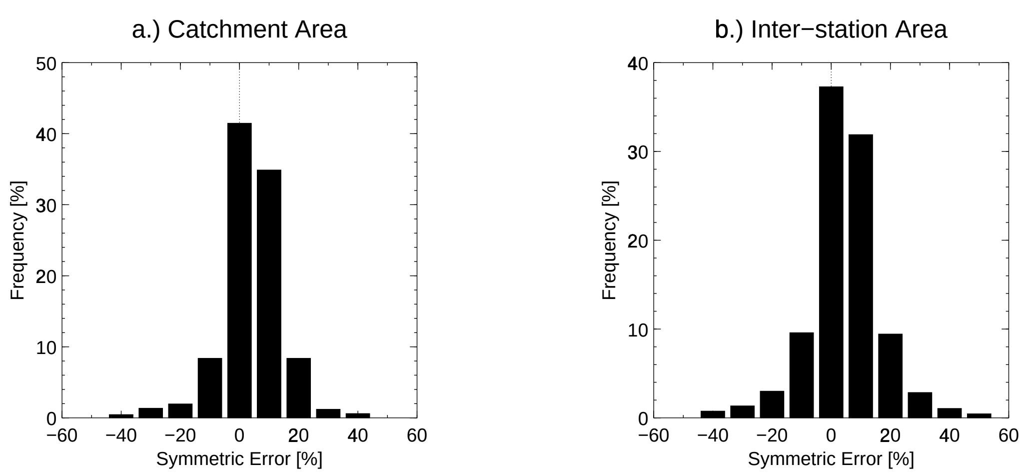

Figure 9: Frequency distribution of Symmetric Error for catchment and inter-station area comparison.

1.4 Spatial Distribution of the Selected Gauging Stations

The first measure of representativeness of the selected gauging stations is the proportion of continental land mass monitored by these sites. This can be determined by selecting the non-nested (or most downstream) gauging sites (with no further stations downstream) and comparing their catchment area to the continental land mass. The total upstream area of the 298 most downstream stations (*Figure 7*) on the STN–30p network is 67 $\times 10^6 km^2$, i.e. more than 50 % of the 133 $\times 10^6 km^2$ continental land mass in STN–30p (which does not include Antarctica, the glaciarized portion of Greenland and the Canadian Arctic Archipelago). If we consider only the actively discharging 93 $\times 10^6 km^2$ portion of STN–30p simulated networks, this data set represents (72 %) coverage.

As stated in Section 1.1, the 30-minute STN–30p does not always accurately represent catchment areas smaller than 25,000 km^2. Therefore the discharge gauging stations should partition the STN–30p domain into inter-station regions of 25,000 km^2 in area or larger. However, these areas should not be too large since (a) modestly sized inter-station regions will preserve important spatial distribution of runoff, and (b) discharge delays within inter-station regions can be neglected. *Table 1* shows the distribution of mean river routing distances within the tributaries of the non-nested stations and the inter-station regions of the final subset. However, the extremely long distances are not fully eliminated by using more stations, but the number of inter-station sub-basins with long routing distance is reduced.

Table 1: Distribution of mean river routing distances within monitored regions.

Mean Distance	**Non-nested Stations**		**All (n=663) Stations**	
[km]	**# of Stations**	**Percent**	**# of Stations**	**Percent**
< **100**	47	15.8	115	17.4
100 - 1000	231	77.5	537	81.0
1000 - 2000	16	5.4	9	1.4
2000 - 5000	4	1.3	2	0.3
Total	298		663	

Travel time delays along river networks can be estimated by assuming uniform river flow velocity. If we assume average river flow velocity of 1 m/s, then a parcel of water can travel ($3600 s/hr * 24 hr/day * 30 day/mo * 1 m/s \simeq$) 2500 km in a month. This means, the monthly inter-station runoff can be estimated from inter-station discharge (expressed as a difference between the discharge measured upstream and the discharge measured at the station) if the maximum travel distance within the inter-station area is significantly less than 2500 km. In this case the inter-station discharge is dominated by the timing of the inter-station runoff and the time delays in discharge traveling along the river systems can be considered negligible in the context of our study.

A distance of 2500 km is long in terms of river networks. The 30-minute STN–30p shows that approximately 90 % of the continental land mass is within 2500 km distance from river mouth along simulated river routes [29]. However STN–30p lengths tend to be shorter than real river lengths, since fine-scale river sinuosity is not considered but this difference is not substantial for most rivers [29]. This suggests that discharge regimes at longer time steps (typically monthly) are dominated by the runoff regime for the major portion of the land mass. This is true for all of the smaller river basins and significant portions of the large rivers. But time delays in the large river networks are not negligible since most of the top 50 river basins have main-stems longer than 2500 km. In the case of large rivers, it is important to partition the basins into smaller inter-station regions where the travel times are negligible on a monthly time scale.

2 Distribution of Continental Runoff

2.1 Estimating Continental Runoff with a Water Balance Model

As the First Symposium in Scale Problems in Hydrology in 1982 pointed out, the main problem in hydrology is not the horizontal routing of water, but how much water to route [2]. Estimates of continental runoff can be based on water balance calculations or discharge gauging records.

2.1.1 Water Balance Calculation

Water balance calculations rely on climate variables such as precipitation, air temperature, etc. The first soil moisture budget was given by Thorthwaite's formula [24], [33] as

$$R = P - E - \frac{\partial W}{\partial t} \tag{3}$$

where

$\frac{\partial W}{\partial t}$	- change in soil moisture $[mm/day]$
P	- rate of precipitation $[mm/day]$
E	- rate of evapotranspiration $[mm/day]$
R	- rate of surplus water (runoff and/or recharge) $[mm/day]$

The first relatively simple procedure for estimating land-surface evaporation was proposed by Thornthwaite [24], [25]. He introduced the concept of *potential evapotranspiration* (PET) as an upper limit to evapotranspiration in given atmospheric conditions when the evapotranspiration is not limited by water stress. Thornthwaite formulated the soil moisture budget given by equation 3, and proposed to express evapotranspiration as a function of available soil moisture and the rates of precipitation and potential evapotranspiration [33]:

$$E = \begin{cases} P + \beta\ (W, W^*)\left[E_0\ (T,h) - P\right], & P < E_0\,(T,h) \\ E_0\ (T,h) & P \geq E_0\,(T,h) \end{cases} \tag{4}$$

where

T	-	daily average air temperature $[^oC]$
h	-	duration of the daylight $[hour]$
$E_0\ (T,h)$	-	potential evapotranspiration $[mm/day]$
W, W^*	-	soil moisture and soil moisture storage capacity $[mm]$
$\beta\ (W, W^*)$	-	function that relates actual to potential evaporation or, more specifically $[(E-P)\,/\,(E_0-P)]$to W/W^*

Numerous methods have been proposed to calculate potential evapotranspiration since Thornthwaite published his concept. Federer et al [5] gave a summary of the most frequently used methods. Vörösmarty et. al. studied the impact of the choice of PET method on water-balance estimates [26] and concluded that it had more importance in wet regions, where evapotranspiration is not limited by the availability of water (i.e. $E = E_0$), than in dry regions where the soil moisture (W) approaches the wilting point (W_0), the $\beta\ (W, W^*)$ function approaches 0:

$$\lim_{W \to W_0} \beta\ (W, W^*) = 0 \tag{5}$$

and the evaporation becomes limited by the precipitation (i.e. $E = P$) [26]. Applying different PET methods on 679 US watersheds Vörösmarty found Hamon's formula [11] to give the least bias among the "reference crop" methods which are designed to represent a generic land-cover (typically a short, complete green plant cover, employed in experimental plot studies with dry leaf surfaces and "well-watered" soil) [5].

Vörösmarty et. al. applied a variant of the Thornthwaite soil moisture budget as a Water Balance Model (WBM) [26], [31] at continental and global scales. They expressed soil-moisture change ($\frac{\partial W}{\partial t}$) as a function of the soil-moisture (W), the soil's water holding capacity (W_c), potential evaporation (E_0), precipitation (P_a) available for soil re-charge as rainfall and any snow-melt:

$$\frac{\partial W}{\partial t} = \begin{cases} g\,(W)\,(E_0 - P_a) & P_a < E_0 \\ P_a - E_0 & 0 < P_a - E_0 < W_c - W \\ W_c - W & W_c - W < P_a - E_0 \end{cases} \tag{6}$$

where $g\ (W)$ is a unit-less soil drying function given as

$$g\ (W) = \frac{1 - e^{\left(\frac{-\alpha W}{W_c}\right)}}{1 - e^{-\alpha}} \tag{7}$$

with α an empirical constant. Evaporation becomes:

$$E = \begin{cases} P_a - \frac{\partial W}{\partial t} & P_a < E_0 \\ E_0 & E_0 < P_a \end{cases} \tag{8}$$

Recent modifications to WBM use quasi-daily time steps to reduce the temporal aggregation bias arising from the use of monthly climatic variables. Monthly precipitation is divided into daily wetting events by applying a probability function based on Rastetter et al. [21]. Precipitation is considered snow when the monthly temperature is below -1 $[C^o]$. Snowmelt is a prescribed function of temperature and elevation as given by Vörösmarty et. al. [31], [26]. Runoff is formed either as snowmelt or when the surplus from the difference between precipitation and evaporation ($P - E$) exceeds soil moisture deficit ($W_c - W$).

WBM maintains a simple runoff detention pool (D_r) to represent the runoff delay caused by water transport through groundwater before it enters river channels. The runoff detention pool dynamics is expressed with the following differential equation:

$$\frac{dD_r}{dt} = (1 - \gamma)\ R - \beta D_r \tag{9}$$

where R is the soil moisture budget runoff from equation 3 and γ and β are empirical constants. The river runoff (R_r) then becomes:

$$R_r = \gamma R + \beta D_r \tag{10}$$

2.1.2 Applying WBM in the Present Study

The Water Balance Model was used to generate a spatial distribution of monthly mean runoff at 30-minute (longitude x latitude) spatial resolution for the global land mass. The current version of WBM is highly modular, allowing for the assembly of water balance calculation schemes from various components such as different potential evapotranspiration functions or different implementations of the core water balance module (e.g. with or without permafrost). For the present study, the WBM was applied using Hamon's [11] temperature-based potential evaporation function. Using more sophisticated canopy dependent functions would have required not only more parameterization of the canopy-related parameters, but additional climate variables such as net radiation, vapor pressure and wind speed with unknown error characteristics. By choosing a temperature-based potential evaporation function, the water balance calculation requires only air temperature, precipitation, land cover and soil information, all available globally at the target resolution of this study and with a well-established record in Earth System analysis.

Contemporary land cover classification was assembled by combining Terrestrial Ecosystem Model (TEM) [17] "potential" vegetation overlayed with cultivated areas from Olson's land-use classification [19]. The TEM/Olson composite vegetation was re-mapped to eight cover types (conifer forest, broad-leaf forest, savannah / shrub-land, grassland, tundra / non-forested wetland, cultivation, desert, open water) which were found to have characteristic evapotranspiration properties [5]. Dominant soil type and texture were from the FAO/UNESCO soil data bank [4]. Land cover classification and dominant soil types were combined to estimate rooting depth and water holding capacity as given by Vörösmarty et. al. [32]. Topographic data were from the ETOPO5 [3] global elevation data set. Climatologically-averaged monthly air temperature and precipitation were from Willmott and Matsuura (*Figure 10*). This data set is a descendent of Legates and Willmott [15], [16] climate fields and was made available to us through an ongoing collaboration.

WBM mean annual runoff is shown on *Figure 11* as an example. *Figure 12* shows the comparison of observed and simulated mean annual runoff averaged over the sub-basins of the selected stations. The spread, and the magnitude of differences look discouraging in terms of WBM performance, but comparing mean annual observed and simulated runoff to annual precipitation (*Figure 13*) suggest that the error in the WBM calculation comes from the precipitation data. WBM Runoff is consistent with the precipitation data used as a driving variable unlike the observed runoff which shows a wide spread and little relationship to observed precipitation. Observed runoff often exceeds the precipitation, which demonstrates a very obvious inconsistency between the two data sets.

Considering the WBM runoff error distribution by catchment area (*Figure 14*) shows WBM performance is significantly better for large basins. The uncertainties in the precipitation distribution show little bias over larger domains, therefore the WBM-based approach can be

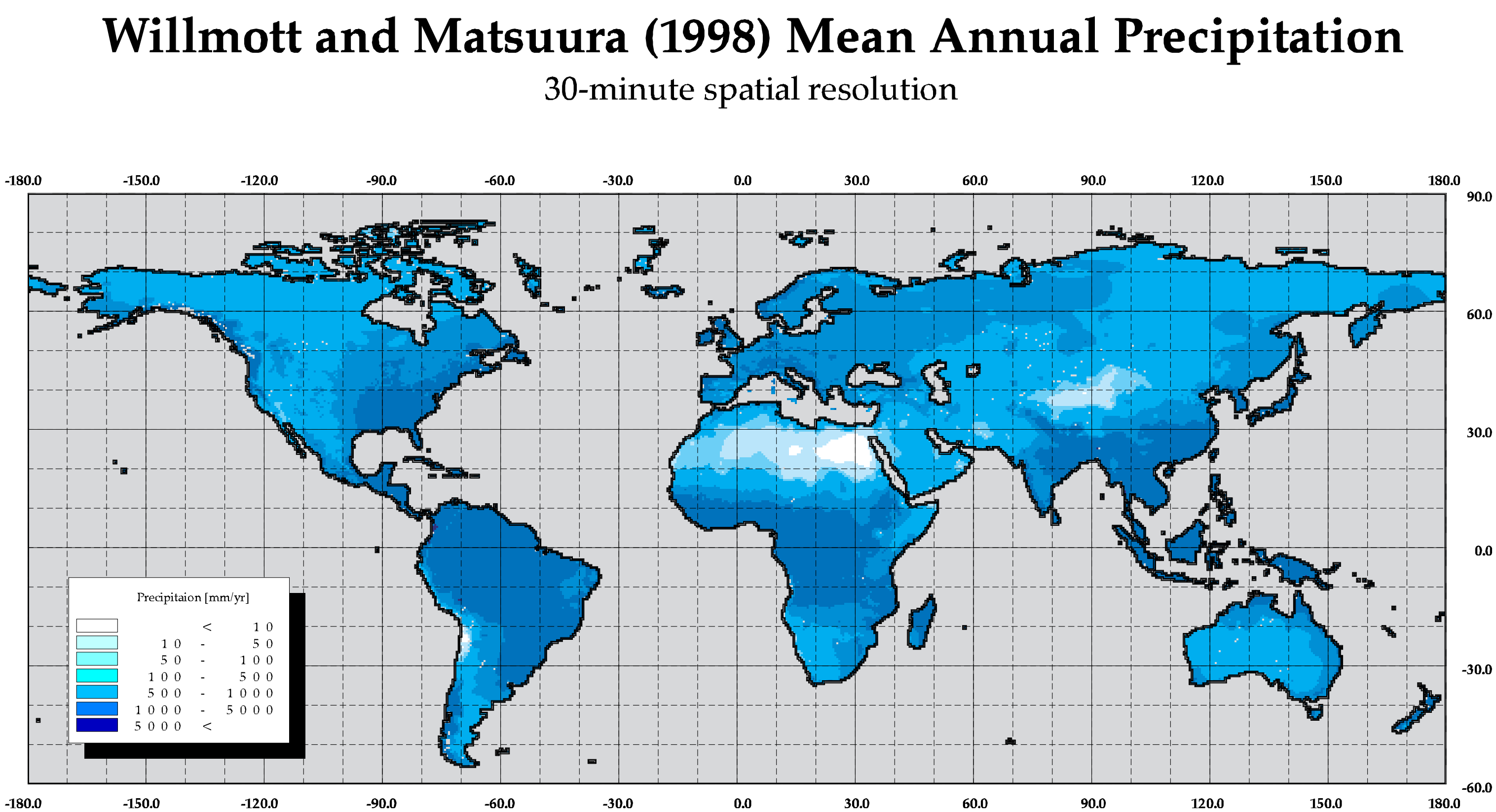

Figure 10: Willmott and Matsuura (1998) mean annual precipitation.

WBM-Simulated Mean Annual Runoff

30-minute spatial resolution

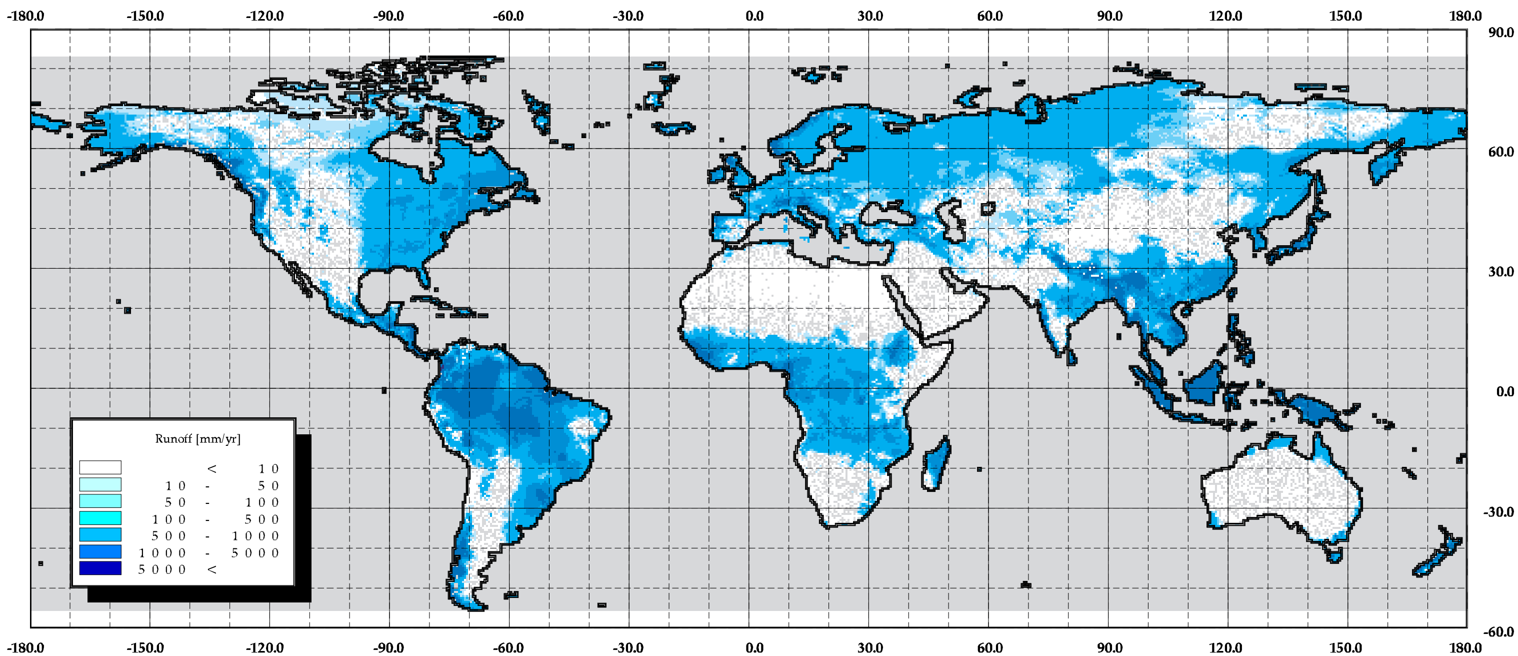

Figure 11: Water Balance Model simulated runoff.

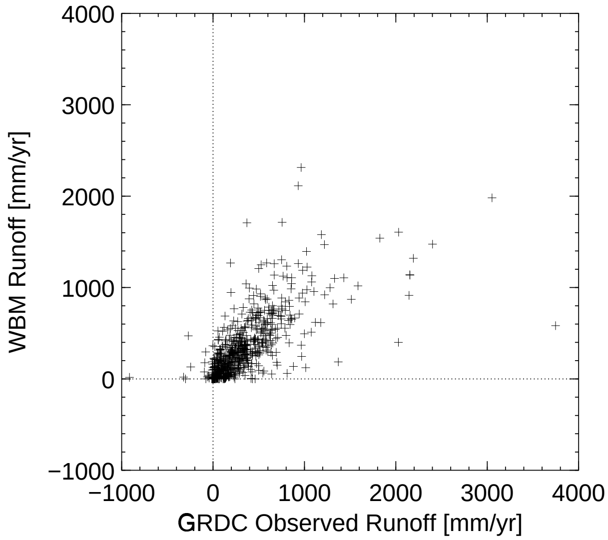

Figure 12: Comparison of observed and simulated sub-basin runoffs.

successfully used to estimate large scale runoff, but it cannot always resolve accurately the distribution of runoff over the terrestrial surface given the apparent problems in the climate fields.

2.2 Creating Composite Runoff Fields

Creating observed runoff fields from observed discharge is ambiguous. As stated earlier, observed discharge is an aggregate signal of terrestrial runoff and spatial disaggregation of discharge requires additional knowledge about the spatial distribution of runoff and the potential time delays along flow pathways. Lacking this information, the only possibility is to assume a uniform spatial distribution and no time delays, i.e. distribute the observed inter-station runoff uniformly over the inter-station areas (*Figure 15*). The observed monthly runoff fields based on this assumption are presented in Appendix F. Note the rather "patchy" pattern of runoff.

As stated above, simulated runoff represents the best potential method of estimating the spatial and temporal pattern of continental runoff, but it is often inherently biased due to inaccuracies in the climate forcings (precipitation in particular). The combination of the two sources of information (observed discharge and simulated runoff) to estimate continental runoff has the possibility of yielding the most reliable assessment at present.

One method to combine water-balance runoff and discharge gauging station data is to use tributaries and inter-station regions of the individual gauging stations in the context of a topological network, and to calculate mean modeled runoff for the defined regions. The simulated mean runoff can be compared to observed runoff over the same domains to calculate a set of correction coefficients for each distinct inter-station area. Assuming there is no substantial

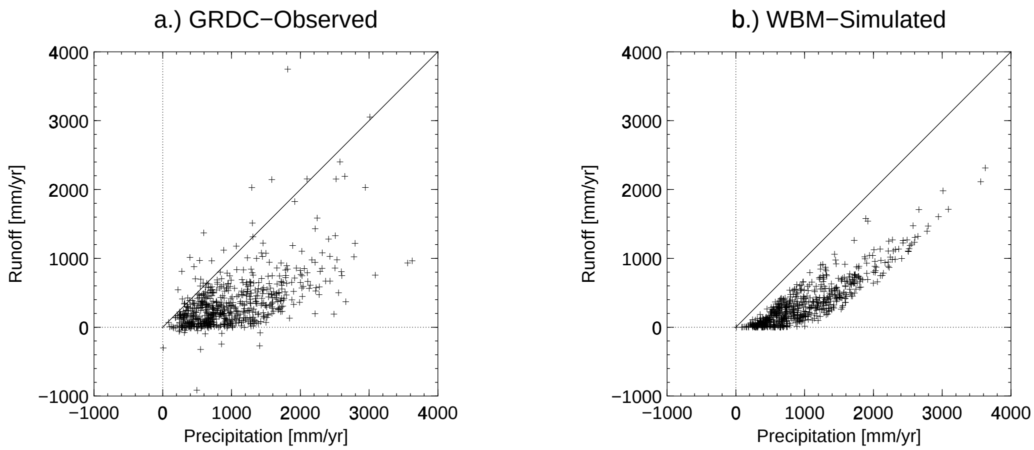

Figure 13: Comparison of Observed precipitation to observed and WBM simulated runoff.

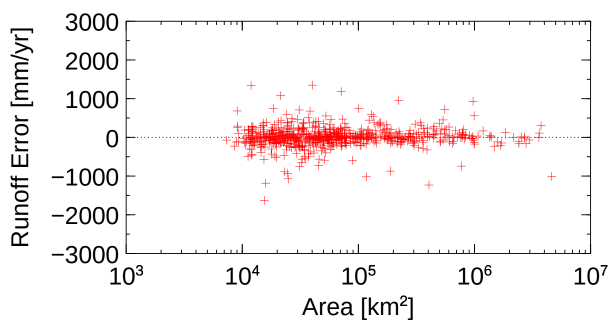

Figure 14: WBM Runoff Error by Catchment Area.

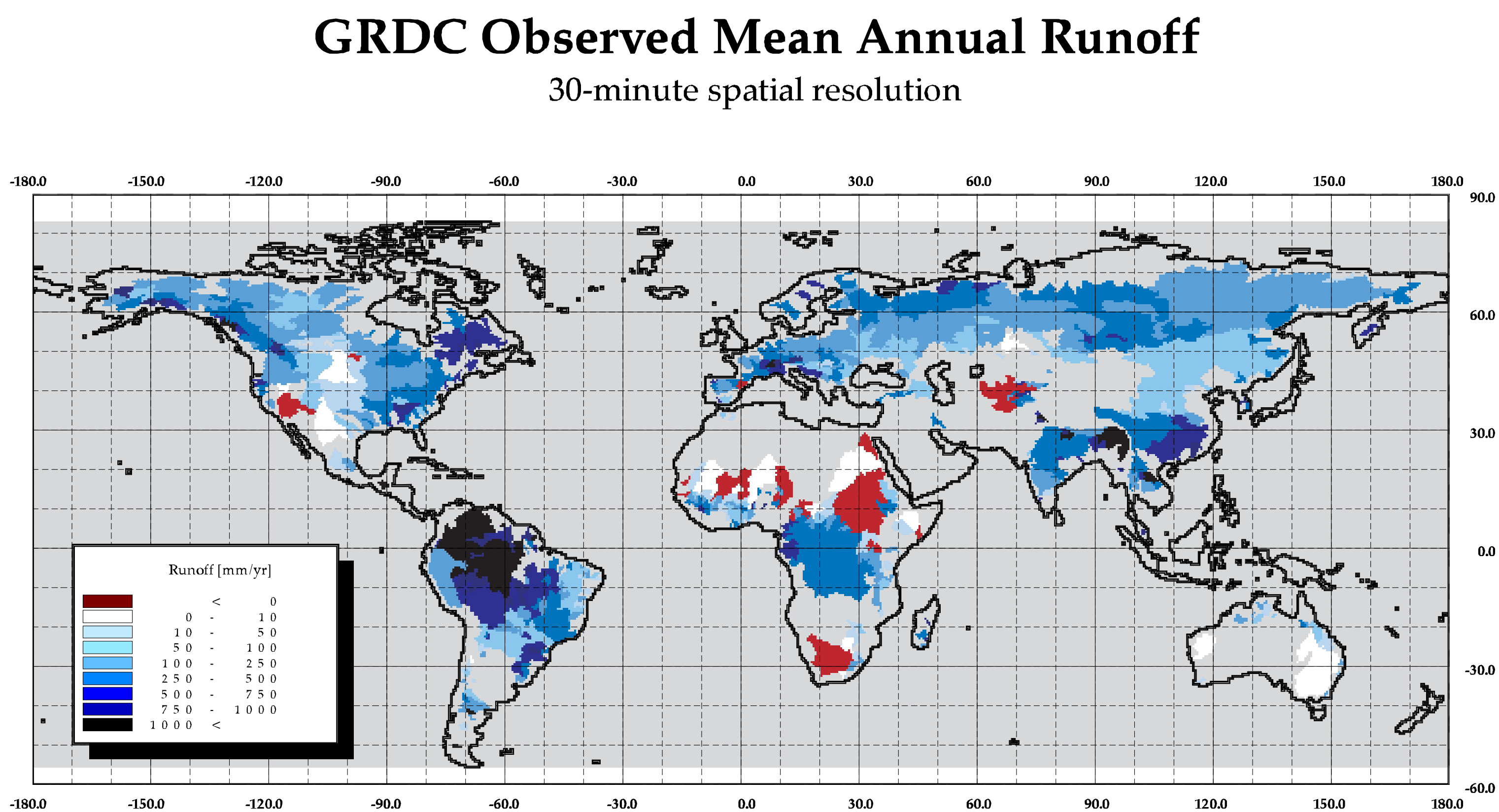

Figure 15: Observed Annual Runoff uniformly distributed along inter-station regions.

year-to-year water storage, the correction coefficients can be calculated on an annual basis to eliminate the impact of travel time delays.

This procedure can be formalized as follows. The mean observed inter-station runoff for inter-station region i can be expressed as:

$$\overline{R}_{oi} = \frac{\overline{Q}_{oi}}{A_{si}} \tag{11}$$

where

$\overline{R}_{oi}$	- Mean annual observed inter-station runoff $[L/T]$
$\overline{Q}_{oi}$	- Mean annual inter-station discharge $[L^3/T]$
A_{si}	- Inter-station area $[L^2]$

The mean water balance runoff in the inter-station region i becomes:

$$\overline{R}_{wi} = \frac{\oint^{A_{si}} R_{wbm} dA}{A_{si}} \tag{12}$$

where

$\overline{R}_{wi}$	- Mean annual water balance runoff $[L/T]$
$\overline{R}_{wbm}$	- Local annual water balance runoff $[L/T]$

Water balance runoff correction coefficient ξ_{si} for inter-station area A_{si} can be calculated as:

$$\xi_{si} = \frac{\overline{R}_{oi}}{\overline{R}_{wi}} \tag{13}$$

The corrected runoff then becomes:

$$R_c = \xi_{si} R_{wbm} \tag{14}$$

The water balance runoff correction coefficient (ξ_{si}) can be calculated on an annual basis (i.e. as a time series of annual correction coefficients) or on a long-term annual mean basis. The runoff correction coefficients were calculated for only those inter-station regions where both the observed and the WBM predicted annual runoff was positive.

The runoff correction coefficient (ξ_{si}) can be viewed as a measure of WBM error. *Figure 16* shows interesting pattern in terms of water balance error. When the runoff correction coefficient $\xi_{si} < 1$ WBM over-estimates runoff when $\xi_{si} > 1$ represents under-estimation of runoff. According to *Figure 16* WBM has a tendency to over-estimate runoff in the tropics with the exception of some portions of the Amazon, while it under-estimates runoff in most of the Arctic basins such as the Ob, Yenisei, Lena, Mackenzie, etc. This is inherent from the precipitation data (*Figure 10*)

The annual composite runoff field is shown on *Figure 17*. Monthly composite fields are presented in Appendix H.

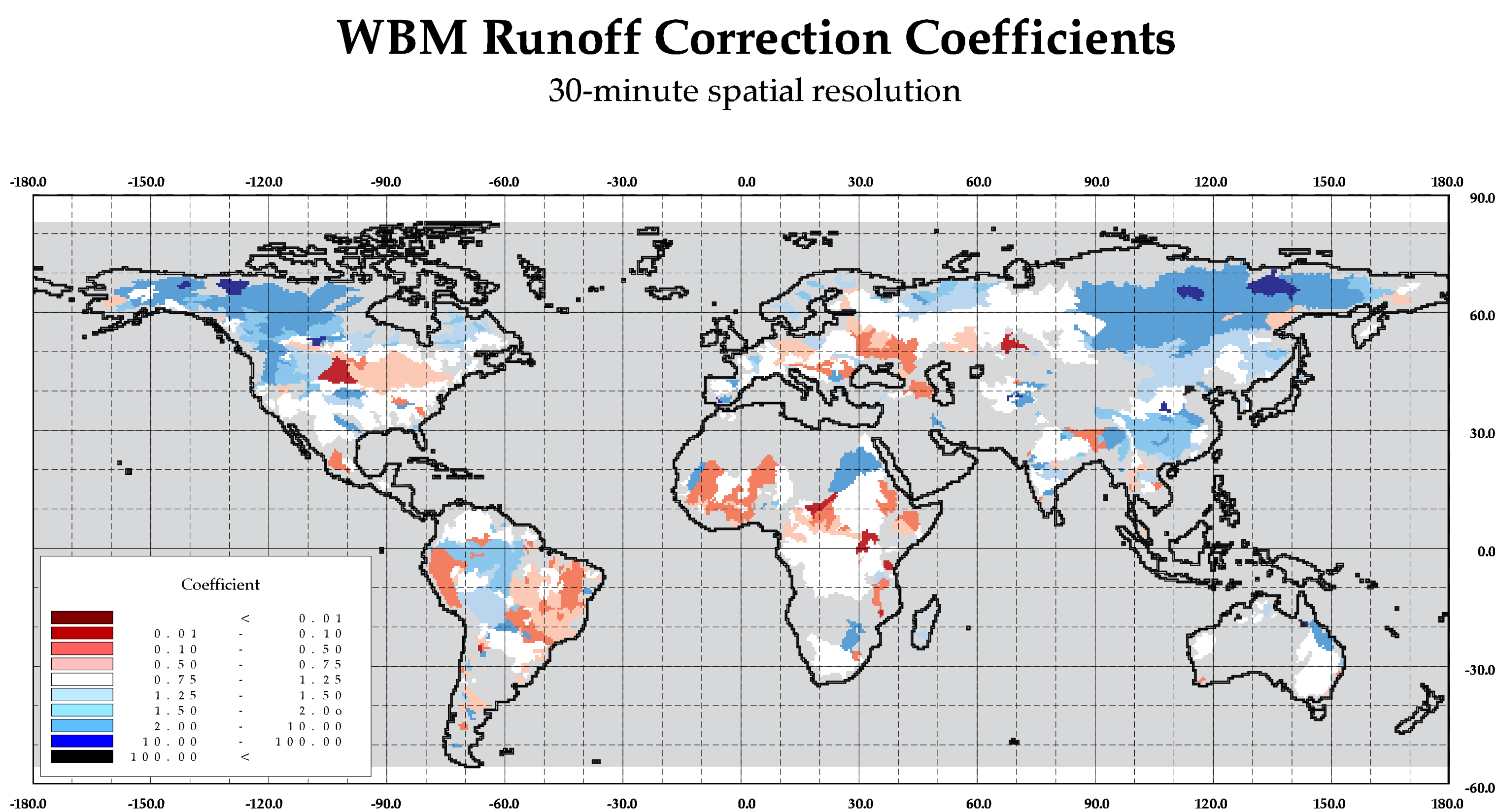

Figure 16: Mean annual runoff correction coefficients. Values < 1.0 indicate underestimate and > 1.0 indicate overestimate by WBM.

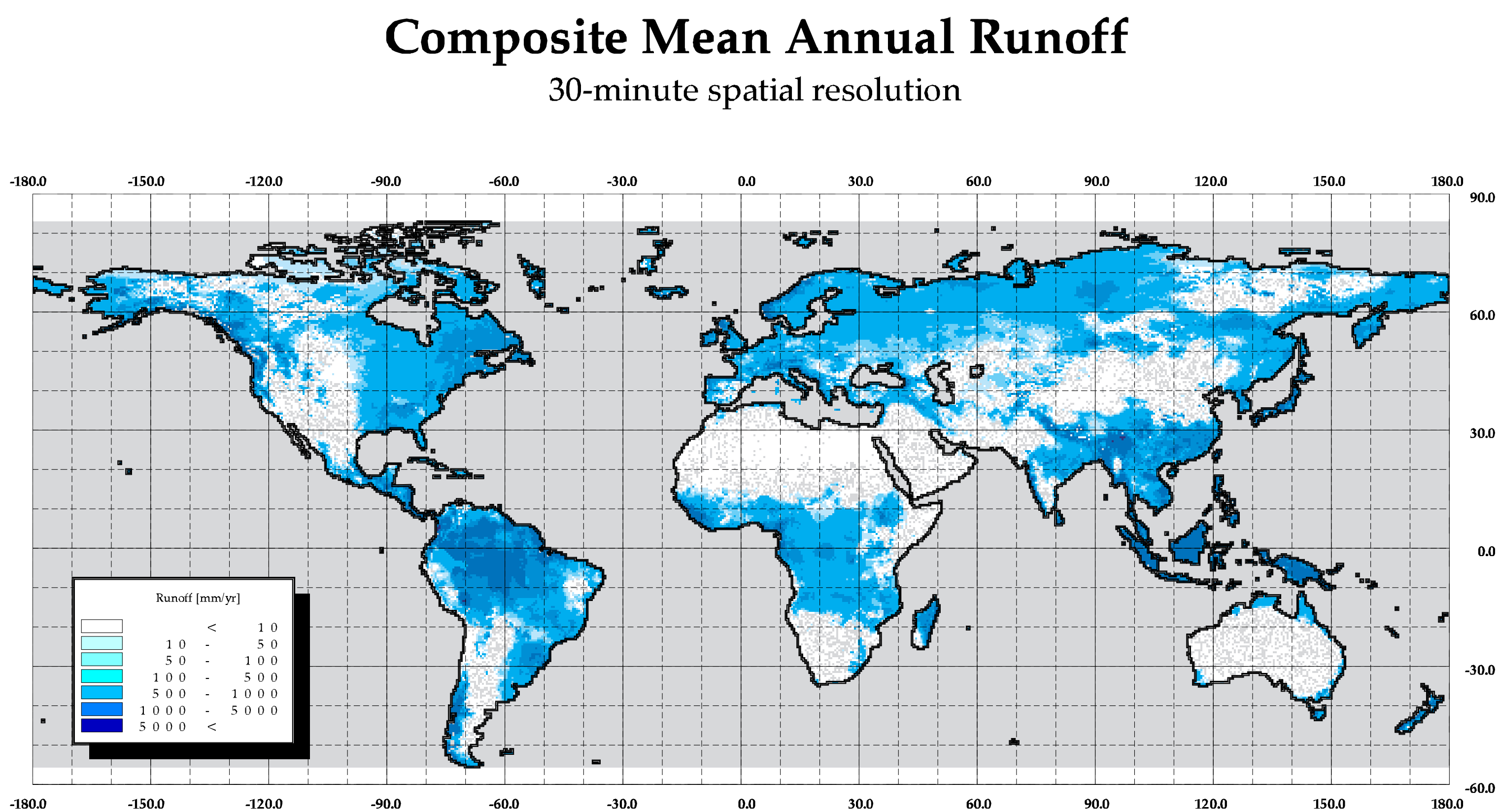

Figure 17: Mean annual combined runoff.

3 Some Applications of the Composite Runoff Fields

Spatially distributed runoff fields have numerous applications ranging from calibrating and validating the soil vegetation atmosphere transfer (SVAT) component of atmospheric models, to providing sustainable water supply estimates in water resource assessments. The scope of the present work has focused on the development of composite runoff fields. We now demonstrate the potential of such a data set by describing some simple applications.

3.1 Characterizing the Distribution of Continental Runoff

One important application of the composite runoff fields is to derive information on the spatial distribution of terrestrial runoff that can be compared to earlier estimates. By putting the runoff fields into the STN–30p context, various statistics and summaries by regions such as continents and receiving water bodies can be calculated (*Table 2*).

Table 2: Distribution of terrestrial runoff $[mm/yr]$ by continents and receiving water bodies.

	Africa	Asia	Australasia	Europe	North America	South America	By Oceans
Arctic Ocean		191		384	115		191
Atlantic Ocean	219			315	286	673	405
Black and Mediterranean Seas	50	149		238			110
Indian Ocean	158	368	42				230
Pacific Ocean		511	722		348	657	496
Endorheic Basins	67	26	0	165	26	97	58
By Continents	150	298	154	275	263	655	**299**

Table 3: Comparison of Continental Runoff $[mm/yr]$ Estimates.

	Korzoun	GRDC	UNH/GRDC
Africa	153	283	150
Asia	324	288	298
Australasia	280	N/A	154
Europe	283	233	275
North America	339	170	263
South America	685	771	655

Comparing the regional runoff summaries to earlier estimates (such as Korzoun's Atlas of World Water Balance[12] and GRDC's current estimate [7]) the degree of agreement varies (*Table 3*). Generally, GRDC and the UNH/GRDC composite shows good agreement in well monitored regions such as Asia, Europe which is not a surprise since these estimates were based on the same discharge data set. The disagreement between the two estimates is higher in dryer regions. Since the GRDC estimate assumes similar runoff in the monitored and un-monitored portions of the continental land-mass, it has the tendency to over-estimate in dry regions like Africa and Australia where the lack of discharge monitoring stations is not only a result of a sparse population, but also the large areas without river networks. UNH/GRDC and Korzoun show better agreement where the disagreement between GRDC and UNH/GRDC is higher (i.e. Africa and South America). Australasia as defined by STN–30p is not really comparable to the other estimates due to the differences in the delineation of the region. The combination of Oceania and Australia as Australasia indeed is questionable inspite of typical cartographic practices. Oceania and Australia have very distinct hydrological characteristics, therefore it would be more appropriate to consider Oceania as part of South-East Asia.

Table 4: Distribution of discharge [km^3/yr] by continents and receiving water bodies.

	Africa	Asia	Australasia	Europe	North America	South America	Total[a]
Arctic Ocean		2143		633	492		3268
Atlantic Ocean	2935			1099	3609	10864	18506
Indian Ocean	1019	3638	201				4868
Mediterranean+Black Sea	352	123		730			1204
Pacific Ocean		6778	1118		1781	799	10479
Endrorheic Basins	211	410	0	311	9	52	993
Total	4517	13091	1320	2772	5892	11715	**39319**

[a]Includes island within major oceans not accounted by continent

Similar to runoff, the discharge by regions can be estimated (*Table 4*). The composite runoff field derived summaries tends to be lower than Korzoun's [12] and Baumgartner's [1] estimates (*Table 5*). Some differences might be due to the different delineation of ocean catchments. Furthemore, Korzoun's estimate includes groundwater flow to ocean, which could be significant in some regions. In general, both Korzoun's and Baumgartner's estimate of the continental total discharge flux to ocean is higher than that of the composite runoff field derived in this study.

Table 5: Comparison of continental discharge to oceans [km^3/yr] estimates.

	Korzoun	Baumgartner	UNH/GRDC
Arctic Ocean	5200	2600	3268
Atlantic Ocean	20800	19300	18507
Indian Ocean	6100	5600	4868
Pacific Ocean	14800	12200	10479

3.2 Spatial Coverage of Monitored Discharge

Considering the discharges by region (*Table 4*) and at the non-nested (most downstream) gauging stations within those regions, the percentage of monitored discharge can be assessed (*Table 6*).

Table 6: Percentage of monitored discharge by continents and receiving water bodies.

	Africa	Asia	Australasia	Europe	North America	South America	By Oceans
Arctic Ocean		81.5		48.2	62.8		72.3
Atlantic Ocean	56.9			45.2	51.6	80.8	69.2
Black and Mediterranean Seas	11.4	5.7		57.8			38.9
Indian Ocean	10.8	47.2	22.6				38.4
Pacific Ocean		29.2	2.0		40.3	5.6	26.4
Land	16.0	17.6	N/A	87.7	N/A	5.7	44.2
By Continents	40.1	42.2	5.2	54.0	49.9	75.3	**52.7**

This information by itself can be misleading in terms of the monitoring station coverage, but still it is useful to understand how well the discharge from the continental land mass is monitored in different regions. Using the most downstream station may create the false impression of good data coverage. A good example is South America and particularly the Amazon, which is not an exceptionally well monitored river system, but since the last discharge gauging station at Obidos monitors much of the discharge to ocean from the Amazon basin, and the Amazon delivers a significant fraction of the continental discharge to ocean, South America has an apparently high percentage of monitored discharge.

3.3 Considering Global Continental Discharge Estimates

The global and the continental river discharge estimates published in the scientific literature vary considerably (36,400 [12]; 38,800 [?]; 39,700 [1]; 40,700 [20]; 42,700 [7] km^3/yr). These differences are partly due to the differences in the set of discharge gauging stations used for the analysis (e.g. GRDC used 198 stations with a total of $52.3 \times 10^6 km^2$ catchment area measuring 18,000 km^3/yr discharge, while this report was based on 298 stations with $67 \times 10^6 km^2$ catchment area monitoring 20,700 km^3/yr discharge).

Beside the differences in selecting discharge gauging stations, the assumption in extrapolating the measured runoff to un-monitored regions may vary. The simplest approach is to assume similar runoff on the monitored and non monitored portion of the continental land mass. Considering the 133 $\times 10^6 km^2$ of total area of the non-glaciarized land-mass this assumption would result in (20,700 $[km^3/yr]$ $\times$ 133 $[10^6 km^2]$ / 67 $[10^6 km^2]$ =) 41,000 km^3/yr annual discharge. Although this approach could be reasonable for some parts of the globe, it fails to recognize the fact that a large portion of the un-monitored regions are actually dry (and there is no river water to monitor). A next approach considers the 93 $\times 10^6 km^2$ of actively flowing continental land-mass and assumes the same average runoff as on the observed portion yielding (20,700 $[km^3/yr]$ $\times$ 93 $[10^6 km^2]$ / 67 $[10^6 km^2]$ =) 28,700 km^3/yr annual discharge. This estimate is much lower than any current other estimate published, but the only possibility to increase this number is to assume higher mean runoff on the un-monitored but flowing regions than the observed in the monitored river basins. This finding suggests that the un-monitored but actively flowing portion of the continental land-mass is probably wetter than the monitored average. It is unlikely however that those regions are significantly wetter than the monitored land-mass, therefore lower global river discharge estimates are likely to be more accurate.

The composite runoff fields developed within the present study capture the higher wetness by applying Water Balance Model runoff estimates in the un-monitored regions. The global total discharge estimate of 39,319 km^3/yr agrees with several earlier estimates like Baumgartner [1], and L'Vovich [?].

3.4 Simple Precipitation Correction Procedure

Since discharge measurements are typically more accurate than precipitation fields, it would be desirable to develop new techniques, which could incorporate discharge measurements into the estimation of distributed precipitation. A simple approach would be to apply an inverse calculation based on spatially (and temporally) distributed precipitation-runoff (similar to rainfall-runoff) coefficients ω given as

$$\omega = \frac{R}{P} \tag{15}$$

where

ω	- Runoff coefficient
R	- Runoff
P	- Precipitation

The traditional use of runoff coefficients (which represents the fraction of the precipitation forming runoff) is to estimate runoff $R = \omega P$ based on precipitation data in order to forecast discharge. The inverse use of runoff coefficient

$$P = \frac{1}{\omega} R \tag{16}$$

could be used to estimate precipitation from runoff data. This formula can be used only when $\omega \neq 0$, i.e. when the runoff $R \neq 0$. As it was shown in Section 1.3, observed inter-station discharge in regions can be negative when the discharge is decreasing due to river water feeding the groundwater or human water consumption. Since neither negative runoff nor negative precipitation is possible, equation 16 cannot be used when $R \leq 0$.

Traditionally ω is calculated from observed precipitation P and runoff R by equation (15). As was shown in Section 2.1.2, observed precipitation and runoff are often inconsistent, furthermore, the goal of estimating ω is to calculate precipitation based on runoff measurements. A possible approach to estimate spatially (and temporally) distributed ω is to simulated runoff and observed precipitation to compute $\omega_{wbm} = \frac{R_{wbm}}{P}$. As shown in Section 2.1.2, WBM is consistent in terms of reducing precipitation to estimate runoff through its estimate of soil water and groundwater dynamics and evapotranspiration. It is therefore a reasonable assumption to expect WBM to represent the runoff/precipitation ratio somewhat realistically.

Using this assumption, an annual precipitation field was created by calculating WBM runoff coefficient ω_{wbm}on a long-term mean annual basis and applying the ω_{wbm} to the combined mean annual runoff field. The resulting precipitation field represents a combination of our best runoff fields with Willmott and Matsuura (1998) climatological annual precipitation *Figure 18*.

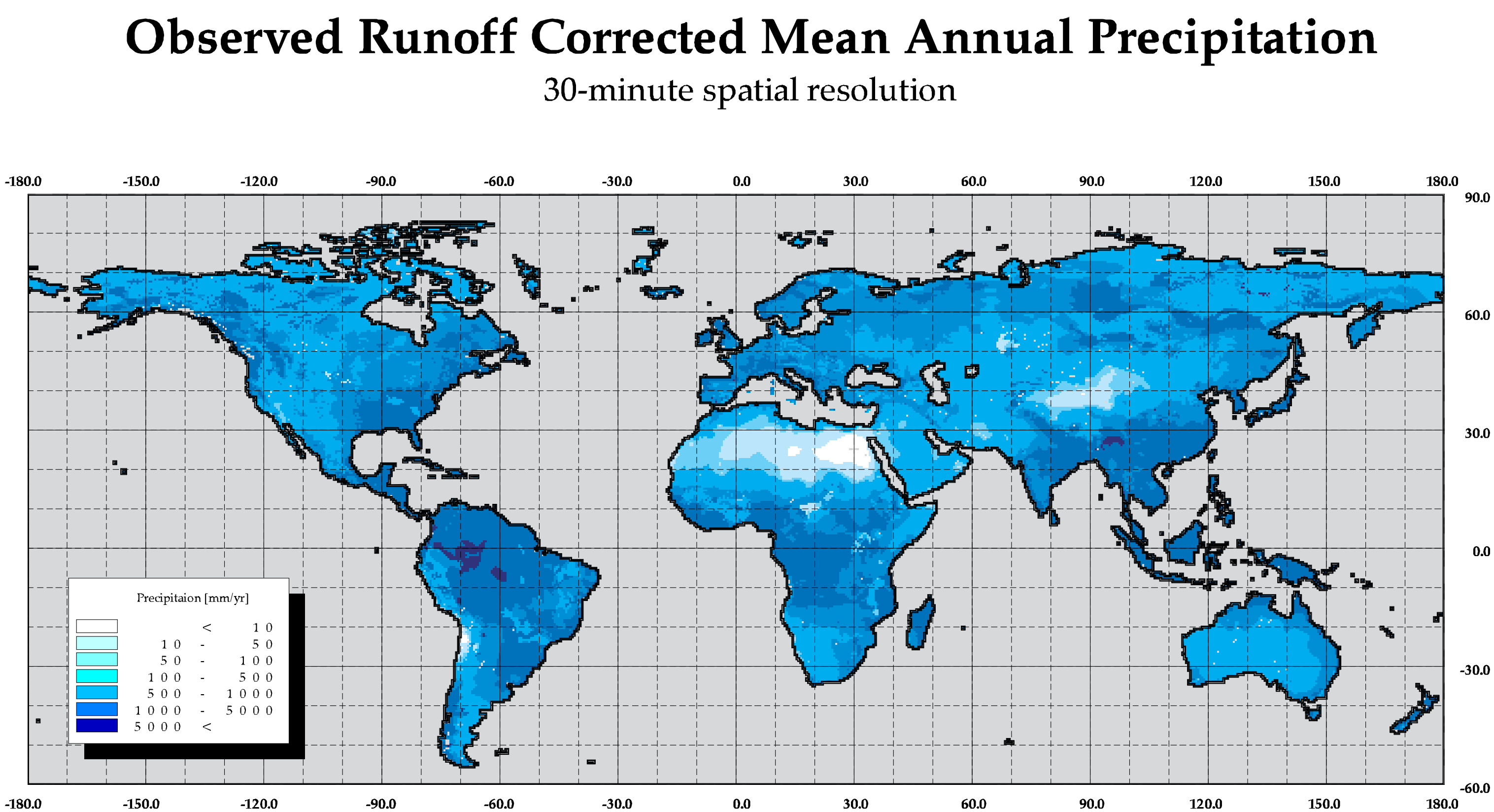

Figure 18: Corrected precipitation field based on discharge observation.

4 Conclusions and Summary

River discharge data represents the most accurate information about terrestrial water cycle, but this information has not been uniformly adopted in Earth Systems studies, such as GCMs or terrestrial productivity models. With the advent of GIS technology and emerging global GIS data sets such as Digital Elevation Models (DEM) and corresponding simulated river routings, the linkage between observed river discharge at individual stations and spatially-distributed fields of runoff can be established. This capability also offers new opportunities to improve the estimates of climate variables such as precipitation and evaporation by closing the water budget at the discharge gauging stations.

This report demonstrates a potential approach to establish a linkage between the spatially distributed runoff and river discharge observation networks. The best available global river discharge data set from GRDC was coupled with a state-of-the-art simulated river network developed by UNH. This exercise demonstrates the difficulties and advantages of linking different geographical data sets. By linking GRDC station data to STN–30p, numerous inconsistencies were found between the two data sets. These inconsistencies where due to either the insufficient resolution of the 30-minute routing or errors in the linked data sets. Linking the two data sets, helped to identify potential problems and often provided information on how to correct the errors discovered.

The coupled discharge gauging station and simulated river networks (which are expected to be important contributions to geo-scientists by themselves) allowed the blending of observed runoff over inter-station regions with simulated water balance estimates driven by long-term mean monthly climate data. By combining observed runoff over inter-station regions with spatially-distributed runoff, spatially distributed runoff fields on long-term mean monthly, seasonal, and annual basis were created. The composite runoff fields are constrained by discharge observations but preserve the spatial and temporal distribution of runoff according to the water balance simulation and are therefore likely to be the most accurate spatially-distributed runoff fields available today.

The composite runoff fields offer the opportunity to analyze the water balance distribution by regions. As an example, some statistics by continents and by receiving water bodies were presented to demonstrate a potential use of the new runoff data set. A further potential of the composite runoff fields is to identify problematic regions represented by current precipitation data sets and to ultimately improve those estimates. A simple approach to correct precipitation estimates by using composite runoff fields and water balance model-derived runoff coefficients was presented. This approach is apparently robust and realistic enough for global analysis using monthly time steps and 30-minute spatial resolution. Although more sophisticated methods will likely be needed at finer spatial and temporal resolutions, the basic concept of combining observed precipitation and discharges with water balance modeling techniques and simulated flow routing appears to provide great potential.

Besides development of the composite runoff fields, the present work also allowed an evaluation of the spatial coverage of present-day discharge observation networks. Roughly 50 % of the continental land mass representing ∼52 % of the discharge are now monitored.

The present report demonstrates the potential of using discharge gauging data in developing runoff surfaces to calibrate and validate Earth System Models. The authors of the present work are fully convinced that discharge data should be routinely collected as part of a global hydro-meteorological monitoring network. The establishment of a core discharge station network with potential real time reporting would allow significant improvement in our capacity to quantitatively describe the global water cycle.

The developed runoff fields are intended to be the first in a series of data products representing the water cycle components. The next product is planned to be a distributed discharge field along the STN–30p network, which will incorporate the present runoff fields and apply a special discharge interpolation algorithm. Future products will be developed on the basis of innovative techniques to incorporate discharge observations into Earth System modeling.

Further work to identify poorly-monitored regions and the addition of new discharge gauging stations in those regions will be necessary [7]. We would like to present this report as a call for establishing a synoptic discharge gauging station network as complementary part of the WMO World Weather Watch (WWW) program and the regional implementation of WMO's World Hydrological Cycle Observing System (WHYCOS). The proposed discharge station network is likely to be more cost effective than the substantial increase in traditional precipitation networks which would be necessary to otherwise significantly improve upon the existing observational networks for precipitation at global scale.

Acknowledgement

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A Appendix: STN–30p Data Structures

The global Simulated Topological Network at 30-minute spatial resolution (STN–30p) represents rivers as a set of spatial and tabular data layers derived from a 30-minute flow-direction grid. These data layers are available on the accompanying CD-ROM as ARC/INFO coverages and ASCII interchange files. The ARC/INFO coverages are located in the `./arc/w_stn30-5.12` workspace while the ASCII files are in `./ascii/stn30-5.12` directory. The ARC/INFO coverages are:

`g_basin`	-	Basin grid with basin attributes
`g_celllength`	-	Grid cell length [km] grid
`g_cumularea`	-	Upstream catchment area [km^2] grid
`g_distmouth`	-	Distance [km] to mouth of river defined as the confluence with equal or higher order stream
`g_distocean`	-	Distance [km] to the outlet of river basins
`g_network`	-	Flow-direction grid
`g_order`	-	Strahler stream order grid
`c_basin`	-	Basin polygon coverage with the same basin attributes as the basin grid
`c_network`	-	Arc/point coverage representing river segments and basin mouthes

`g_basin` grid, `c_basin` polygons and `c_network` points have the following STN–30p derived attributes additional to the default ARC/INFO attributes:

`BASINNAME`	-	Basin Name (GHAASBasin#### or real basin name from GEMS/GLORI)
`BASINORDER`	-	Strahler stream order at mouth
`COLOR`	-	Optimized color (7 - 11) to display basins
`BASINLENGTH`	-	Mainstem length [km]
`BASINAREA`	-	Basin area [km^2]
`CONTINENTNAME`	-	Continent name
`SEANAME`	-	Name of the recipient sea
`OCEANNAME`	-	Name of the recipient ocean

The flow direction grid is given as the standard ARC/INFO representation of the 8 flow direction grid using the following encoding scheme:

32	64	128
16		1
8	4	2

c_network arc/line coverage has the following arc attributes besides the point attributes listed before:

`BASINNAME`	-	Basin name
`ORDER`	-	Strahler stream order
`BASINID`	-	Integer basin identifier
`BASINCELLS`	-	Number of 30-minute cells upstream
`TRAVEL`	-	Number of cells downstream
`CELLAREA`	-	Cell area [km^2]
`SUBBASINLENGTH`	-	Mainstem length [km] upstream
`SUBBASINAREA`	-	Upstream area [km^2]
`DISTTOMOUTH`	-	Distance [km] to river mouth defined as confluence with equal or higher order stream
`DISTTOOCEAN`	-	Distance [km] to the outlet of river basins
`CELLLENGTH`	-	Length [km] of 30 minute river segment

The ASCII data are organized in the `./ascii` directory similarly to the ARC/INFO coverages:

`basin.grd`	-	Basin grid with basin attributes
`celllength.grd`	-	Grid cell length [km] grid
`cumularea.grd`	-	Upstream catchment area [km^2] grid
`distmouth.grd`	-	Distance [km] to river mouth defined as confluence with equal or higher order stream
`distocean.grd`	-	Distance [km] to the outlet of river basins
`network.grd`	-	Flow-direction grid
`order.grd`	-	Strahler stream order grid
`basins`.txt	-	Basin attribute table
`cells.txt`	-	Cell attribute table

The grids were exported as ARC/INFO ASCII grid, which has six lines header followed by the actual cell values row by row:

```
ncols 720
nrows 300
xllcorner -180
yllcorner -60
cellsize 0.5
NODATA_value -9999
```

where

`ncols`	-	number of columns
`nrows`	-	number of rows
`xllcorner`	-	horizontal coordinate of the lower left corner
`yllcorner`	-	vertical coordinate of the lower left corner
`cellsize`	-	cell size
`NODATA_value`	-	missing data value

The attribute tables are tab-delimited, strings in quotes and the first line contains field names.

B Appendix: List of Named River Basins in STN–30p

Name	Order	Area $[km^2]$	Length $[km]$	Continent	Ocean
Amazon	6	5853804	4327	South America	Atlantic Ocean
Nile	5	3826122	5909	Africa	Mediterranean Sea
Zaire	5	3698803	4339	Africa	Atlantic Ocean
Mississippi	5	3202959	4185	North America	Atlantic Ocean
Amur	5	2902864	5061	Asia	Pacific Ocean
Parana	5	2661392	2748	South America	Atlantic Ocean
Yenisei	5	2582221	4803	Asia	Arctic Ocean
Ob	5	2570130	3977	Asia	Arctic Ocean
Lena	6	2417937	4387	Asia	Arctic Ocean
Niger	5	2240019	3401	Africa	Atlantic Ocean
Zambezi	5	1988756	2541	Africa	Indian Ocean
Chang Jiang	5	1794242	4734	Asia	Pacific Ocean
Mackenzie	5	1712738	3679	North America	Arctic Ocean
Ganges	5	1628404	2221	Asia	Indian Ocean
Chari	5	1571536	1733	Africa	Land
Volga	5	1463315	2785	Europe	Land
St. Lawrence	5	1266642	3175	North America	Atlantic Ocean
Indus	5	1143101	2382	Asia	Indian Ocean
Syr-Darya	5	1070230	1615	Asia	Land
Nelson	5	1047386	2045	North America	Atlantic Ocean
Orinoco	4	1039362	1970	South America	Atlantic Ocean
Murray	5	1031512	1767	Australia	Indian Ocean
Great Artesian Basin	5	977516	1045	Australia	Land
Shatt el Arab	4	967341	2200	Asia	Indian Ocean
Orange	5	943577	1840	Africa	Atlantic Ocean
Huang He	5	893627	4168	Asia	Pacific Ocean
Yukon	5	852029	2716	North America	Pacific Ocean
Senegal	4	847273	1680	Africa	Atlantic Ocean
Jubba	5	816054	1699	Africa	Indian Ocean
Colorado (Ari)	5	807573	1808	North America	Pacific Ocean
Rio Grande (US)	4	804792	2219	North America	Atlantic Ocean
Danube	4	788002	2222	Europe	Black Sea
Mekong	4	773728	3977	Asia	Pacific Ocean
Tocantins	4	768616	2234	South America	Atlantic Ocean
Tarim	5	732728	1227	Asia	Land
Columbia	5	724025	1791	North America	Pacific Ocean
Kolyma	4	665674	2091	Asia	Arctic Ocean
Sao Francisco	4	615148	2212	South America	Atlantic Ocean
Amu-Darya	4	612314	1976	Asia	Land
Dnepr	4	508839	1544	Europe	Black Sea
Don	5	423038	1401	Europe	Black Sea
Colorado (Arg)	4	421798	1750	South America	Atlantic Ocean
Limpopo	4	420337	1316	Africa	Indian Ocean
Zhujiang	4	408528	1696	Asia	Pacific Ocean
Irrawaddy	4	405963	1781	Asia	Indian Ocean
Volta	4	398071	1301	Africa	Atlantic Ocean
Farah	4	385230	1053	Asia	Land
Khatanga	5	371417	1048	Asia	Arctic Ocean
Dvina	5	367123	1441	Europe	Arctic Ocean
Urugay	4	355505	1424	South America	Atlantic Ocean
Qarqan	4	351254	1216	Asia	Land
Parnaiba	4	330977	1192	South America	Atlantic Ocean
Indigirka	5	323710	1379	Asia	Arctic Ocean
Churchill (Hud)	4	315986	1813	North America	Atlantic Ocean
Godavari	4	311575	950	Asia	Indian Ocean
Pur - Taz	4	306961	1238	Asia	Arctic Ocean
Pechora	4	301599	1417	Europe	Arctic Ocean
Baker	4	299165	1299	North America	Atlantic Ocean
Ural	3	296283	1411	Asia	Land
Neva	5	284506	911	Europe	Atlantic Ocean
Liao	4	274053	1094	Asia	Pacific Ocean
Salween	3	273362	2576	Asia	Indian Ocean
Jordan	3	268914	1068	Asia	Mediterranean Sea
Magdalena	3	251743	1271	South America	Atlantic Ocean
Krishna	3	251684	1091	Asia	Indian Ocean
Salado	4	251460	1229	South America	Atlantic Ocean
Fraser	4	245452	1072	North America	Pacific Ocean
Hai Ho	4	245410	587	Asia	Pacific Ocean
Huai	4	244293	854	Asia	Pacific Ocean
Yana	4	235457	1004	Asia	Arctic Ocean
Kura	4	218906	796	Europe	Land
Olenek	4	212044	1623	Asia	Arctic Ocean
Ogooue	3	210155	815	Africa	Atlantic Ocean
Taymyr	4	204446	965	Australia	Indian Ocean

Name	Order	Area [km^2]	Length [km]	Continent	Ocean
Negro Arg	4	197542	1112	South America	Atlantic Ocean
Chubut	4	196710	961	South America	Atlantic Ocean
Sacramento	4	192563	927	North America	Pacific Ocean
Fitzroy West	4	192439	965	Australia	Indian Ocean
Grande de Santiago	4	191899	776	North America	Pacific Ocean
Rufiji	4	186759	809	Africa	Indian Ocean
Wisla	4	180583	901	Europe	Atlantic Ocean
Hong	3	170903	976	Asia	Pacific Ocean
Swan-Avon	4	166000	762	Australia	Indian Ocean
Rhine	3	165059	1018	Europe	Atlantic Ocean
Cuanza	3	163832	1027	Africa	Atlantic Ocean
Roviuna	3	154171	828	Africa	Indian Ocean
Essequibo	3	150769	736	South America	Atlantic Ocean
Elbe	3	148530	877	Europe	Atlantic Ocean
Koksoak	4	142888	861	North America	Atlantic Ocean
Chao Phraya	3	141830	710	Asia	Pacific Ocean
Brahmani	3	141207	866	Asia	Indian Ocean
Pyasina	4	139062	1139	Asia	Arctic Ocean
Fitzroy East	3	138489	637	Australia	Pacific Ocean
Albany	4	132800	953	North America	Atlantic Ocean
Sanaga	3	129212	803	Africa	Atlantic Ocean
Brazos (Tex)	3	125040	1261	North America	Atlantic Ocean
Alabama	3	124158	620	North America	Atlantic Ocean
Balsas	3	122987	706	North America	Pacific Ocean
Burdekin	3	121214	573	Australia	Pacific Ocean
Colorado (Texas)	3	121178	1047	North America	Atlantic Ocean
Odra	3	119846	663	Europe	Atlantic Ocean
Loire	3	118282	839	Europe	Atlantic Ocean
Galana	3	117369	962	Africa	Indian Ocean
Kuskowin	3	115809	888	North America	Pacific Ocean
Moose	3	114729	577	North America	Atlantic Ocean
Narmada	2	114088	1098	Asia	Indian Ocean
Flinders	3	110341	767	Australia	Indian Ocean
Kizil Irmak	3	109687	675	Asia	Black Sea
Save	3	107293	771	Africa	Indian Ocean
Roper	3	107214	427	Australia	Indian Ocean
Churchill (Atlantic)	4	106898	799	North America	Atlantic Ocean
Victoria	3	106413	659	Australia	Indian Ocean
Back	3	106037	951	North America	Arctic Ocean
Bandama	4	104088	692	Africa	Atlantic Ocean
Severn (Can)	3	104062	804	North America	Atlantic Ocean
Po	3	102183	500	Europe	Mediterranean Sea
Rhone	3	99298	637	Europe	Mediterranean Sea
Tana (Ken)	2	98896	671	Africa	Indian Ocean
La Grande	3	98876	622	North America	Atlantic Ocean
Cunene	3	98117	828	Africa	Atlantic Ocean
Douro	3	97109	555	Europe	Atlantic Ocean
Nemanus	3	95298	734	Europe	Atlantic Ocean
Anabar	4	94023	769	Asia	Arctic Ocean
Hayes	3	94019	633	North America	Atlantic Ocean
Mearim	3	92402	592	South America	Atlantic Ocean
Panuco	3	92037	490	North America	Atlantic Ocean
Doce	3	90357	727	South America	Atlantic Ocean
Gasgoyne	3	89660	784	Australia	Indian Ocean
Ashburton	3	84996	632	Australia	Indian Ocean
Peel	3	84059	776	North America	Arctic Ocean
Daugava	2	83416	812	Europe	Atlantic Ocean
Ebro	3	82841	553	Europe	Mediterranean Sea
Comoe	3	82408	813	Africa	Atlantic Ocean
Jacui	3	80764	458	South America	Atlantic Ocean
Kapuas	3	80368	569	Asia	Pacific Ocean
Penzhina	3	78794	625	Asia	Pacific Ocean
Cauweri	3	78680	627	Asia	Indian Ocean
Mamberamo	3	77145	592	Asia	Pacific Ocean
Sepik	3	77048	569	Asia	Pacific Ocean
Sassandra	2	76626	569	Africa	Atlantic Ocean
Nottaway	3	74326	591	North America	Atlantic Ocean
Barito	2	74155	579	Asia	Pacific Ocean
Seine	3	73472	451	Europe	Atlantic Ocean
Tejo	3	73363	766	Europe	Atlantic Ocean
Gambia	3	72190	745	Africa	Atlantic Ocean
Susquehanna	3	72147	514	North America	Atlantic Ocean
Dnestr	2	71995	867	Europe	Black Sea
Murchinson	3	71730	670	Australia	Indian Ocean

Name	Order	Area [km^2]	Length [km]	Continent	Ocean
Deseado	2	71638	725	South America	Atlantic Ocean
Mitchell	3	71158	556	Australia	Indian Ocean
Mahakam	3	71093	569	Asia	Pacific Ocean
Pangani	3	70887	457	Africa	Indian Ocean
Bug	3	69228	699	Europe	Black Sea
Usumacinta	3	68130	525	North America	Atlantic Ocean
Jequitinhonha	2	68016	683	South America	Atlantic Ocean
Corantijn	3	67877	569	South America	Atlantic Ocean
Fuchun Jiang	3	67212	439	Asia	Pacific Ocean
Copper	3	67204	504	North America	Pacific Ocean
Tapti	2	66331	594	Asia	Indian Ocean
Menjiang	3	66246	360	Asia	Pacific Ocean
Karun	3	65465	704	Asia	Indian Ocean
Mezen	3	65459	718	Europe	Arctic Ocean
Guadiana	2	65021	766	Europe	Atlantic Ocean
Maroni	3	64789	445	South America	Atlantic Ocean
Uda	3	64511	388	Asia	Pacific Ocean
Kuban	2	63890	648	Europe	Black Sea
Colville	3	63433	659	North America	Arctic Ocean
Thaane	3	63428	669	North America	Atlantic Ocean
Alazeya	3	63152	657	Asia	Arctic Ocean
Paraiba do Sul	3	63001	663	South America	Atlantic Ocean
Fortesque	3	62775	712	Australia	Indian Ocean
Winisk	3	62119	665	North America	Atlantic Ocean
Ikopa	3	61893	530	Africa	Indian Ocean
Gilbert	3	61779	491	Australia	Indian Ocean
Kouilou	3	61707	481	Africa	Atlantic Ocean
Fly	2	61413	678	Asia	Pacific Ocean
Mangoky	3	60263	486	Africa	Indian Ocean
Damodar	3	59662	562	Asia	Indian Ocean
Onega	3	59359	525	Europe	Arctic Ocean
Moulouya	3	59263	391	Africa	Mediterranean Sea
Ord	3	59094	482	Australia	Indian Ocean
Narva	3	58230	520	Europe	Atlantic Ocean
Seal	3	58051	476	North America	Atlantic Ocean
Cheliff	3	57982	549	Africa	Mediterranean Sea
Garonne	3	57980	484	Europe	Atlantic Ocean
Rupert	3	57814	647	North America	Atlantic Ocean
Brahmani	3	57358	551	Asia	Indian Ocean
Sakarya	3	57055	506	Asia	Black Sea
Gourits	3	56945	295	Africa	Atlantic Ocean
Sittang	2	55667	518	Asia	Indian Ocean
Rajang	3	55604	491	Asia	Pacific Ocean
Evros	3	55096	415	Europe	Mediterranean Sea
Appalachicola	2	54830	697	North America	Atlantic Ocean
Attawapiskat	2	54646	736	North America	Atlantic Ocean
Lurio	2	53949	556	Africa	Indian Ocean
Daly	2	53948	574	Australia	Indian Ocean
Penner	3	53909	479	Asia	Indian Ocean
Guadalquivir	2	53722	487	Europe	Atlantic Ocean
Nadym	3	53129	509	Asia	Arctic Ocean
Saint John	2	53027	616	North America	Atlantic Ocean
Cross	3	52257	480	Africa	Atlantic Ocean
Omoloy	3	52096	409	Asia	Arctic Ocean
Oueme	3	51955	444	Africa	Atlantic Ocean
Gota	3	51451	603	Europe	Atlantic Ocean
Nueces	2	51438	529	North America	Atlantic Ocean
Stikine	3	51316	546	North America	Pacific Ocean
Yalu	2	51165	557	Asia	Pacific Ocean
Arnaud	3	51155	446	North America	Atlantic Ocean
Jequitinhonha	2	50665	499	South America	Atlantic Ocean
Kamchatka	2	50604	626	Asia	Pacific Ocean
Grijalva	2	50315	517	North America	Atlantic Ocean
Kemijoki	3	50179	444	Europe	Atlantic Ocean
Olifants	3	50067	249	Africa	Atlantic Ocean
Tsiribihina	3	49467	390	Africa	Indian Ocean
Coppermine	3	49435	690	North America	Arctic Ocean
Kovda	3	47858	405	Europe	Arctic Ocean
Trinity	3	47549	477	North America	Atlantic Ocean
Glama	3	47456	490	Europe	Atlantic Ocean
Luan	3	46497	612	Asia	Pacific Ocean
Leichhardt	3	46470	507	Australia	Indian Ocean
Gurupi	2	46280	569	South America	Atlantic Ocean
GR Baleine	3	45900	543	North America	Atlantic Ocean

Name	Order	Area [km^2]	Length [km]	Continent	Ocean
Aux Feuilles	2	45728	517	North America	Atlantic Ocean
Weser	3	45629	457	Europe	Atlantic Ocean
Yesil	3	44792	364	Asia	Black Sea
Incomati	2	44722	486	Africa	Indian Ocean
Pungoe	3	43932	390	Africa	Indian Ocean
Meuse	2	43336	565	Europe	Atlantic Ocean
Eastmain	2	43314	639	North America	Atlantic Ocean
Araguari	3	43265	435	South America	Atlantic Ocean
Hudson	3	43252	486	North America	Atlantic Ocean
Kobuk	3	42460	463	North America	Arctic Ocean
Altamaha	2	41580	449	North America	Atlantic Ocean
Mand	2	40768	417	Asia	Indian Ocean
Santee	2	40590	446	North America	Atlantic Ocean
Hari	2	40169	435	Asia	Pacific Ocean
Wami	2	39943	489	Africa	Indian Ocean
San Juan	3	39433	375	North America	Atlantic Ocean
George	2	39064	546	North America	Atlantic Ocean
Omoloy	3	38531	464	Asia	Arctic Ocean
Potomac	3	38419	297	North America	Atlantic Ocean
Sebou	3	38402	321	Africa	Atlantic Ocean
Anderson	2	37848	674	North America	Arctic Ocean
Guayas	2	37084	370	South America	Pacific Ocean
Gamtoos	2	36381	358	Africa	Indian Ocean
Grande-Matagalpa	2	36138	348	North America	Atlantic Ocean
Kymijoki	3	35932	433	Europe	Atlantic Ocean
Savannah	2	35905	457	North America	Atlantic Ocean
Burnside	3	35498	473	North America	Arctic Ocean
Nushagak	3	35396	497	North America	Pacific Ocean
Roanoke	2	34756	509	North America	Atlantic Ocean
Tornionjoki	3	34638	454	Europe	Atlantic Ocean
Ceyhan	2	34201	400	Asia	Mediterranean Sea
Great Fish	2	34071	393	Africa	Indian Ocean
Dongjiang	2	33930	388	Asia	Pacific Ocean
Oum Er Rbia	2	33928	431	Africa	Atlantic Ocean
Pahang	2	33924	324	Asia	Pacific Ocean
Purari	2	33773	379	Asia	Pacific Ocean
Atrato	2	33756	434	South America	Atlantic Ocean
Fuerte	2	33136	503	North America	Pacific Ocean
Mae Klong	3	32914	399	Asia	Pacific Ocean
Noatak	2	32524	501	North America	Arctic Ocean
A la Baleine	3	32313	396	North America	Atlantic Ocean
Amgerman	3	32205	436	Europe	Atlantic Ocean
Klamath	2	32197	318	North America	Pacific Ocean
Harricana	3	32016	420	North America	Atlantic Ocean
Connecticut	2	31536	497	North America	Atlantic Ocean
Great Kei	2	31472	321	Africa	Indian Ocean
Oyapok	2	30869	291	South America	Atlantic Ocean
Burnett	2	30673	336	Australia	Pacific Ocean
Kem	2	30254	345	Europe	Arctic Ocean
Messalo	2	30148	528	Africa	Indian Ocean
Dalalven	2	29902	507	Europe	Atlantic Ocean
Patuca	3	29893	373	North America	Atlantic Ocean
Ulua	3	29886	266	North America	Atlantic Ocean
Ume-Vindealven	2	29862	500	Europe	Atlantic Ocean
Licungo	3	29691	321	Africa	Indian Ocean
Papaloapan	3	29481	265	North America	Atlantic Ocean
Attawapiskat	2	29354	393	North America	Atlantic Ocean
Lulealven	3	29037	428	Europe	Atlantic Ocean
Sabine	2	28939	564	North America	Atlantic Ocean
Hunter	3	28700	213	Australia	Pacific Ocean
Povuntnituk	3	28650	368	North America	Atlantic Ocean
Tuloma	2	28586	359	Europe	Arctic Ocean
Mahi	3	28465	378	Asia	Indian Ocean
Onilahy	2	28370	380	Africa	Indian Ocean
Rabarmati	2	28346	373	Asia	Indian Ocean
Coroch	2	28030	307	Europe	Black Sea
Inderagiri	2	27820	357	Asia	Pacific Ocean
Kokemaenjoki	3	27799	318	Europe	Atlantic Ocean
Ntem	2	27797	356	Africa	Atlantic Ocean
Asi	2	27735	329	Asia	Mediterranean Sea
Pee Dee	2	27735	455	North America	Atlantic Ocean
Mono	2	27568	412	Africa	Atlantic Ocean
Maputo	2	27543	347	Africa	Indian Ocean
Medjerda	2	27438	349	Africa	Mediterranean Sea

Name	Order	Area [km^2]	Length [km]	Continent	Ocean
Broadback	2	27361	411	North America	Atlantic Ocean
Saint John's	2	26956	307	North America	Atlantic Ocean
Coco	2	26952	370	North America	Atlantic Ocean
Motagua	2	26863	393	North America	Atlantic Ocean
Cagayan	2	26600	299	Asia	Pacific Ocean
Petit Mecatina	2	26579	442	North America	Atlantic Ocean
Dordogne	2	26192	401	Europe	Atlantic Ocean
Buzi	2	26166	257	Africa	Indian Ocean
Alsek	2	25887	441	North America	Pacific Ocean
Santa Cruz	2	25759	441	South America	Atlantic Ocean
Oulujoki	2	25491	315	Europe	Atlantic Ocean
Hanjiang	2	25365	262	Asia	Pacific Ocean
Oulujoki	2	25249	338	Europe	Atlantic Ocean
Nyanga	2	24704	324	Africa	Atlantic Ocean
Nyong	2	24685	402	Africa	Atlantic Ocean
Ramu	2	24619	402	Asia	Pacific Ocean
Cavally	2	24602	379	Africa	Atlantic Ocean
Pra	2	24588	245	Africa	Atlantic Ocean
Buyuk Menderes	2	24392	334	Asia	Mediterranean Sea
Seyhan	2	24391	379	Asia	Mediterranean Sea
Nass	2	24176	438	North America	Pacific Ocean
Ponnaiyar	2	24154	374	Asia	Indian Ocean
Suwannee	2	23923	294	North America	Atlantic Ocean
Sofia	2	23779	287	Africa	Indian Ocean
Pearl	2	23612	489	North America	Atlantic Ocean
Natashquan	2	23070	356	North America	Atlantic Ocean
Baker (Chile)	2	23002	284	South America	Pacific Ocean
Subamarekha	2	22837	354	Asia	Indian Ocean
Amguema	2	22613	269	Asia	Arctic Ocean
James	2	22031	391	North America	Atlantic Ocean
Segura	2	21898	273	Europe	Mediterranean Sea
Suriname	2	21567	301	South America	Atlantic Ocean
Mazaruni	2	21553	379	South America	Atlantic Ocean
Scheldt	2	21514	347	Europe	Atlantic Ocean
Jucar	2	21510	228	Europe	Mediterranean Sea
Kikori	2	21504	378	Asia	Pacific Ocean
Santa	2	21382	299	South America	Pacific Ocean
Moisie	2	21198	343	North America	Atlantic Ocean
Neches	2	21196	386	North America	Atlantic Ocean
Palar	2	21087	296	Asia	Indian Ocean
Tensift	2	21086	245	Africa	Atlantic Ocean
Delaware	2	20950	459	North America	Land
Strymon	2	20773	389	Europe	Mediterranean Sea
Petite Riviere Baleine	2	20766	251	North America	Atlantic Ocean
Skagit	2	20483	263	North America	Pacific Ocean
Hong	2	20147	284	Asia	Pacific Ocean
Zeroud	2	20133	325	Africa	Mediterranean Sea
Kaladan	2	20056	354	Asia	Indian Ocean
Nag Dong	2	20006	271	Asia	Pacific Ocean
Drammenselva	2	19776	344	Europe	Atlantic Ocean
Kennebec	2	19681	274	North America	Atlantic Ocean
Han	2	19652	221	Asia	Pacific Ocean
Ellice	2	19548	276	North America	Arctic Ocean
Bio Bio	2	19537	327	South America	Pacific Ocean
Penobscot	2	19432	324	North America	Atlantic Ocean
Taku	2	19336	359	North America	Pacific Ocean
Kalix	2	19200	456	Europe	Atlantic Ocean
Patsjoki	2	19097	259	Europe	Land
Simav	2	19030	252	Asia	Land
Ljungan	2	18902	367	Europe	Atlantic Ocean
Guadalupe	2	18866	399	North America	Atlantic Ocean
Sous	2	18665	225	Africa	Atlantic Ocean
Perak	2	18479	268	Asia	Indian Ocean
Mindanao	2	18398	244	Asia	Pacific Ocean
Tugur	2	18387	260	Asia	Pacific Ocean
Minho	2	18251	275	Europe	Atlantic Ocean
Pregolya	2	18017	280	Europe	Atlantic Ocean
Maipo	2	18007	267	South America	Pacific Ocean
Skelleftalv	2	17971	440	Europe	Atlantic Ocean
Breede	2	17932	220	Africa	Atlantic Ocean
Sepik	3	17860	285	North America	Arctic Ocean
Rapel	2	17841	236	South America	Pacific Ocean
Tone	2	17402	217	Asia	Pacific Ocean
Itata	2	17338	286	South America	Pacific Ocean

Name	**Order**	**Area** $[km^2]$	**Length** $[km]$	**Continent**	**Ocean**
Thames	2	17330	270	Europe	Atlantic Ocean
Aksu	2	17159	255	Asia	Mediterranean Sea
Waikato	2	17009	282	Oceania	Pacific Ocean
Trent	2	16968	256	Europe	Atlantic Ocean
Mandrare	2	16866	237	Africa	Indian Ocean
Gediz	2	16859	260	Asia	Mediterranean Sea
Axios	2	16463	280	Europe	Mediterranean Sea
Pitalven	2	16333	375	Europe	Atlantic Ocean
Abitibi	2	15813	309	North America	Atlantic Ocean
Indalsalven	2	15689	328	Europe	Atlantic Ocean
Clutha	2	15195	259	Oceania	Pacific Ocean
Maule	2	15037	234	South America	Pacific Ocean
Chowan	2	14861	303	North America	Atlantic Ocean
Shinano	2	14812	253	Asia	Pacific Ocean
Eel	2	14208	252	North America	Pacific Ocean
Romaine	2	13586	233	North America	Atlantic Ocean
Merrimack	2	13509	262	North America	Atlantic Ocean
Adour	2	13454	189	Europe	Atlantic Ocean
Saint Augustin	2	13354	176	North America	Atlantic Ocean
Gizhiga	2	12810	240	Asia	Pacific Ocean
Luga	2	12806	188	Europe	Atlantic Ocean
Kola	2	10459	307	Europe	Arctic Ocean
Shchuchya	3	10434	230	Asia	Arctic Ocean
Skienselva	2	9367	243	Europe	Atlantic Ocean
Thjorsa	1	6763	225	Europe	Atlantic Ocean
Olfusa	2	6691	201	Europe	Atlantic Ocean
Guadalquivir	1	2540	72	Africa	Mediterranean Sea

C Appendix: Selected (n = 663) GRDC Discharge Gauging Stations and the STN–30p derived data layers

The station attributes and annual discharge regime of the 663 discharge gauging stations from the GRDC archive (which were used in the present study) are provided on the accompanying CD-ROM in the `./arc/w_stations` workspace as a set of ARC/INFO coverages and in the `./ascii/stations` directory as ASCII files. The ARC/INFO workspace consists of `c_grdc663`, `g_subbasins` grid and `c_subbasins` polygon coverage. `g_subbasins` and `c_subbasins` coverages represent the inter-station regions between the selected discharge gauging stations along the STN–30p network. The additional attributes beside the default ARC/INFO attributes are the same as follows for all three coverages:

`STATIONNAME`	-	Gauging station name
`RIVERNAME`	-	River name according to GRDC Archive
`COUNTRY`	-	Country name
`GRDC-AREA`	-	Reported catchment area [km^2]
`STARTMONTH`	-	Beginning month of observations
`STARTYEAR`	-	Beginning year of observations
`ENDMONTH`	-	Last month of observations
`ENDYEAR`	-	Last year of observations
`TIMESERIES`	-	Time series type (Monthly, “M” or daily ,“D”)
`PERCENTRECORD`	-	Percent of missing values in GRDC records
`CELLID`	-	STN–30p Cell-id
`BASINID`	-	STN–30p Basin-id
`BASINNAME`	-	STN–30p Basin name
`ORDER`	-	Strahler stream order on STN–30p network at the station
`NUMBEROFCELLS`	-	Number of 30-minute cells upstream
`STNMAINSTEMLENGT`	-	Main-stem length [km] upstream
`STNCATCHMENTAREA`	-	Catchment area [km^2] upstream
`NEXTSTATION`	-	Next gauging station downstream
`INTERSTNA`	-	Inter-station area [km^2] along STN–30p Network

The ASCII files are organized similarly to the ARC/INFO coverages in the `./ascii/stations` directory. `GRDC663.txt` file is a tab-delimited ASCII file (strings in quotes, first line contains field names), containing the 663 record of the selected GRDC stations with the same attributes as given in ARC/INFO format. `subbasins.grd` is an ARC/INFO ASCII grid (as described in Appendix A) containing the record identifiers of the gauging stations.

D Appendix: List of Selected GRDC Discharge Gauging Stations Used in the Present Report with Catalog and STN–30p Derived Attributes

GRDC	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
Code	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
1112200	Gourbassy				Faleme				
1	119	117.4	15.2	319.3	Senegal	15000	15092	15000	15092
1112300	Galougo				Senegal				
2	118	510.0	84.3	1195.2	Senegal	127000	120332	78000	71990
1112320	Oualia				Bakoye				
3	0	141.0	16.6	354.8	Gambia	84400	72190	42400	27017
1112340	Toukoto				Bakoye				
4	2	75.7	9.8	180.8	Senegal	16000	18107	16000	18107
1112350	Dibia				Bafing				
5	2	332.3	63.5	825.1	Senegal	33000	30235	33000	30235
1134050	Selingue				Sankarani				
6	7	286.2	65.2	616.7	Niger	34200	33496	34200	33496
1134100	Koulikoro				Niger				
7	11	1407.3	500.8	2789.5	Niger	120000	121466	15800	18096
1134110	Bougouni				Baoule				
8	9	101.3	15.3	210.8	Niger	15700	15195	15700	15195
1134200	Dioila				Baoule				
9	12	143.4	21.6	412.6	Niger	32500	33336	16800	18142
1134220	Pankourou				Bagoe				
10	12	169.8	23.6	439.0	Niger	31800	33430	31800	33430
1134250	Kirango aval				Niger				
11	13	1290.4	414.7	2471.6	Niger	137000	136517	17000	15050
1134300	Douna				Bani				
12	13	512.6	59.5	1207.2	Niger	101600	102981	37300	36214
1134500	Mopti				Niger				
13	14	1100.6	453.4	1646.9	Niger	281600	308186	43000	68688
1134700	Dire				Niger				
14	15	1003.2	400.2	1622.4	Niger	340000	367900	58400	59715
1134900	Ansongo				Niger				
15	27	914.8	369.7	1471.8	Niger	566000	647527	226000	279627
1147010	Kinshasa				Zaire				
16	0	39535.6	29705.2	55291.2	Zaire	3475000	3615698	2816650	2929069
1159100	Vioolsdrif				Oranje				
17	0	146.0	5.8	656.8	Orange	850530	838168	814074	485823
1159300	Upington				Oranje				
18	17	219.6	66.2	927.3	Orange	36456	352345	-141546	180606
1159500	de Hoop 65				Vaal				
19	18	32.6	0.7	210.4	Orange	121052	123447	82488	76706
1159650	Aliwal Noord				Oranje				
20	18	145.4	8.7	578.7	Orange	37075	29400	37075	29400
1159800	Engelbrechtsdrift				Vaal				
21	19	38.8	4.4	214.4	Orange	38564	46741	38564	46741
1160510	Piggot's Bridge				Groot-Vis				
22	23	5.1	0.0	20.7	Great Fish	23067	23671	23067	23671
1160580	Outspan				Groot-Vis				
23	0	7.6	0.0	42.2	Great Fish	29745	28886	6678	5214
1160880	Mandini				Tugela				
24	0	100.1	10.9	312.5	GHAASBasin444	28920	29901	28920	29901
1196400	Oxenham Ranch				Limpopo				
25	69	27.1	0.0	120.7	Limpopo	98160	107086	98160	107086
1234080	Alcongui				Gorouol				
26	27	8.6	1.3	50.5	Niger	44900	56713	44900	56713
1234150	Niamey				Niger				
27	103	893.1	335.4	1484.4	Niger	700000	791121	89100	86881
1234180	Diongore amont				Goroubi				
28	103	6.1	0.5	21.8	Niger	15350	18102	15350	18102
1237500	Bagara Diffa				Komadougou Yobe				
29	0	14.6	4.0	30.3	Noname (GHAASBasin49)	115000	449161	60850	385981
1259150	Seaka				Senqu				
30	18	117.4	14.0	394.7	Orange	19875	18893	19875	18893
1286660	Mtera				Great Ruaha				
31	32	123.9	18.6	384.1	Rufiji	67950	73280	67950	73280
1286900	Stigler				Rufiji				
32	0	791.8	343.9	2006.9	Rufiji	158200	177570	78850	88901

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
1287800	Bahi				Bubu				
33	32	5.2	0.0	25.8	Rufiji	11400	15389	11400	15389
1289200	Korogwe				Pangani				
34	0	26.7	9.7	63.3	Pangani	25110	64728	25110	64728
1289450	Dar-Es-Salam-Morogoro Road Bridge				Ruvu				
35	0	64.6	16.1	223.8	GHAASBasin817	15190	15343	15190	15343
1308600	Dar el Caid				Moulouya				
36	0	20.0	1.1	102.6	Moulouya	24422	25806	24422	25806
1309700	Azib Soltane				Sebou				
37	0	56.7	11.7	244.8	Sebou	17250	17962	17250	17962
1335014	Riao				Benoue				
38	29	249.1	76.8	463.9	Noname (GHAASBasin49)	30650	32888	30650	32888
1335122	Safaie				Faro				
39	29	307.2	154.8	497.5	Noname (GHAASBasin49)	23500	30291	23500	30291
1335500	Garoua				Benoue				
40	122	362.9	113.2	767.5	Niger	64000	61021	64000	61021
1338050	Edea				Sanaga				
41	0	1984.7	1170.2	3007.1	Sanaga	131520	129212	13220	9252
1338201	Betare-Oya				Lom				
42	0	175.1	104.7	272.3	Niger	11100	11991	11100	11991
1338252	Mantoum				Mbam				
43	0	320.6	193.2	478.8	Niger	14700	12143	14700	12143
1338300	Goura				Mbam				
44	41	710.1	404.8	1070.8	Sanaga	42300	43054	42300	43054
1338400	Nachtigal				Sanaga				
45	41	1078.1	582.8	1654.1	Sanaga	76000	76906	55610	58478
1338600	Mbakaou				Djerem				
46	45	389.1	120.0	678.0	Sanaga	20390	18428	20390	18428
1339017	Olama				Nyong				
47	0	226.8	139.7	362.2	Niger	18510	21248	5100	12137
1339100	Dehane				Nyong				
48	0	446.3	243.0	829.8	Nyong	26400	24685	26400	24685
1339500	Mbalmayo				Nyong				
49	61	149.4	78.2	255.2	Zaire	13555	12345	13555	12345
1340500	Ngoazik				Ntem				
50	0	275.5	119.1	580.2	Ntem	18100	18530	18100	18530
1348152	Pana				Kadei				
51	0	246.2	150.2	367.6	Niger	20370	17956	20370	17956
1362100	el Ekhsase				Nile				
52	0	1251.3	1095.2	1438.7	Nile	2900000	3746812	-712000	157881
1362600	Aswan Dam				Nile				
53	52	2759.8	861.9	5114.2	Nile	3612000	3588931	918000	894447
1389090	Bevoay				Mangoky				
54	0	596.6	175.8	1448.8	Mangoky	53225	54530	53225	54530
1389470	Amboasary				Mandrare				
55	0	60.3	7.1	226.8	Mandrare	12435	16866	12435	16866
1389500	Antsatrana				Ikopa				
56	0	438.0	149.2	803.2	Ikopa	18550	14653	18550	14653
1389600	Maroangaty				Mananara				
57	0	241.9	81.8	546.1	GHAASBasin883	14160	8542	14160	8542
1428400	Aniassue				Comoe				
58	0	106.1	13.9	271.9	Comoe	67400	70112	67400	70112
1445100	Sounda				Kouilou				
59	0	856.0	482.1	1232.5	Kouilou	55010	55542	31625	30860
1445490	Loudima				Niari				
60	59	379.2	229.5	572.1	Kouilou	23385	24682	23385	24682
1448050	Ngbala				Dja				
61	62	420.0	209.9	738.4	Zaire	38600	40139	25045	27794
1448100	Ouesso				Sangha				
62	16	1662.4	968.7	2455.0	Zaire	158350	163481	51450	55566
1472150	Paara				Victoria Nile				
63	98	946.0	453.8	1757.7	Nile	340000	342767	71000	89634
1472300	Owen Reservoir				Victoria Nile				
64	63	1175.9	879.1	1491.2	Nile	269000	253133	238800	222254

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
1491200	Kamativi G/w				Gwaai				
65	0	23.3	0.2	143.9	Zambezi	38600	37973	17600	20419
1491210	Dahlia Control Section				Gwaai				
66	65	7.3	0.0	44.4	Zambezi	21000	17554	21000	17554
1495200	Tokwe Confluence U/s C/s				Lundi				
67	0	48.2	0.2	245.9	Limpopo	17100	17325	17100	17325
1495240	Tokwe Confluence D/s C/s				Lundi				
68	0	66.3	0.0	342.7	Save	23000	23237	23000	23237
1496500	Beitbridge Pumpstation C/s				Limpopo				
69	0	86.5	0.3	594.3	Limpopo	196000	207296	97840	100210
1526300	Daboasi				Pra				
70	0	196.9	44.2	583.9	Pra	22714	24588	22714	24588
1530100	Alanda				Tano				
71	0	143.8	64.7	263.8	GHAASBasin813	15800	15363	15800	15363
1531100	Bamboi				Black Volta				
72	77	262.5	76.9	672.2	Volta	134200	139548	67660	64050
1531420	Yagaba				Kulpawn				
73	74	34.9	1.9	119.5	Volta	10600	12172	10600	12172
1531450	Nawuni				White Volta				
74	77	249.1	60.8	476.9	Volta	92950	102902	19000	24290
1531550	Pwalagu				White Volta				
75	74	125.2	33.8	311.3	Volta	63350	66440	18660	9106
1531650	Nangodi				Red Volta				
76	75	23.1	4.6	57.9	Volta	11570	12111	11570	12111
1531700	Senchi(Halcrow)				Volta				
77	0	1105.6	35.8	4210.5	Volta	394100	394995	108280	94848
1531800	Sabari				Oti				
78	77	354.0	155.9	676.3	Volta	58670	57698	36390	27396
1537100	Ndjamena(Fort Lamy)				Chari				
79	0	1059.4	193.9	1933.2	Chari	600000	603275	76300	84974
1537150	Bongor				Logone				
80	79	491.7	119.9	797.9	Chari	73700	76533	25430	27501
1537180	Moundou				Logone				
81	80	366.6	121.6	692.2	Chari	33970	33707	33970	33707
1537250	Doba				Pende				
82	80	127.5	25.6	244.2	Chari	14300	15325	14300	15325
1537300	Bousso				Chari				
83	79	811.9	204.6	1280.6	Chari	450000	441767	109400	112603
1537450	Moissala				Bahr Sara				
84	83	479.9	162.2	1018.2	Chari	67600	67541	22900	24525
1537500	Sarh(Fort Archambault)				Chari				
85	83	266.4	14.9	521.4	Chari	193000	177081	97000	73504
1537800	Am-Timan				Bahr Azoum				
86	83	30.6	5.7	63.2	Chari	80000	84543	80000	84543
1634400	Kouroussa				Niger				
87	90	242.4	113.9	452.4	Niger	18000	15205	18000	15205
1634420	Baro				Niandan				
88	90	251.2	107.2	444.9	Niger	12770	12186	12770	12186
1634600	Ouaran				Tinkisso				
89	90	181.4	64.2	353.2	Niger	18700	12133	18700	12133
1634650	Tiguibery				Niger				
90	7	1097.6	542.0	1827.6	Niger	70000	69875	20530	30351
1643100	Lambarene				Ogooue				
91	0	4688.7	2891.6	7182.2	Ogooue	205000	207065	205000	207065
1662100	Dongola				Nile				
92	53	2621.9	1004.8	4467.4	Nile	2694000	2694484	711806	395792
1663100	Khartoum				Blue Nile				
93	92	1512.8	171.2	2875.7	Nile	325000	275123	115000	120132
1663800	Roseires Dam				Blue Nile				
94	93	1548.4	570.2	2847.4	Nile	210000	154992	210000	154992
1664100	Kilo 3				Atbara				
95	92	358.6	78.3	936.2	Nile	69000	173580	69000	173580
1673100	Mogren				White Nile				
96	92	897.3	688.6	1149.1	Nile	1588194	1849988	508194	664792

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
1673600	Malakal				White Nile				
97	96	938.6	629.8	1786.7	Nile	1080000	1185196	630000	629315
1673900	Mongalla				Bahr el Jebel				
98	97	1050.2	444.1	2164.3	Nile	450000	555881	110000	213114
1731400	Porga				Pendjari				
99	78	56.3	9.5	136.0	Volta	22280	30302	22280	30302
1732100	Athieme				Mono				
100	0	53.9	0.8	155.1	Mono	21575	24495	21575	24495
1733100	Pont de Beterou				Oueme				
101	102	53.9	0.8	155.1	Oueme	10326	9144	10326	9144
1733600	Bonou				Oueme				
102	0	170.2	3.7	416.9	Oueme	46990	45818	36664	36674
1734500	Malanville				Niger				
103	0	1053.1	440.8	1709.2	Niger	1000000	1399238	284650	590016
1734600	Couberi				Sota				
104	47	30.8	4.2	101.8	Niger	13410	9111	13410	9111
1737150	Bossangoa				Ouham				
105	106	219.1	41.0	402.1	Chari	22800	21519	22800	21519
1737210	Batangafo				Ouham				
106	84	311.3	90.2	535.2	Chari	44700	43016	21900	21498
1737700	Golongosso				Bahr Aouk				
107	85	74.3	18.4	134.8	Chari	96000	103577	96000	103577
1748500	Salo				Sangha				
108	62	744.9	416.5	1168.4	Zaire	68300	67776	68300	67776
1749050	M'bata				Lobaye				
109	111	320.9	167.9	441.1	Zaire	31000	36972	31000	36972
1749080	Bossele-Bali				M'poko				
110	111	90.1	20.0	162.1	Zaire	10800	12308	10800	12308
1749100	Bangui				Oubangui				
111	16	4091.6	1950.7	6837.5	Zaire	500000	523148	327300	341793
1749480	Kembe				Kotto				
112	111	447.0	233.2	768.8	Zaire	78400	79767	78400	79767
1749550	Rafai				Chinko				
113	111	397.1	176.2	652.1	Zaire	52500	52308	23200	21523
1749600	Zemio				M'bomou				
114	113	196.1	77.4	532.8	Zaire	29300	30785	29300	30785
1789300	Garissa				Tana				
115	0	155.4	31.8	599.7	Tana (Ken)	42220	43277	42220	43277
1812100	Dagana				Senegal				
116	0	687.4	255.9	1135.3	Senegal	268000	793731	38000	29560
1812300	Matam				Senegal				
117	116	761.4	239.5	1689.6	Senegal	230000	764171	12000	172953
1812500	Bakel				Senegal				
118	117	705.2	170.8	1719.4	Senegal	218000	591218	62100	437772
1812600	Kidira				Faleme				
119	118	169.9	25.5	481.8	Senegal	28900	33114	13900	18022
1813200	Gouloumbou				Gambie				
120	3	149.5	48.8	329.7	Gambia	42000	45172	42000	45172
1815020	Saltinho amont				Corubal				
121	0	305.2	161.4	496.7	GHAASBasin437	23840	24206	23840	24206
1835800	Yola				Benue				
122	0	21.9	4.5	58.9	Niger	107000	100781	43000	39760
1870600	Kanzenze				Nyabarongo				
123	124	109.0	67.8	158.7	Nile	14600	15445	14600	15445
1870800	Rusumo				Kagera				
124	64	224.0	157.8	324.2	Nile	30200	30879	15600	15434
1878100	Afgoi				Shebelle				
125	0	45.9	12.8	87.9	Jubba	278000	270030	66200	52426
1878500	Belet Uen				Shebelle				
126	125	68.0	17.8	175.4	Jubba	211800	217605	211800	217605
1880100	Lugh Ganana				Juba				
127	0	192.7	43.6	479.0	Jubba	179520	172335	179520	172335
1931370	Boromo				Mou Houn (Volta Noire)				
128	129	32.7	3.1	72.0	Volta	37140	57323	37140	57323

GRDC Code	ID	Station Name	Next Station	Discharge [m^3/s] Mean	Min	Max	RiverName	STN Basin Name	Area [km^2] GRDC	STN-30p	Inter-Stn Area [km^2] GRDC	STN-30p
1931400	129	Dapola	72	101.0	12.2	292.5	Mou Houn (Volta Noire)	Volta	66540	75498	29400	18175
1931725	130	Wayen	131	7.3	0.8	27.8	Nakanbe (Volta Blanche)	Volta	20880	21050	20880	21050
1931790	131	Bagre	75	33.1	7.2	90.8	Nakanbe (Volta Blanche)	Volta	33120	45222	12240	24172
1992700	132	Liwonde	133	471.6	108.7	828.5	Shire	Zambezi	130200	123809	130200	123809
1992900	133	Chiromo	0	485.5	109.5	1004.2	Shire	Zambezi	149500	147536	19300	23726
2106500	134	Haerbin	200	1204.7	196.6	3562.6	Songhuajiang	Amur	391000	394873	346900	354218
2106600	135	Jilin	134	429.6	121.9	1252.6	Songhuajiang	Amur	44100	40655	44100	40655
2151100	136	Yangcun	172	916.4	478.3	1740.7	Yaluzangbu Jiang	Ganges	153191	152985	153191	152985
2178300	137	Guanting	0	37.5	2.3	150.4	Yongding	Hai Ho	42500	49404	42500	49404
2178500	138	Luanxian	0	130.0	16.8	536.1	Luanhe	Luan	44100	46497	44100	46497
2180500	139	Zhangjiashan	140	60.8	17.2	202.9	Jinghe	Huang He	43200	45123	43200	45123
2180710	140	Shanxian	141	1346.7	544.0	2576.0	Huanghe(Yellow River)	Huang He	687869	780448	644669	735324
2180800	141	Huayuankou	0	1438.0	447.2	3130.5	Huanghe(Yellow River)	Huang He	730036	823531	42167	43083
2181400	142	Gongtan	143	1142.4	331.7	2573.0	Wujiang	Chang Jiang	58300	52125	58300	52125
2181600	143	Yichang	144	14185.4	8117.5	22973.3	Changjiang	Chang Jiang	1010000	1003478	951700	951354
2181800	144	Hankou	146	23301.2	10954.2	37733.3	Changjiang	Chang Jiang	1488036	1489373	436636	444459
2181850	145	Jian	146	1670.1	662.3	3428.3	Ganjiang	Chang Jiang	56200	61204	56200	61204
2181900	146	Datong	0	28811.4	16369.2	47508.3	Changjiang (Yangtze)	Chang Jiang	1705383	1712673	161147	162095
2181950	147	Bengbu	0	863.6	30.8	3833.0	Huaihe	Huai	121330	116778	121330	116778
2182100	148	Ankang	144	655.1	137.5	2021.2	Hanjiang	Chang Jiang	41400	41436	41400	41436
2186500	149	Nanning	150	1304.0	374.8	3098.5	Yujiang	Zhujiang	75500	76744	75500	76744
2186800	150	Wuzhou 3	0	6964.9	2207.7	16465.0	Xijiang	Zhujiang	329705	329344	254205	252600
2186900	151	Hengshi	0	1092.2	299.9	2819.6	Beijiang	Dongjiang	34013	31079	8688	2840
2186950	152	Boluo	151	754.7	242.4	1870.5	Dongjiang	Dongjiang	25325	28239	25325	28239
2260100	153	Hkamti	0	2407.1	1240.2	4022.2	Chindwin	Irrawaddy	27420	24867	27420	24867
2260500	154	Sagaing	0	8024.5	5458.1	10951.6	Irrawaddy	Irrawaddy	117900	117452	117900	117452
2261500	155	Toungoo	0	299.2	161.8	504.2	Sittang	Sittang	14660	14520	14660	14520
2423500	156	Ahvaz	0	575.4	267.8	1427.6	Karun	Karun	60769	60138	60769	60138
2469050	157	Luang Prabang	243	3625.4	2228.9	5095.7	Mekong	Mekong	268000	278692	79000	86915
2469260	158	Pakse	0	9001.0	6465.2	12514.2	Mekong	Mekong	545000	536010	50000	41570
2548400	159	Chisapani	170	1353.0	226.8	2257.3	Karnali River	Ganges	42890	45887	21650	21733
2548450	160	Benighat	159	612.5	357.6	958.2	Karnali River	Ganges	21240	24154	21240	24154

GRDC Code ID	Next Station	Station Name / Discharge [m^3/s] Mean	Min	Max	RiverName / STN Basin Name	Area [km^2] GRDC	Area [km^2] STN-30p	Inter-Stn Area [km^2] GRDC	Inter-Stn Area [km^2] STN-30p
2549500	Devghat				Narayani River				
161	170	1559.9	1048.4	2566.8	Ganges	31100	32521	31100	32521
2550200	Turkeghat				Arun River				
162	170	420.7	302.1	573.0	Ganges	28200	29902	28200	29902
2587100	Ishikari-Ohashi				Ishikari				
163	0	467.2	146.4	901.8	GHAASBasin1057	12697	11221	12697	11221
2651100	Bahadurabad				Brahmaputra				
164	0	21260.9	13660.1	28732.0	Ganges	636130	554542	198360	116081
2677100	Indogyo				Han				
165	0	525.5	127.9	1673.3	Han	25046	19652	25046	19652
2694510	Samnangjin				Nagdong				
166	0	289.9	54.5	777.2	Nag Dong	22916	20006	22916	20006
2836100	Baramula Br.				Jhelum				
167	0	221.4	93.5	388.2	Indus	12494	12776	12494	12776
2837100	Akhnoor				Chenab				
168	0	796.6	534.0	1157.6	Indus	22681	23296	22681	23296
2839100	Mandi Plain				Beas				
169	0	497.3	247.5	811.6	Indus	18274	20886	18274	20886
2846800	Farakka				Ganga				
170	0	12037.3	6133.0	18667.9	Ganges	935000	941428	832810	833118
2851250	Mathanguri				Manas				
171	164	1223.9	497.0	2311.7	Ganges	32770	32764	32770	32764
2851300	Pandu				Brahmaputra				
172	164	18099.5	10512.2	28251.2	Ganges	405000	405697	251809	252712
2853050	Ahmedabad				Sabarmati				
173	0	32.6	1.6	124.2	Rabarmati	12950	11274	12950	11274
2853150	Sevalia				Mahi				
174	0	382.6	28.4	1672.0	Mahi	33670	28465	33670	28465
2853200	Garudeshwar				Narmada				
175	0	1216.2	202.9	3097.9	Narmada	89345	94020	72769	76936
2853300	Kathore				Tapi				
176	0	488.9	10.9	2152.3	Tapti	61575	60569	61575	60569
2853500	Jamtara				Narmada				
177	175	303.8	36.5	1163.8	Narmada	16576	17084	16576	17084
2854020	Kokpara				Subarnarekha				
178	0	310.2	89.2	713.1	Subamarekha	15152	17104	15152	17104
2854050	Rhondia				Damodar				
179	0	296.3	7.5	860.7	Damodar	19220	22603	19220	22603
2854100	Takali				Bhima				
180	181	236.3	43.8	571.0	Krishna	33916	32250	33916	32250
2854300	Vijayawada				Krishna				
181	0	1641.7	86.3	4976.9	Krishna	251355	251684	217439	219434
2854500	Nellore				Penner				
182	0	74.3	4.4	272.2	Penner	53290	53909	53290	53909
2854700	Krishnarajasagar				Cauvery				
183	0	168.3	48.4	352.4	Cauweri	10600	9051	10600	9051
2856200	Dhalegaon				Godavari				
184	185	126.3	6.4	387.7	Godavari	30840	31994	30840	31994
2856500	Mancherial				Godavari				
185	187	430.7	50.8	1474.6	Godavari	102900	105189	72060	73195
2856550	Ashti				Wainganga				
186	187	690.1	180.9	1512.5	Godavari	50990	51866	50990	51866
2856900	Polavaram				Godavari				
187	0	3038.2	468.1	10393.9	Godavari	299320	305663	145430	148608
2901200	Novy Eropol				Anadyr				
188	0	464.0	195.5	976.6	GHAASBasin91	47300	46258	47300	46258
2901300	Kamenskoe				Penzhina				
189	0	695.5	264.2	1451.2	Penzhina	71600	73037	71600	73037
2902800	Kluchi				Kamchatka				
190	0	779.0	513.9	1166.7	Kamchatka	45600	45475	45600	45475
2903050	Bodaibo				Vitim				
191	196	1622.4	784.6	3153.4	Lena	186000	190305	186000	190305
2903080	Chabda				Maya				
192	196	1300.6	652.5	2452.3	Lena	165000	162522	165000	162522

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next Station	Discharge [m^3/s]							
ID		Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
2903150	Saskylakh				Anabar				
193	0	445.4	20.6	1025.0	Anabar	78800	79099	78800	79099
2903300	Shorokhovo				Kirenga				
194	196	652.5	349.4	1009.5	Lena	46500	48329	46500	48329
2903410	Tulun				Iya				
195	205	149.1	83.6	274.2	Yenisei	14500	14382	14500	14382
2903430	Stolb				Lena				
196	0	15204.2	8567.0	23126.3	Lena	2460000	2417046	1949000	1898359
2903700	Bugurtak				Tuba				
197	205	775.4	404.4	1422.4	Yenisei	31800	34816	31800	34816
2906200	Sretensk				Shilka				
198	200	409.2	118.7	1233.2	Amur	175000	177872	175000	177872
2906500	Ust-Ulma				Selemdhza				
199	200	654.8	194.1	1611.5	Amur	67000	63142	67000	63142
2906700	Khabarovsk				Amur				
200	202	8474.4	3056.9	16440.0	Amur	1630000	2686517	972600	2028526
2906800	Kirovsky				Ussuri				
201	200	222.3	55.4	625.7	Amur	24400	22104	24400	22104
2906900	Komsomolsk				Amur				
202	0	9874.4	4131.3	16963.2	Amur	1730000	2782795	100000	96278
2907400	Mostovoy				Selenga				
203	205	950.6	417.6	1619.0	Yenisei	440200	446029	414500	422959
2908400	Maleta				Khilok				
204	203	61.6	15.8	172.1	Yenisei	25700	23070	25700	23070
2909150	Igarka				Yenisei				
205	0	18050.0	10037.1	28900.6	Yenisei	2440000	2413479	1735500	1700922
2909280	Malykai				Markha				
206	196	393.9	124.2	899.8	Lena	89600	93685	89600	93685
2909400	Kuzmovka				Podkamennaya Tunguska				
207	205	1628.9	794.2	3082.9	Yenisei	218000	217331	218000	217331
2910100	Ugut				Bolshoi Yugan				
208	217	151.4	48.8	308.0	Ob	22100	21941	22100	21941
2910200	Napas				Tym				
209	217	205.5	76.9	355.6	Ob	24500	22915	24500	22915
2910300	Tomsk				Tom				
210	217	1047.0	471.7	1958.9	Ob	57000	57736	27200	26295
2910470	Biysk				Biya				
211	217	478.3	162.0	1063.2	Ob	36900	34656	36900	34656
2910490	Novokuznetsk				Tom				
212	210	650.9	206.4	1463.0	Ob	29800	31441	29800	31441
2911100	Omsk				Irtish				
213	217	734.2	463.8	985.2	Ob	321000	316015	321000	316015
2911200	Petropavlovsk				Ishim				
214	217	37.4	1.0	115.7	Ob	118000	118146	118000	118146
2912400	Tiumen				Tura				
215	217	189.9	30.8	1189.6	Ob	58500	65659	58500	65659
2912550	Sosva				Northern Sosva				
216	217	608.5	193.5	1209.7	Ob	65200	68905	65200	68905
2912600	Salekhard				Ob				
217	0	12532.2	6646.7	20690.5	Ob	2949998	2532786	2246798	1826812
2913200	Akutkul				Kara-Turgay				
218	0	9.4	0.6	27.8	Syr-Darya	14700	14227	14700	14227
2913550	Sergiopolskoye				Nura				
219	0	10.8	0.2	83.7	GHAASBasin189	12300	16040	12300	16040
2914450	Ush-Tobe				Karatal				
220	0	55.4	2.2	139.1	GHAASBasin73	13200	10939	13200	10939
2916200	Tyumen-Aryk				Syr-Darya				
221	0	541.9	98.2	1241.8	Syr-Darya	219000	268980	136600	183669
2916500	Arys				Arys				
222	221	20.8	6.3	89.2	Syr-Darya	13100	13693	13100	13693
2916550	Hodjikent				Chirchik				
223	221	218.3	111.6	472.2	Syr-Darya	10900	11495	10900	11495
2916850	Uch-Kurgan				Naryn				
224	221	365.2	124.8	737.2	Syr-Darya	58400	60123	23800	25333

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
2916860	Ust. Kekirim				Naryn				
225	224	204.7	125.1	329.8	Syr-Darya	34600	34790	24100	25530
2916890	Naryn				Naryn				
226	225	86.9	43.5	147.1	Syr-Darya	10500	9261	10500	9261
2917100	Chatly				Amu-Darya				
227	0	1376.2	506.5	2483.9	Amu-Darya	450000	550123	130800	240877
2917110	Kerki				Amu-Darya				
228	227	1696.1	789.0	3095.8	Amu-Darya	309000	297328	151300	148745
2917400	Manguzar				Surkhandarya				
229	228	49.9	1.6	166.1	Amu-Darya	13500	12104	13500	12104
2917450	Dupuli				Zaravchan				
230	227	155.0	96.8	239.4	Amu-Darya	10200	11918	10200	11918
2917700	Khorog				Gunt				
231	235	103.8	61.0	169.6	Amu-Darya	13700	14780	13700	14780
2917830	Murgab				Bartang				
232	235	16.2	6.2	31.5	Amu-Darya	10500	7333	10500	7333
2917900	Tutkaul				Vakhsh				
233	228	639.2	442.2	896.2	Amu-Darya	31200	31137	11200	12037
2917920	Garm				Vakhsh				
234	233	329.7	170.7	622.0	Amu-Darya	20000	19099	20000	19099
2917950	Niz. Pjandge				Pjandge				
235	228	1012.4	711.3	1425.8	Amu-Darya	113000	105343	88800	83230
2919200	Kushum				Ural				
236	0	296.7	30.1	1075.6	Ural	190000	187003	179000	175205
2919500	Aktubinsk				Ilek				
237	236	14.9	1.8	38.8	Ural	11000	11798	11000	11798
2964080	Sirikit Dam				Nan				
238	239	175.7	69.0	431.2	Chao Phraya	13300	14678	13300	14678
2964100	Nakhon Sawan				Chao Phraya				
239	0	646.6	248.2	1224.4	Chao Phraya	110569	117902	97269	103224
2964999	Srinagarind Dam				Quae Yai				
240	0	140.0	51.2	326.2	Mae Klong	10880	11915	10880	11915
2969010	Chiang Saen				Mekong				
241	157	2711.1	1717.4	4477.2	Mekong	189000	191777	189000	191777
2969082	Ban Chot				Nam Chi				
242	245	50.1	8.5	146.2	Mekong	10200	11886	10200	11886
2969090	Nong Khai				Mekong				
243	244	4083.6	2598.5	5923.1	Mekong	302000	305079	34000	26387
2969100	Mukdahan				Mekong				
244	158	7949.9	4248.2	12477.3	Mekong	391000	390302	89000	85224
2969200	Ubon				Nam Mun				
245	158	615.7	126.3	1574.6	Mekong	104000	104137	93800	92251
2998110	Ubileynaya				Yana				
246	0	1022.4	417.4	2073.4	Yana	224000	234464	224000	234464
2998400	Vorontsovo				Indigirka				
247	0	1587.2	677.2	3217.1	Indigirka	305000	299735	282700	278200
2998450	Andrushkino				Alazeja				
248	0	45.0	7.4	90.0	Alazeya	29000	28511	29000	28511
2998500	Sredne-Kolymsk				Kolyma				
249	250	2214.7	765.0	5686.2	Kolyma	361000	362791	361000	362791
2998510	Kolymskaya				Kolyma				
250	0	3109.0	1371.2	6313.6	Kolyma	526000	536288	165000	173497
2998600	Ala-Chubuk				Nera				
251	247	115.9	29.9	261.8	Indigirka	22300	21535	22300	21535
2999200	Nadym				Nadym				
252	0	460.7	216.2	755.6	Nadym	48000	42948	48000	42948
2999250	Sidorovsk				Taz				
253	0	1034.5	533.0	1731.8	Pur - Taz	100000	97166	100000	97166
2999500	Samburg				Pur				
254	0	906.2	461.5	1446.9	Pur - Taz	95100	91603	95100	91603
2999800	Buyaga				Amga				
255	196	129.0	59.8	284.1	Lena	23900	23846	23900	23846
2999910	7.5km Downstream of River Pur				Olenek				
256	0	999.5	484.3	2066.5	Olenek	198000	197908	71000	61522

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
2999920	Sukhana				Olenek				
257	256	717.2	285.5	1547.1	Olenek	127000	136386	127000	136386
3103500	Puerto Berrio				Magdalena				
258	0	2481.0	1605.5	3564.3	Magdalena	74410	70913	74410	70913
3142500	Pte Pusmeo				Patia				
259	0	290.4	135.3	479.4	GHAASBasin687	13147	12360	13147	12360
3178800	Panamericana				Limari				
260	0	11.7	0.0	68.2	GHAASBasin923	11343	13269	11343	13269
3179200	Cabimbao				Maipo				
261	0	119.3	25.8	318.7	Maipo	14823	15437	14823	15437
3206630	Dos Aguas				Caura				
262	0	1876.0	1268.3	2616.5	Orinoco	25000	24635	25000	24635
3206720	Puente Angostura				Orinoco				
263	0	30620.8	19134.2	43036.4	Orinoco	836000	907313	717170	796117
3206800	Tama-Tama				Orinoco				
264	263	1227.0	666.2	1830.1	Orinoco	37870	40139	37870	40139
3218100	Solano				Brazo Casiquiare				
265	263	2100.8	1283.9	3110.5	Orinoco	80960	71057	80960	71057
3264500	Posadas				Parana				
266	269	12049.9	6559.4	24973.4	Parana	975000	958816	105483	89273
3265005	la Punilla				Calchaqui				
267	268	6.4	0.0	30.2	Parana	19800	19548	19800	19548
3265100	el Arenal				Salado				
268	0	19.2	1.1	73.8	Parana	40000	41960	20200	22412
3265300	Corrientes				Parana				
269	0	16595.2	7583.8	39291.7	Parana	1950000	2172009	353769	518973
3268130	Algarrobito (1971: San Telmo)				Grande de Tarija				
270	271	115.8	52.8	214.2	Parana	10460	11475	10460	11475
3268150	Zanja del Tigre				Bermejo				
271	269	317.5	109.0	830.9	Parana	24931	22908	14471	11434
3268270	Caimancito (Puente Carretero)				San Francisco				
272	269	98.5	23.4	353.2	Parana	25800	56651	25800	56651
3268500	la Paz				Pilcomayo				
273	269	188.1	71.8	409.1	Parana	96000	103995	96000	103995
3274030	Tinogasta				Abaucan				
274	0	2.1	1.0	5.6	Colorado (Arg)	14000	16351	14000	16351
3274150	el Sauce (1967: Embalse Rio Hondo)				Dulce				
275	0	94.2	5.4	411.7	Noname (GHAASBasin174)	20200	22071	20200	22071
3275050	Pachimoco				Jachal				
276	0	8.9	3.2	37.2	Colorado (Arg)	25500	26836	25500	26836
3275100	la Puntilla				San Juan				
277	0	56.1	13.2	238.7	Colorado (Arg)	25000	26356	25000	26356
3275270	Arco del Desaguadero				Desaguadero				
278	0	10.9	0.0	84.6	Colorado (Arg)	10212	10311	10212	10311
3275700	Buta Ranquil				Colorado				
279	281	143.9	49.8	312.8	Negro Arg	15300	12287	15300	12287
3275750	Pichi Mahuida				Colorado				
280	0	130.4	38.5	299.0	Colorado (Arg)	22300	69068	22300	69068
3275800	Paso de los Indios				Neuquen				
281	283	311.9	65.2	910.2	Negro Arg	30200	29246	14900	16960
3275900	Paso Limay				Limay				
282	0	746.0	287.6	1632.1	Chubut	26400	23205	26400	23205
3275990	Primera Angostura				Negro				
283	0	870.1	243.6	1772.7	Negro Arg	95000	185798	64800	156551
3276200	Los Altares				Chubut				
284	0	48.8	16.3	116.1	Chubut	16400	13601	16400	13601
3276320	Vuelta del Senguerr				Senguerr				
285	0	48.9	9.2	124.2	Chubut	17500	32739	17500	32739
3276800	Charles Fuhr				Santa Cruz				
286	0	689.8	330.1	1025.5	Santa Cruz	15550	15875	15550	15875
3308300	Apaikwa				Mazaruni				
287	0	773.1	350.8	1339.1	Essequibo	14000	15373	14000	15373
3308600	Plantain Island				Essequibo				
288	0	2103.5	657.1	3751.1	Essequibo	66600	67866	66600	67866

GRDC Code / ID	Next Station	Station Name / Discharge [m^3/s] Mean	Min	Max	RiverName / STN Basin Name	Area [km^2] GRDC	Area [km^2] STN-30p	Inter-Stn Area [km^2] GRDC	Inter-Stn Area [km^2] STN-30p
3469050	Salto				Uruguay				
289	0	5224.9	1111.7	12277.0	Urugay	244000	243471	160235	151687
3469100	Palmar				Negro				
290	0	721.6	26.5	3371.2	Urugay	63000	67709	37189	41480
3469200	Paso de la Laguna				Tacuarembo				
291	290	226.2	32.2	601.8	Urugay	14038	15715	14038	15715
3469400	Paso Pereira				Negro				
292	290	180.1	18.2	643.0	Urugay	11773	10515	11773	10515
3512400	Langa Tabiki				Maroni				
293	0	1682.3	482.4	3401.1	Maroni	60930	61713	60930	61713
3514800	Maripa				Oyapock				
294	0	835.0	267.5	1617.8	Oyapok	25120	21614	25120	21614
3618500	Caracarai				Rio Branco				
295	313	2926.2	796.2	5423.8	Amazon	124980	123421	124980	123421
3618950	Uaracu				Rio Uaupes				
296	313	2387.5	1533.0	3377.9	Amazon	40506	37088	40506	37088
3621200	Acanaui				Rio Japura				
297	313	13914.9	9400.0	18288.2	Amazon	242259	222518	45123	33988
3621400	Vila Bittencourt				Rio Japura				
298	297	13100.3	8595.4	17596.0	Amazon	197136	188529	197136	188529
3622400	Estirao do Repouso				Rio Javari				
299	301	2462.6	1480.7	3455.0	Amazon	58107	58417	58107	58417
3622801	Seringal do Itui				Rio Itui				
300	301	797.7	466.4	1168.1	Amazon	19103	24599	19103	24599
3623100	Sao Paulo de Olivenca				Amazonas (Rio Solimoes)				
301	313	7034.6	4350.8	9951.4	Amazon	990781	992798	913571	909782
3624120	Gaviao				Rio Jurua				
302	313	4765.3	3089.1	6205.4	Amazon	162000	168447	78513	82875
3624160	Cruzeiro do Sul				Rio Jurua				
303	302	913.3	331.7	1588.5	Amazon	38537	42802	21956	27555
3624180	Taumaturgo				Rio Jurua				
304	303	412.1	209.7	709.4	Amazon	16581	15246	16581	15246
3624300	Envira				Rio Tarauaca				
305	302	1276.9	744.5	1836.3	Amazon	44950	42770	44950	42770
3625150	Rio Branco				Rio Acre				
306	309	353.6	115.1	660.8	Amazon	22670	18251	22670	18251
3625310	Aruma-Jusante				Rio Purus				
307	313	10434.6	6860.5	13452.2	Amazon	359853	360991	139502	119834
3625340	Labrea				Rio Purus				
308	307	5569.6	3814.2	7298.8	Amazon	220351	241157	157185	171116
3625370	Seringal Da Caridade				Rio Purus				
309	308	1279.0	498.0	2284.7	Amazon	63166	70040	40496	51789
3627040	Porto Velho				Rio Madeira				
310	313	19758.4	12676.0	27381.0	Amazon	954285	992572	954285	992572
3627408	Jiparana (Rondonia)				Rio Jiparana				
311	313	671.6	430.7	949.2	Amazon	32606	33301	32606	33301
3628500	Estirao Da Angelica				Rio Mapuera				
312	313	727.1	92.0	1609.5	Amazon	26040	27819	26040	27819
3629000	Obidos				Amazonas				
313	0	176176.7	129280.1	217490.0	Amazon	4640300	4622624	1706990	1663668
3629180	Barra do Sao Manuel-Jusante				Rio Tapajos				
314	0	8341.7	6541.7	10460.2	Amazon	332163	348344	136720	139384
3629380	Fontanilhas				Rio Juruena				
315	314	1425.5	198.2	1777.7	Amazon	57958	54127	57958	54127
3629790	Tres Marias				Rio Sao Manoel				
316	314	3978.1	2940.8	5200.2	Amazon	137485	154833	137485	154833
3630050	Altamira				Xingu				
317	0	8670.1	4976.7	14308.4	Amazon	446570	448086	322743	322365
3630120	Pedra do o				Rio Iriri				
318	317	2614.7	1045.2	4233.7	Amazon	123827	125721	37837	46161
3630150	Laranjeiras				Rio Iriri				
319	318	1234.8	639.1	2079.0	Amazon	65187	58138	65187	58138
3630215	Boca do Inferno				Rio Curua				
320	318	129.4	4.6	391.2	Amazon	20803	21422	20803	21422

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
3630300	Arapari				Rio Maicuru				
321	0	115.2	12.5	294.7	Amazon	17072	18546	17072	18546
3631100	Sao Francisco				Rio Jari				
322	0	1004.1	281.7	1790.5	Amazon	51343	52541	20398	21638
3631210	Fazenda Paquira				Rio Paru de Este				
323	322	489.6	100.1	952.0	Amazon	30945	30903	30945	30903
3649014	Colonia Dos Americanos				Rio Das Almas				
324	327	335.4	162.8	612.5	Tocantins	18282	26841	18282	26841
3649211	Jacinto				Rio Santa Tereza				
325	330	187.7	62.0	374.2	Tocantins	13811	12048	13811	12048
3649240	Fazenda Lobeira				Rio Manuel Alves				
326	327	207.0	79.8	488.0	Tocantins	14462	15138	14462	15138
3649250	Porto Nacional				Tocantins				
327	334	2245.5	856.9	5180.8	Tocantins	175360	174391	142616	132411
3649412	Araguaiana				Rio Araguaia				
328	329	915.7	458.8	1523.5	Tocantins	50930	56324	50930	56324
3649414	Fazenda Telesforo				Rio Araguaia				
329	330	1482.4	515.5	2404.5	Tocantins	131600	134108	80670	77785
3649416	Conceicao do Araguaia				Rio Araguaia				
330	331	4857.9	9.9	9053.4	Tocantins	320290	315378	119533	112369
3649418	Xambioa				Rio Araguaia				
331	334	5507.8	2218.8	8984.4	Tocantins	364496	364358	44206	48980
3649614	Toriqueje				Rio Das Mortes				
332	333	344.7	204.0	535.4	Tocantins	17850	17887	17850	17887
3649619	Santo Antonio do Leverger				Rio Das Mortes				
333	330	867.5	391.6	1411.2	Tocantins	55346	56853	37496	38966
3649900	Itupiranga				Tocantins				
334	0	11363.6	5875.0	18813.9	Tocantins	727900	743944	188044	205196
3650150	Badajos				Rio Capim				
335	0	555.4	233.0	786.8	GHAASBasin180	38178	37016	38178	37016
3650202	Alto Bonito				Rio Gurupi				
336	0	480.9	115.7	835.8	Gurupi	31850	33923	31850	33923
3650335	Bacabal				Rio Mearim				
337	0	111.2	55.5	237.2	Mearim	25500	24630	25500	24630
3650355	Caxias				Rio Itapecuru				
338	339	80.3	37.3	181.1	GHAASBasin198	31750	33809	31750	33809
3650359	Cantanhede				Rio Itapecuru				
339	0	252.5	73.4	722.8	GHAASBasin198	50800	52295	19050	18486
3650385	Nina Rodrigues				Rio Munim				
340	0	150.7	40.6	362.1	GHAASBasin198	12350	12338	12350	12338
3650460	Santa Cruz do Piaui				Rio Itam				
341	342	12.7	0.1	85.8	Parnaiba	17500	12273	17500	12273
3650481	Luzilandia				Rio Parnaiba				
342	0	846.3	427.0	2043.2	Parnaiba	322823	330977	279323	291250
3650488	Fazenda Paracati				Rio Parnaiba				
343	342	203.4	143.3	297.1	Parnaiba	26000	27454	26000	27454
3650525	Sobral				Rio Acarau				
344	0	56.3	0.0	308.2	GHAASBasin596	11160	9244	11160	9244
3650634	Morada Nova Ii				Rio Banabuiu				
345	0	52.9	0.5	422.0	GHAASBasin192	17900	18467	17900	18467
3650645	Iguatu				Rio Jaguaribe				
346	347	29.5	0.0	289.8	GHAASBasin192	21770	18419	21770	18419
3650649	Peixe Gordo				Rio Jaguaribe				
347	0	116.7	0.4	593.7	GHAASBasin192	48200	42986	26430	24567
3650750	Jardim de Piranhas				Rio Piranhas				
348	0	78.6	1.5	403.1	GHAASBasin369	22875	27628	22875	27628
3650885	Ponte Da Batalha				Rio Paraiba				
349	0	33.8	0.7	172.1	GHAASBasin433	19244	24511	19244	24511
3651309	Varzea Da Palma				Rio Das Velhas				
350	354	296.2	87.6	682.4	Sao Francisco	25940	26317	25940	26317
3651408	Porto Alegre				Rio Paracatu				
351	354	439.9	120.8	1015.1	Sao Francisco	41709	38385	41709	38385
3651678	Boqueirao				Rio Grande				
352	353	269.7	195.2	431.3	Sao Francisco	65900	60549	65900	60549

GRDC Code ID	Station Name: Next Station	Discharge [m^3/s]: Mean	Min	Max	RiverName / STN Basin Name	Area [km^2]: GRDC	STN-30p	Inter-Stn Area [km^2]: GRDC	STN-30p
3651800	Juazeiro				Sao Francisco				
353	0	2710.8	1115.3	5951.6	Sao Francisco	510800	508266	244111	256505
3651805	Manga				Sao Francisco				
354	353	2020.6	710.3	4692.2	Sao Francisco	200789	191212	133140	126510
3652039	Usina Altamira				Rio Itapicuru				
355	0	40.9	5.9	142.7	GHAASBasin322	35150	36439	35150	36439
3652130	Fazenda Santa-Fe				Rio Paraguacu				
356	0	95.9	21.3	229.6	GHAASBasin250	31488	30162	31488	30162
3652220	Jequie				Rio Contas				
357	0	28.5	0.8	174.3	GHAASBasin308	42245	44968	42245	44968
3652320	Mascote				Rio Pardo				
358	0	77.7	12.4	264.2	Jequitinhonha	30360	41732	30360	41732
3652450	Jacinto				Jequitinhonha				
359	0	408.6	79.2	1238.8	Jequitinhonha	62365	62081	62365	62081
3652890	Campos-Ponte Municipal				Paraiba do Sul				
360	0	841.6	226.6	1950.3	Paraiba do Sul	55083	57259	55083	57259
3662100	Uhe Jupia-Jusante-Jju				Parana				
361	362	6369.0	2683.6	12378.8	Parana	478000	471509	478000	471509
3663100	Guaira				Parana				
362	266	8593.8	4268.3	16137.1	Parana	802200	802804	239386	249077
3663650	Novo Porto Taquara				Rio Ivai				
363	362	690.7	216.0	1792.2	Parana	34432	34383	34432	34383
3663655	Porto Paraiso do Norte				Rio Ivai				
364	362	524.3	114.9	1709.2	Parana	28427	25321	28427	25321
3663700	Jataizinho				Rio Tibaji				
365	362	367.7	65.7	1588.1	Parana	21955	22514	21955	22514
3664150	Salto Ozorio				Iguacu				
366	367	963.3	208.8	3247.8	Parana	46400	50011	22189	22227
3664160	Salto Cataratas				Iguacu				
367	266	1418.7	292.7	5568.0	Parana	67317	66740	20917	16729
3664802	Uniao Da Vitoria				Iguacu				
368	366	423.1	96.0	1677.9	Parana	24211	27784	24211	27784
3666050	Caceres (Dnpvn)				Paraguai				
369	372	534.3	238.3	951.2	Parana	33890	32848	33890	32848
3666200	Sao Jeronimo				Rio Piquiri				
370	371	190.7	108.8	315.5	Parana	27150	26694	27150	26694
3666400	Porto Alegre				Rio Cuiaba				
371	372	589.2	409.3	760.3	Parana	102750	106760	75600	80066
3667020	Porto Esperanca (Dnos)				Paraguai				
372	373	1813.7	1107.0	3330.8	Parana	363500	371254	184360	190852
3667060	Porto Murtinho (Fb/dnos)				Paraguai				
373	269	2299.0	833.5	4899.4	Parana	474500	510665	111000	139411
3667200	Miranda				Rio Miranda				
374	372	85.0	27.7	198.4	Parana	15460	14415	15460	14415
3667300	Coxim				Rio Taquari				
375	372	264.1	157.7	483.9	Parana	27040	26379	27040	26379
3669600	Passo Mariano Pinto				Rio Ibicui				
376	289	798.1	109.0	2796.6	Urugay	42498	50787	42498	50787
3669700	Marcelino Ramos				Uruguai				
377	289	846.4	127.0	3012.0	Urugay	41267	40998	41267	40998
3844100	D.J.Sade				Esmeraldas				
378	0	994.0	542.1	2008.4	GHAASBasin796	18800	15456	18800	15456
4102100	Crooked Creek, Alas.				Kuskokwim				
379	0	1111.9	622.5	1937.6	Kuskowin	80549	78072	50246	47080
4102110	Mcgrath				Kuskokwim				
380	379	381.5	231.0	631.4	Kuskowin	30303	30993	30303	30993
4102700	Chitina, Alas.				Copper				
381	0	1050.6	614.1	1589.3	Copper	53354	58189	53354	58189
4102800	Susitna Station				Susitna				
382	0	1400.8	986.7	2172.1	GHAASBasin321	50246	45580	50246	45580
4103200	Pilot Station				Yukon				
383	0	6346.8	4376.1	8721.7	Yukon	831390	840586	64390	71605
4103300	Kaltag, Alas.				Yukon				
384	383	6040.2	3732.4	8838.1	Yukon	767000	768981	47757	51739

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
4103450	Ruby, Alas.				Yukon				
385	384	4215.5	2690.3	6258.8	Yukon	670810	666937	96089	89461
4103500	Hughes, Alas.				Koyukuk				
386	384	381.6	91.7	789.0	Yukon	48433	50305	48433	50305
4103550	near Stevens Village				Yukon River				
387	385	3378.3	2413.8	4948.8	Yukon	508417	506410	138047	134449
4103600	Nenana, Alas.				Tanana				
388	385	651.9	469.8	941.4	Yukon	66304	71066	44160	47125
4103700	Fort Yukon, Alas.				Porcupine River				
389	387	410.5	116.9	783.6	Yukon	76405	76724	21005	21766
4103750	Tanacross, Alas.				Tanana				
390	388	221.1	148.5	301.2	Yukon	22144	23941	22144	23941
4103800	Eagle				Yukon River				
391	387	2359.2	1405.6	3679.2	Yukon	293965	295238	29965	30742
4113300	Grand Forks, N.D.				Red of The North				
392	495	105.3	12.8	290.2	Nelson	77959	75474	77959	75474
4115100	Salem, Oreg.				Willamette				
393	0	688.1	157.7	2224.8	Columbia	18855	17771	18855	17771
4115200	The Dalles, Oreg.				Columbia				
394	0	5438.1	2289.3	11335.8	Columbia	613830	656568	193130	232154
4116180	Clarkston, Wash.				Snake River				
395	394	1414.7	619.9	2788.5	Columbia	267300	270819	267300	270819
4118440	Imlay, Nev.				Humboldt				
396	0	11.3	0.6	58.0	GHAASBasin214	40663	63381	40663	63381
4118850	Juab, Utah				Sevier River				
397	0	8.9	2.0	44.9	GHAASBasin590	13261	12121	13261	12121
4119650	Clinton, Iowa				Mississippi				
398	399	1466.4	554.1	2716.8	Mississippi	221704	227644	221704	227644
4119800	Alton, Ill.				Mississippi				
399	416	2895.6	862.1	6919.2	Mississippi	444185	440389	222481	212744
4120900	Culbertson, Mont.				Missouri				
400	402	349.2	195.8	596.9	Mississippi	237133	220207	237133	220207
4120950	Sidney, Mont.				Yellowstone				
401	402	390.5	177.7	657.4	Mississippi	178977	173162	178977	173162
4121800	Yankton, S.D.				Missouri				
402	404	748.9	269.3	1845.7	Mississippi	723900	716161	307790	322792
4122600	Louisville, Nebr.				Platte				
403	404	214.5	74.4	536.5	Mississippi	222222	215978	222222	215978
4122650	Nebraska City, Nebr.				Missouri				
404	406	1179.7	731.8	1960.9	Mississippi	1061899	1074472	115777	142333
4122700	Desoto, Kans.				Kansas				
405	406	262.9	48.1	866.7	Mississippi	154768	167148	154768	167148
4122900	Hermann, Mo.				Missouri				
406	416	2307.5	628.6	7079.4	Mississippi	1357677	1364134	141010	122514
4123050	Metropolis, Ill.				Ohio				
407	416	7450.4	535.6	18925.8	Mississippi	525770	497409	65778	58857
4123060	Paducah, Ky.				Tennessee				
408	407	1857.0	756.8	4014.8	Mississippi	104118	90452	104118	90452
4123080	Grand River, Ky.				Cumberland				
409	407	1183.8	357.5	2181.1	Mississippi	45579	37361	45579	37361
4123130	Mount Carmel, Ill.				Wabash				
410	407	838.0	207.3	1914.2	Mississippi	74165	76066	74165	76066
4123300	Louisville, Ky.				Ohio				
411	407	3464.7	1157.4	7118.8	Mississippi	236130	234672	236130	234672
4125500	Tulsa, Okla.				Arkansas				
412	414	198.3	25.4	757.2	Mississippi	193253	198789	193253	198789
4125550	Whitefield, Okla.				Canadian				
413	414	124.6	11.3	465.2	Mississippi	123222	123036	123222	123036
4125800	Little Rock, Ark.				Arkansas				
414	416	1065.7	41.5	5159.8	Mississippi	409453	408872	92978	87047
4126800	Alexandria, La.				Red				
415	0	861.2	127.3	3202.8	Mississippi	174825	169478	174825	169478
4127800	Vicksburg, Miss.				Mississippi				
416	0	17599.8	7448.0	31341.1	Mississippi	2964252	2957806	227167	247002

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
4133200	Wrightstown, Wis.				Fox River				
417	521	126.4	46.8	284.4	St. Lawrence	16084	17732	16084	17732
4135200	Waterville, Ohio				Maumee				
418	521	158.2	27.2	492.4	St. Lawrence	16395	16269	16395	16269
4143300	Ogdensburg, N.Y.				St.Lawrence				
419	0	6782.0	4997.5	8264.8	St. Lawrence	764600	783664	78600	96032
4145900	Agness, Oreg.				Rogue				
420	0	187.7	41.8	499.8	GHAASBasin1050	10202	11350	10202	11350
4146110	Klamath, Calif.				Klamath				
421	0	521.5	98.3	1505.2	Klamath	31339	32197	31339	32197
4146280	Sacramento, Calif.				Sacramento				
422	0	683.7	195.1	1462.4	Sacramento	60886	58907	60886	58907
4146360	Vernalis, Calif.				San Joaquim				
423	0	158.2	11.8	660.8	Sacramento	35058	39596	35058	39596
4147010	West Enfield, Me.				Penobscot				
424	0	339.6	135.8	897.7	Penobscot	17275	17237	17275	17237
4147380	Lowell, Mass.				Merrimack				
425	0	231.5	83.6	506.2	Merrimack	12005	11239	12005	11239
4147460	Thompsonville, Conn.				Connecticut				
426	0	470.1	170.3	1234.0	Connecticut	25022	22383	25022	22383
4147500	Green Island, N.Y.				Hudson				
427	0	388.9	144.9	856.2	Hudson	20953	24767	20953	24767
4147600	Trenton, N.J.				Delaware				
428	0	333.6	95.6	979.0	Delaware	17560	16214	17560	16214
4147700	Harrisburg, Pa.				Susquehanna				
429	0	974.1	221.8	3194.8	Susquehanna	62419	65000	62419	65000
4147900	Washington, D.C.				Potomac				
430	0	312.7	66.3	1068.0	Potomac	29940	33598	29940	33598
4148050	Richmond, Va.				James				
431	0	202.2	35.6	588.3	James	17503	17110	17503	17110
4148090	Roanoke Rapids, N.C.				Roanoke				
432	0	223.4	78.3	550.5	Roanoke	21782	22259	21782	22259
4148300	Pee Dee, S.C.				Pee Dee				
433	0	282.7	90.9	833.4	Pee Dee	22870	25164	22870	25164
4148550	Pineville, S.C.				Santee				
434	0	66.7	13.4	328.4	Santee	38073	38004	38073	38004
4148720	Doctortown, Ga.				Altamaha				
435	0	392.6	105.5	1156.2	Savannah	35224	35905	35224	35905
4149120	Bogalusa, La.				Pearl				
436	0	282.2	61.9	895.4	Pearl	17172	18285	17172	18285
4149300	Merrill, Miss.				Pascagoula				
437	0	285.3	56.9	957.8	GHAASBasin785	17094	15814	17094	15814
4149400	Claiborne, Ala.				Alabama				
438	0	943.4	275.8	2574.6	Alabama	56895	54164	56895	54164
4149630	Chattahoochee, Fla.				Apalachicola				
439	0	638.4	242.8	1647.9	Appalachicola	44548	44163	44548	44163
4149780	Branford, Fla.				Suwannee				
440	0	217.6	64.2	512.0	Suwannee	20409	18569	20409	18569
4150280	Mathis, Tex.				Nueces				
441	0	24.7	1.8	191.2	Nueces	43149	43269	43149	43269
4150500	Richmond, Tex.				Brazos				
442	0	199.4	23.8	679.9	Colorado (Texas)	116568	118467	116568	118467
4150600	Romayor, Tex.				Trinity				
443	0	206.1	18.4	717.7	Trinity	44512	47549	44512	47549
4150680	Evadale, Tex.				Neches				
444	0	146.2	20.6	432.8	Neches	20593	21196	20593	21196
4150700	Ruliff, Tex.				Sabine				
445	0	207.4	27.9	565.2	Sabine	24162	23585	24162	23585
4151800	Laredo, Tex.				Rio Grande				
446	0	114.8	8.6	542.3	Rio Grande (US)	352178	566451	352178	566451
4152100	Yuma, Ariz.				Colorado				
447	0	20.5	13.0	29.2	Colorado (Ari)	629100	608155	339538	324612
4152450	Lees Ferry, Ariz.				Colorado				
448	447	463.7	40.2	1315.9	Colorado (Ari)	289562	283543	184408	180698

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
4152550	Green River, Utah				Green				
449	448	177.0	68.4	364.5	Colorado (Ari)	105154	102845	105154	102845
4203050	Old Crow				Porcupine River				
450	389	319.4	78.8	610.7	Yukon	55400	54958	55400	54958
4203150	Mayo				Stewart River				
451	452	382.2	187.4	653.0	Yukon	31598	34470	31598	34470
4203200	Dawson				Yukon River				
452	391	2160.0	1573.7	2874.3	Yukon	264000	264496	82441	86300
4203250	above White River				Yukon River				
453	452	1186.5	723.4	1865.2	Yukon	149961	143725	39840	36506
4203500	Pelly Crossing				Pelly River				
454	453	370.5	188.2	576.1	Yukon	49000	47306	49000	47306
4203770	near Teslin				Teslin River				
455	453	302.7	143.1	503.3	Yukon	30300	30724	30300	30724
4203900	above Frank Creek				Yukon River				
456	453	316.4	205.9	444.4	Yukon	30821	29190	30821	29190
4204050	above Butterfly Creek				Stikine				
457	459	631.0	414.8	917.3	Stikine	36000	34503	6700	6598
4204100	Telegraph Creek				Stikine				
458	457	396.8	241.2	621.8	Stikine	29300	27905	29300	27905
4204900	near Wrangell				Stikine				
459	0	1603.9	1055.0	2514.4	Stikine	51593	51316	15593	16813
4205600	near Tulsequah				Taku				
460	0	264.8	153.8	452.9	Taku	15500	16106	15500	16106
4206100	above Shumal Creek				Nass				
461	0	774.8	461.2	1420.5	Nass	19200	20608	19200	20608
4206250	Usk				Skeena				
462	0	900.3	487.4	1846.8	GHAASBasin261	42200	40322	42200	40322
4207150	near Fort St. James				Stuart River				
463	465	132.2	70.5	234.6	Fraser	14600	12378	14600	12378
4207305	below Big Creek				Chilcotin				
464	467	97.0	66.5	147.9	Fraser	19300	19138	19300	19138
4207310	Marguerite				Fraser River				
465	467	1477.6	834.9	2387.3	Fraser	114000	111710	99400	99332
4207830	Mclure				North Thompson				
466	467	433.5	263.9	685.8	Fraser	19600	19621	19600	19621
4207900	Hope				Fraser River				
467	0	2718.1	1594.0	4739.2	Fraser	217000	229432	64100	78964
4208025	Arctic Red River				Mackenzie River				
468	0	9118.7	6289.6	12594.8	Mackenzie	1660000	1678481	90000	108883
4208150	Norman Wells				Mackenzie River				
469	468	8324.0	6025.0	11162.2	Mackenzie	1570000	1569598	344600	346739
4208220	above Clausen Creek				South Nahanni River				
470	469	408.2	266.6	915.9	Mackenzie	33400	33223	33400	33223
4208270	Lower Crossing				Liard River				
471	472	1144.0	662.1	1831.8	Mackenzie	104000	103458	104000	103458
4208280	Fort Liard				Liard River				
472	469	1878.5	1184.4	3034.9	Mackenzie	222000	219420	118000	115962
4208300	near Fort Providence				Mackenzie River				
473	469	4384.6	3233.1	5647.5	Mackenzie	970000	970216	364000	359594
4208400	Fitzgerald				Slave River				
474	473	3409.1	1969.7	5412.5	Mackenzie	606000	610621	180000	174941
4208450	Peace Point				Peace River				
475	474	1934.9	840.8	3454.8	Mackenzie	293000	294429	107000	99959
4208550	Hudson Hope				Peace River				
476	477	1071.1	146.2	2353.3	Mackenzie	70200	72214	70200	72214
4208630	Peace River				Peace River				
477	475	1763.8	676.6	3700.0	Mackenzie	186000	194470	65500	72171
4208640	Watino				Smoky River				
478	477	354.2	159.9	754.4	Mackenzie	50300	50085	50300	50085
4208730	below Mcmurray				Athabasca River				
479	474	668.7	396.8	1071.3	Mackenzie	133000	141252	58400	63403
4208870	Athabasca				Athabasca River				
480	479	437.8	230.0	929.3	Mackenzie	74600	77848	74600	77848

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next Station	Discharge [m^3/s] Mean	Min	Max					
ID					STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
4209400	Point Lake Outlet				Coppermine River				
481	0	106.4	56.1	173.8	Coppermine	19300	19779	19300	19779
4209600	near The mouth				Ellice River				
482	0	82.6	19.5	171.3	Ellice	16900	18378	16900	18378
4209805	above Hermann River				Back				
483	0	488.2	204.0	969.2	Back	93900	93513	93900	93513
4213250	Medicine Hat				South Saskatchewan				
484	487	199.6	40.8	629.9	Nelson	56500	55199	56500	55199
4213290	near Unwin				Battle				
485	488	8.8	0.7	49.1	Nelson	25900	26239	25900	26239
4213300	near Deer Creek				North Saskatchewan				
486	488	208.6	124.8	396.2	Nelson	57000	55614	57000	55614
4213400	Saskatoon				South Saskatchewan				
487	490	263.3	37.2	880.4	Nelson	141000	140246	84500	85047
4213440	Prince Albert				North Saskatchewan				
488	490	242.6	88.0	732.4	Nelson	131000	130413	48100	48561
4213510	Turnberry				Carrot River				
489	490	18.0	3.8	48.8	Nelson	12600	10793	12600	10793
4213550	The Pas				Saskatchewan River				
490	496	591.1	303.2	1046.8	Nelson	347000	334978	62400	53527
4213560	near mouth				Red Deer River				
491	493	22.4	3.8	53.8	Nelson	14300	13119	14300	13119
4213590	Wawanesa				Souris				
492	494	10.6	0.0	98.2	Nelson	60300	62550	60300	62550
4213603	near Waterhen				Waterhen				
493	496	76.5	9.0	201.2	Nelson	55100	47395	40800	34276
4213650	Headingley				Assiniboine River				
494	496	48.2	5.8	211.6	Nelson	153000	154385	92700	91834
4213680	Emerson				Red River				
495	496	94.3	5.2	498.8	Nelson	104000	106127	26041	30653
4213710	above Bladder Rapids				Nelson River				
496	0	2402.8	1035.1	3558.8	Nelson	1000000	974453	214900	202917
4213800	Slave Falls				Winnipeg River				
497	496	838.5	283.3	2049.2	Nelson	126000	128651	126000	128651
4214050	above Beverly Lake				Thelon River				
498	0	237.3	109.1	561.9	Baker	65300	65170	65300	65170
4214090	above Kazan Falls				Kazan River				
499	0	441.7	206.4	885.4	Baker	72300	71906	72300	71906
4214210	Cold Lake Reserve				Beaver River				
500	501	22.0	2.8	96.4	Churchill (Hud)	14500	14339	14500	14339
4214260	above Granville Falls				Churchill River				
501	0	860.3	576.4	1292.4	Churchill (Hud)	228000	240626	213500	226287
4214330	near Island Lake				Island Lake River				
502	503	86.2	32.6	173.7	Hayes	14000	12730	14000	12730
4214350	Outlet of Gods Lake				Gods				
503	0	163.4	72.2	300.8	Hayes	25900	21628	11900	8898
4214450	below Asheweig River Tributary				Winisk				
504	0	454.0	173.9	874.7	Winisk	50000	49587	50000	49587
4214480	below Attawapiskat Lake				Attawapiskat				
505	0	261.2	94.7	542.9	Attawapiskat	24200	24815	24200	24815
4214520	near Hat Island				Albany River				
506	0	940.5	355.4	1798.4	Albany	118000	119425	118000	119425
4214550	Moose River Crossing				Moose				
507	0	760.0	319.2	1405.8	Moose	61100	66968	61100	66968
4214650	Tete du Lac Soscumica				Nottaway				
508	0	1051.7	597.9	1792.8	Nottaway	57500	62550	57500	62550
4214680	en aval du Lac Nemiscau				Rupert				
509	0	864.4	593.2	1218.5	Rupert	40900	44396	40900	44396
4214700	Tete de la Gorge De Basile				Eastmain				
510	0	942.8	526.1	1624.9	Eastmain	44300	43314	44300	43314
4214750	en amont de la Riviere De Pontois				Grande Riviere				
511	512	758.7	435.8	1174.7	La Grande	37000	38341	37000	38341
4214770	en aval de la Riviere Acazi				Grande Riviere				
512	0	1749.5	983.3	2580.2	La Grande	96300	97049	59300	58707

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
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4214830	Sortie du Lac Bienville				Grande R. de la Baleine				
513	0	352.6	211.7	558.3	GR Baleine	21000	19404	21000	19404
4215200	Birchbank				Columbia River				
514	394	2013.4	935.4	3839.8	Columbia	88100	88953	53400	50907
4215220	International Boundary				Pend Oreille				
515	394	771.5	220.1	1651.0	Columbia	65300	64643	65300	64643
4215320	near Copeland				Kootenai				
516	514	455.3	123.6	1653.2	Columbia	34700	38047	21100	22359
4215705	Wardner				Kootenay				
517	516	208.5	113.3	365.7	Columbia	13600	15688	13600	15688
4231200	Fort Kent				Saint John				
518	519	273.5	54.3	712.1	Saint John	14700	12649	14700	12649
4231600	Pokiok				St.John				
519	0	727.7	222.3	1943.8	Saint John	38800	37966	24100	25317
4234010	Sault Ste. Marie				St. Mary's River				
520	521	2141.6	1240.8	3229.2	St. Lawrence	210000	223837	210000	223837
4236010	Queenston				Niagara River				
521	419	5826.3	4259.2	7195.8	St. Lawrence	686000	687632	443521	429794
4243050	la Cave Rapids				Ottawa				
522	523	696.0	428.7	1144.6	St. Lawrence	47900	48022	47900	48022
4243100	Chats Falls				Ottawa				
523	0	1165.3	437.8	2766.7	St. Lawrence	89600	88772	41700	40750
4243300	Centrale de Grande-Mere				Saint-Maurice				
524	0	755.8	219.2	2620.1	St. Lawrence	42000	37530	42000	37530
4243400	Centrale D'isle Maligne				Saguenay				
525	0	1467.4	547.8	3118.3	St. Lawrence	73000	75700	46100	50257
4243410	Centrale de Chute-A-La-Savane				Peribonca				
526	525	634.1	390.8	936.9	St. Lawrence	26900	25443	26900	25443
4243600	Centrale de Chute-Aux-Outardes				Aux Outardes				
527	0	391.1	25.2	982.5	St. Lawrence	18900	19556	18900	19556
4243610	Centrale Mccormick				Manicouagan				
528	0	868.6	315.6	1667.4	St. Lawrence	45800	46157	45800	46157
4243800	above Qnslr Bridge				Moisie				
529	0	457.9	252.5	761.5	Moisie	19000	17266	19000	17266
4244050	en amont de la Riviere Hamelin				Arnaud				
530	0	345.8	194.4	564.2	Arnaud	26900	31144	26900	31144
4244100	en aval de la Riviere Paladeau				Aux Feuilles				
531	0	623.4	290.2	1462.3	Aux Feuilles	41700	40871	41700	40871
4244150	pres de la Riviere Koksoak				Aux Melezes				
532	0	628.9	243.3	1156.3	Koksoak	42700	42729	42700	42729
4244180	Chute de la Pyrite				Caniapiscau				
533	0	1584.7	576.7	2882.9	Koksoak	86800	85199	86800	85199
4244200	pres de L'embouchure				A la Baleine				
534	0	535.3	203.2	1064.1	A la Baleine	29800	29037	29800	29037
4244250	Aux Chutes Helen				George				
535	0	746.4	411.8	1331.6	George	35200	37461	35200	37461
4244500	above Upper Muskrat Falls				Churchill River				
536	0	1861.3	893.8	2903.3	Churchill (Atlantic)	92500	99457	92500	99457
4244640	pres de L'embouchure				Natashquan				
537	0	348.5	195.7	661.2	Natashquan	16000	19137	16000	19137
4244660	en amont de la Riviere Netagamiou				du Petit Mecatina				
538	0	490.8	234.8	862.4	Petit Mecatina	19100	20753	19100	20753
4356100	el Capomal				Santiago				
539	0	290.7	107.0	730.4	Grande de Santiago	128943	189027	128943	189027
4358300	Las Adjuntas				Panuco				
540	0	481.0	166.7	1039.7	Panuco	58115	86315	58115	86315
4362600	Boca del Cerro				Usumacinta				
541	0	1646.4	163.1	3119.8	Usumacinta	50743	50458	50743	50458
5101200	Clare				Burdekin				
542	0	329.6	2.8	3017.7	Burdekin	129660	121214	129660	121214
5101301	The Gap				Fitzroy				
543	0	163.0	0.1	1649.8	Fitzroy East	135860	135648	135860	135648
5109170	Rockfields				Gilbert River				
544	0	43.7	0.4	402.6	Gilbert	11800	11682	11800	11682

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
5109200	Koolatah				Mitchell River				
545	0	385.2	17.4	1295.9	GHAASBasin387	46050	29210	46050	29210
5202044	Lilydale (Newbold Crossing)				Clarence River				
546	0	117.2	1.9	960.3	GHAASBasin674	16690	18932	16690	18932
5202101	Belmore Bridge (Maitland)				Hunter River				
547	0	31.6	0.6	188.3	GHAASBasin930	17476	13129	17476	13129
5204268	Lock 9 Upper				Murray				
548	0	256.9	22.2	1122.2	Murray	991000	972414	394700	972414
5224500	Temerloh				Pahang				
549	0	551.8	219.9	1418.8	Pahang	19000	21579	19000	21579
5302229	Jarramond				Snowy River				
550	0	51.6	3.5	353.0	GHAASBasin960	13421	12352	13421	12352
5410100	Callamurra				Cooper Creek				
551	0	61.0	0.0	791.8	Great Artesian Basin	230000	232556	230000	232556
5606100	Darradup				Blackwood River				
552	0	20.2	2.7	92.7	GHAASBasin632	20500	20622	20500	20622
5607100	Emu Springs				Murchison River				
553	0	5.1	0.0	64.3	Murchinson	82300	71730	82300	71730
5607200	Nune Mile Bridge				Gascoyne River				
554	0	21.8	0.0	312.1	Gasgoyne	73400	78453	73400	78453
5607400	Nanutarra				Ashburton River				
555	0	18.5	0.0	193.6	Ashburton	70200	76444	70200	76444
5607450	Jimbegnyinoo Pool				Fortescue River				
556	0	7.7	0.0	104.6	Fortesque	48900	57023	48900	57023
5608023	Dimond Gorge				Fitzroy River				
557	558	70.8	1.2	409.4	Fitzroy West	16800	20525	16800	20525
5608024	Fitzroy Crossing				Fitzroy				
558	0	188.2	0.0	1696.3	Fitzroy West	45300	50014	28500	29489
5608095	Old Ord Homestead				Ord				
559	0	51.9	0.0	272.1	Ord	19600	14704	19600	14704
5708110	Coolibah Homestead				Victoria River				
560	0	97.2	1.3	593.7	Victoria	44900	55926	44900	55926
5708126	Victoria Highway				West Baines River				
561	0	34.4	0.6	246.7	Victoria	10204	8880	10204	8880
5708145	Mount Nancar				Daly				
562	0	211.0	19.8	786.0	Daly	47000	38941	47000	38941
5709100	Red Rock				Roper River				
563	0	75.2	1.6	291.1	Roper	47400	71500	47400	71500
5709110	Mim Pump				Macarthur River				
564	0	23.9	0.1	140.9	GHAASBasin299	10400	11825	10400	11825
6112090	Regua				Douro				
565	0	544.0	111.8	1945.9	Douro	91491	90154	28331	23276
6122300	Paris				Seine				
566	0	268.2	62.3	799.6	Seine	44320	35052	44320	35052
6123100	Montjean				Loire				
567	0	838.1	170.8	2535.4	Loire	110000	109908	71760	69278
6123300	Blois				Loire				
568	567	364.0	78.4	1133.8	Loire	38240	40630	38240	40630
6125100	Mas-D'agenais				Garonne				
569	0	610.1	116.2	1717.5	Garonne	52000	53590	52000	53590
6139100	Beaucaire				Rhone				
570	0	1692.6	600.8	3866.2	Rhone	95590	99298	45390	46290
6139390	la Mulatiere				Rhone				
571	570	1046.5	352.7	2582.5	Rhone	50200	53008	39901	42319
6140400	Decin				Labe				
572	591	303.4	72.7	1143.7	Elbe	51104	45730	51104	45730
6142200	Bratislava				Danube				
573	598	2047.1	1005.2	4375.4	Danube	131338	131486	35293	36543
6211100	Orense				Mino				
574	0	232.0	48.5	780.8	Minho	12925	11405	12925	11405
6212400	Villachica				Duero				
575	576	142.9	27.2	494.8	Douro	41856	41582	41856	41582
6212420	Puente Pino				Duero				
576	565	279.4	64.0	929.8	Douro	63160	66878	21304	25296

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
6213600	Alcantara				Tajo				
577	0	235.7	18.7	1178.8	Tejo	51958	54333	51958	54333
6217100	Alcala del Rio				Guadalquivir				
578	0	316.3	2.3	2026.7	Guadalquivir	46995	51245	2124	9793
6217110	Cantillana				Guadalquivir				
579	578	117.2	4.8	593.2	Guadalquivir	44871	41451	44871	41451
6226400	Zaragoza				Ebro				
580	581	615.9	82.8	2160.6	Ebro	40434	38952	40434	38952
6226800	Tortosa				Ebro				
581	0	483.2	76.7	1523.8	Ebro	84230	82841	43796	43889
6229500	Vaenersborg				Vaenern-Goeta				
582	0	534.1	196.3	888.0	Gota	46830	44945	46830	44945
6233650	Solleftea				Angerman				
583	0	489.4	276.5	816.5	Ångerman	30640	30790	30640	30790
6233750	Boden Waterworks				Lule				
584	0	488.7	277.2	775.1	Lulealven	24490	26522	24490	26522
6242400	Stein-Krems				Danube				
585	573	1865.6	971.5	3545.0	Danube	96045	94943	19448	18586
6335020	Rees				Rhein				
586	0	2278.4	922.6	4998.2	Rhine	159680	159424	28851	33059
6335100	Kaub				Rhein				
587	586	1608.3	616.6	3636.9	Rhine	103729	97892	43800	38234
6335600	Rockenau				Neckar				
588	587	133.5	37.5	390.6	Rhine	24000	23968	24000	23968
6336050	Cochem				Mosel				
589	586	314.6	70.1	952.3	Rhine	27100	28473	27100	28473
6337200	Intschede				Weser				
590	0	316.6	102.2	842.8	Weser	37788	34424	37788	34424
6340110	Neu-Darchau				Labe				
591	0	783.8	328.8	1606.7	Elbe	131950	131927	80846	86197
6342500	Ingolstadt				Danube				
592	593	313.7	115.9	659.2	Danube	20001	20583	20001	20583
6342800	Hofkirchen				Danube(Donau)				
593	594	634.3	266.6	1444.2	Danube	47496	45081	27495	24498
6342900	Achleiten				Danube				
594	585	1419.4	642.6	2966.7	Danube	76597	76357	29101	31275
6348400	Piacenza				Po				
595	596	981.6	338.4	2700.0	Po	42030	47838	42030	47838
6348800	Pontelagoscuro				Po				
596	0	1514.6	505.8	3745.0	Po	70091	78362	28061	30524
6421500	Borgharen				Maas				
597	0	246.1	34.2	714.4	Meuse	21300	27899	21300	27899
6442500	Nagymaros				Danube(Duna)				
598	599	2346.0	1093.6	4929.4	Danube	183533	182903	52195	51417
6442600	Mohacs				Danube				
599	619	2401.3	1096.2	4588.8	Danube	209064	206123	25531	23220
6444100	Szeged				Tisza				
600	619	829.3	200.2	2446.7	Danube	138408	142313	33146	42144
6444110	Mako				Maros				
601	600	168.8	0.9	508.1	Danube	30149	29946	30149	29946
6444200	Szolnok				Tisza				
602	600	595.9	180.4	1376.6	Danube	75113	70223	59830	55834
6444600	Csenger				Szamos				
603	602	124.2	28.8	410.6	Danube	15283	14389	15283	14389
6457010	Gozdowice				Odra				
604	0	546.6	201.6	2853.2	Odra	109729	110663	56347	52021
6457100	Slubice				Odra				
605	604	351.8	116.0	2319.1	Odra	53382	58642	53382	58642
6458010	Tczew				Wisla				
606	0	1041.7	345.6	2954.7	Wisla	194376	180583	48538	46752
6458450	Szczucin				Wisla				
607	608	248.1	21.6	2225.8	Wisla	23901	27797	23901	27797
6458500	Warszawa				Wisla				
608	606	561.2	168.3	1515.0	Wisla	84857	72881	44253	31124

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
6458550	Wyszkow				Bug				
609	606	145.8	35.2	555.0	Wisla	39119	40627	39119	40627
6458600	Radomysl				San				
610	608	132.7	30.9	453.1	Wisla	16703	13960	16703	13960
6458810	Ostroleka				Narew				
611	606	110.9	42.6	309.8	Wisla	21862	20323	21862	20323
6545800	Sremska Mitrovica				Sava				
612	619	1609.1	524.9	3655.0	Danube	87966	85461	87966	85461
6546610	Gornja Radgona				Mura				
613	619	155.6	78.5	315.2	Danube	10197	10512	10197	10512
6547500	Lubicevsky Most				Velika Morava				
614	619	240.3	55.4	663.5	Danube	34345	31465	34345	31465
6691650	Misis				Ceyhan				
615	0	222.4	85.6	454.4	Seyhan	20466	24391	20466	24391
6695200	Keban				Firat(Euphrates)				
616	0	663.3	295.4	1341.2	Shatt el Arab	63835	64684	63835	64684
6730500	Polmak				Tana				
617	0	165.7	59.5	408.9	GHAASBasin895	14005	14035	14005	14035
6731400	Langnes				Gloma				
618	0	672.1	274.8	1494.4	Glama	40221	42784	40221	42784
6742200	Orsova (1971:drobata-Turnu Severin)				Danube				
619	623	5456.5	2424.2	10986.7	Danube	576232	570835	96252	94961
6742450	Stoenesti				Olt				
620	623	161.3	58.8	365.4	Danube	22683	19470	22683	19470
6742700	Lungoci				Siret				
621	622	171.6	58.3	529.1	Danube	36036	37530	36036	37530
6742900	Ceatal Izmail				Danube				
622	0	6488.3	2845.6	11631.6	Danube	807000	788002	120624	99899
6842700	Svistov				Danube				
623	622	6152.2	2709.2	10640.0	Danube	650340	650574	51425	60268
6854100	Kalsinkosi				Kokemjenjoki				
624	0	219.9	58.7	556.0	Kokemaenjoki	26025	26312	26025	26312
6854500	near The mouth				Oulujoki				
625	0	255.0	100.0	454.1	Oulujoki	22900	21244	22900	21244
6854600	near The mouth				Siurnanjoki				
626	0	171.0	55.2	398.7	Oulujoki	14315	25491	14315	25491
6854700	near The mouth				Kenijoki				
627	0	562.1	240.5	1264.2	Kemijoki	50900	50179	50900	50179
6855200	Anjala				Kymijoki				
628	0	280.3	81.4	598.1	Kymijoki	36305	35932	36305	35932
6855400	Tainionkoski				Vuoksi				
629	644	592.7	243.0	1079.9	Neva	61061	60690	61061	60690
6865500	Harmanli				Maritza				
630	0	113.3	20.2	272.0	Evros	19693	18360	19693	18360
6935050	Basel(St.Alban)				Rhein				
631	587	1106.1	619.5	1749.8	Rhine	35929	35691	18304	16826
6935300	Untersiggenthal				Aare				
632	631	558.1	296.2	977.2	Rhine	17625	18865	17625	18865
6939050	Chancy				Rhone				
633	571	341.6	177.5	536.8	Rhone	10299	10688	10299	10688
6970100	Porog				Onega				
634	0	513.1	235.5	1026.6	Onega	55770	56600	55770	56600
6970250	Ust-Pinega				Severnaya Dvina				
635	0	3331.5	1178.8	7920.8	Dvina	348000	357844	271600	289297
6970270	Filaievskaya				Vaga				
636	635	110.8	31.4	295.7	Dvina	13200	13523	13200	13523
6970400	Kulogory				Pinega				
637	635	367.8	217.2	722.9	Dvina	36700	30246	36700	30246
6970500	Malonisogorskaya				Mezen				
638	0	649.3	279.3	1365.2	Mezen	56400	56522	56400	56522
6970650	Ust-Tsilma				Pechora				
639	641	3404.8	1197.5	6981.2	Pechora	248000	233553	193300	184523
6970680	Malaya Kushba				Vytchegda				
640	635	258.1	110.2	572.2	Dvina	26500	24778	26500	24778

GRDC Code	Station Name				RiverName	Area [km^2]		Inter-Stn Area [km^2]	
	Next	Discharge [m^3/s]							
ID	Station	Mean	Min	Max	STN Basin Name	GRDC	STN-30p	GRDC	STN-30p
6970710	Oksino				Pechora				
641	0	4515.1	2367.0	7272.1	Pechora	312000	301599	64000	68045
6970850	Adzva				Usa				
642	639	993.2	356.7	2029.0	Pechora	54700	49031	54700	49031
6972350	Narva (Hep)				Narva				
643	0	379.2	187.2	754.9	Narva	56000	58230	56000	58230
6972430	Novosaratovka				Neva				
644	0	2504.1	1290.5	3764.2	Neva	281000	279904	219939	219214
6972800	Yushkozero				Kem				
645	0	198.5	105.8	347.8	Kem	19800	22391	19800	22391
6972810	Putkinskaya Ges				Kem				
646	0	297.5	166.0	494.0	GHAASBasin509	27700	26001	27700	26001
6973300	Daugavpils				Western Dvina (Daugava)				
647	0	390.8	191.4	850.8	Daugava	64500	62897	64500	62897
6974150	Smalininkai				Neman				
648	0	538.3	222.6	1536.8	Nemanus	81200	79440	81200	79440
6975080	Staritsa				Volga				
649	654	153.7	38.4	494.3	Volga	21100	22347	21100	22347
6975140	Kaluga				Oka				
650	654	292.1	73.7	972.5	Volga	54900	51003	54900	51003
6975500	Makariev				Unzha				
651	654	168.7	41.1	462.8	Volga	18500	17640	18500	17640
6976200	Kirov				Viatka				
652	654	373.6	105.9	829.5	Volga	48300	52825	48300	52825
6976450	Ufa				Belaya				
653	654	338.7	9.5	1449.1	Volga	100000	108083	100000	108083
6977100	Volgograd Power Plant				Volga				
654	0	8087.1	3146.7	16125.0	Volga	1360000	1348501	1117200	1096604
6978250	Razdorskaya				Don				
655	0	790.3	185.4	2657.7	Don	378000	391664	344300	364451
6978500	Archedinskaia				Medveditsa				
656	655	51.8	15.5	134.8	Don	33700	27213	33700	27213
6979500	Mozyr				Pripiat				
657	660	454.9	161.7	1209.2	Dnepr	101000	116685	101000	116685
6979600	Chernigov				Desna				
658	660	321.1	87.3	1086.4	Dnepr	81400	84721	81400	84721
6980300	Aleksandrovka				Southern Bug				
659	0	110.3	40.1	284.2	Bug	46200	46326	46200	46326
6980800	Dniepr Power Plant				Dniepr				
660	0	1483.7	479.5	3211.7	Dnepr	463000	463075	280600	261670
6981800	Bendery				Dniestr				
661	0	376.6	143.8	823.9	Dnestr	66100	67739	66100	67739
6983350	Tikhovsky				Kuban				
662	0	317.2	141.6	638.7	Kuban	48100	50794	48100	50794
6990700	Surra				Kura				
663	0	550.9	204.7	1173.3	Kura	178000	211793	178000	211793

E Appendix: Runoff Field Data Structures

Three sets of annual and monthly climatological (1+12 layers per set) runoff fields are included on the accompanying CD-ROM. The sets are observed, WBM-simulated, and composite monthly runoff fields in the `./arc/w_runoff` ARC/INFO workspace and `./ascii/runoff` directory. The grid coverage names are `g_obs_ro01`, `g_obs_ro02`, ..., `g_obs_ro12` and `g_obs_ro`, where the numbered coverages are the monthly values and `g_obs_ro` contains the annual sum of the observed runoffs. The WBM simulated and the composite fields are organized similarly in `g_wbm_ro##` and `g_cmp_ro##` coverages.

The same grid coverages are given as ARC/INFO ASCII grids as well in the `./ascii/runoff` directory using the same naming convention (`obs_ro##.grd`, `wmb_ro##.grd` and `cmp_ro##.grd`). The format of ARC/INFO grid is the same as describe in Appendix A.

```
ncols 720
nrows 300
xllcorner -180
yllcorner -60
cellsize 0.5
NODATA_value -9999
-9999 -9999 -9999-9999 -9999 -9999 -9999 -9999 -9999 ...
```

...

where

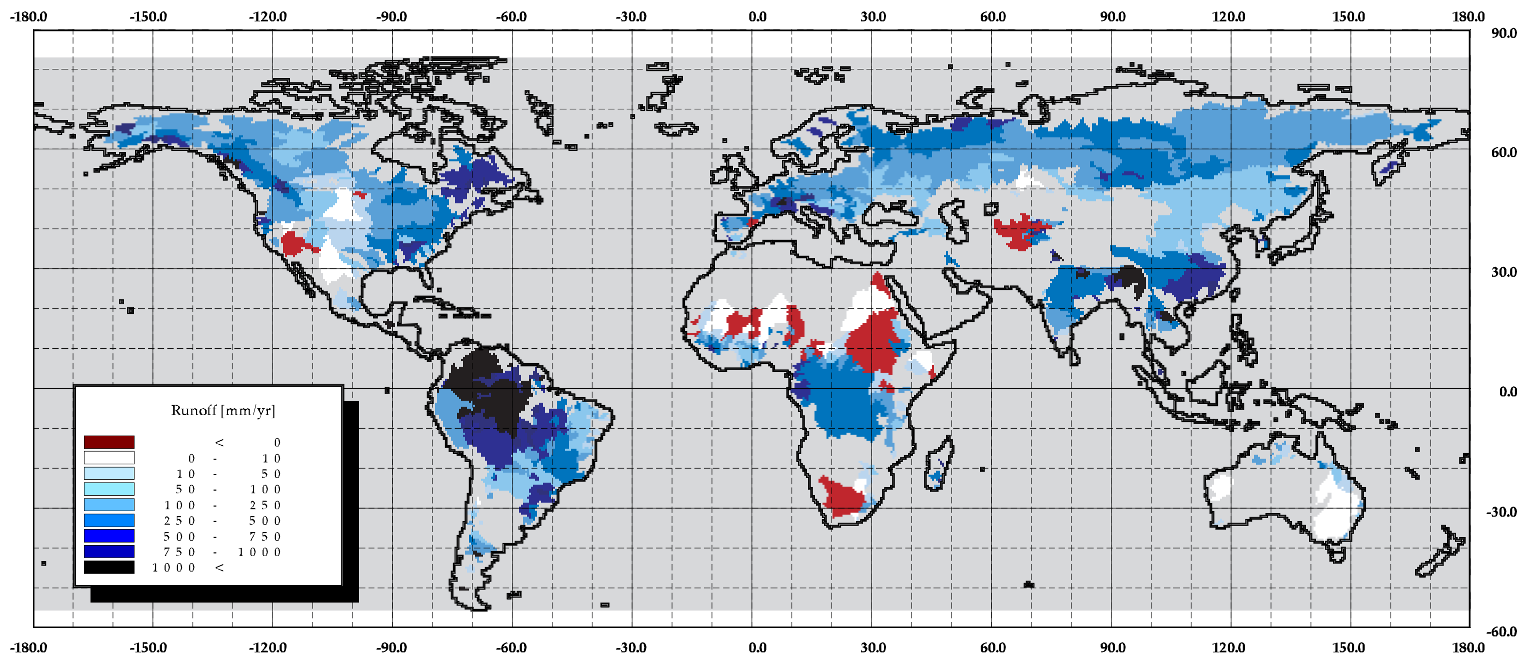
ncols	-	number of columns
nrows	-	number of rows
xllcorner	-	horizontal coordinate of the lower left corner
yllcorner	-	vertical coordinate of the lower left corner
cellsize	-	cell size
NODATA	-	missing data value

The monthly runoff values are given in mm/mo at 30-minute ($0.5 degree$) spatial resolution. The annual values are given in mm/yr.

F Appendix: Observed Annual and Monthly Runoff Fields

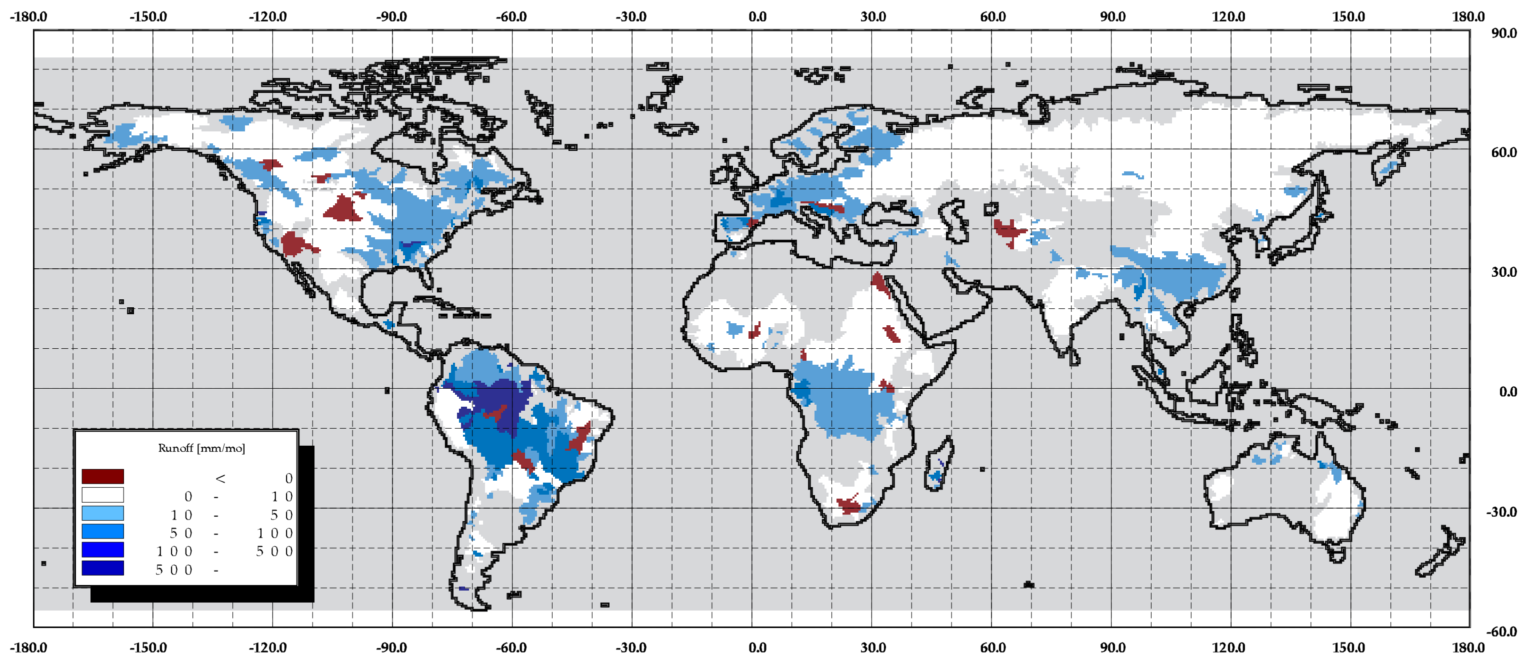
GRDC Observed Mean Annual Runoff

30-minute spatial resolution



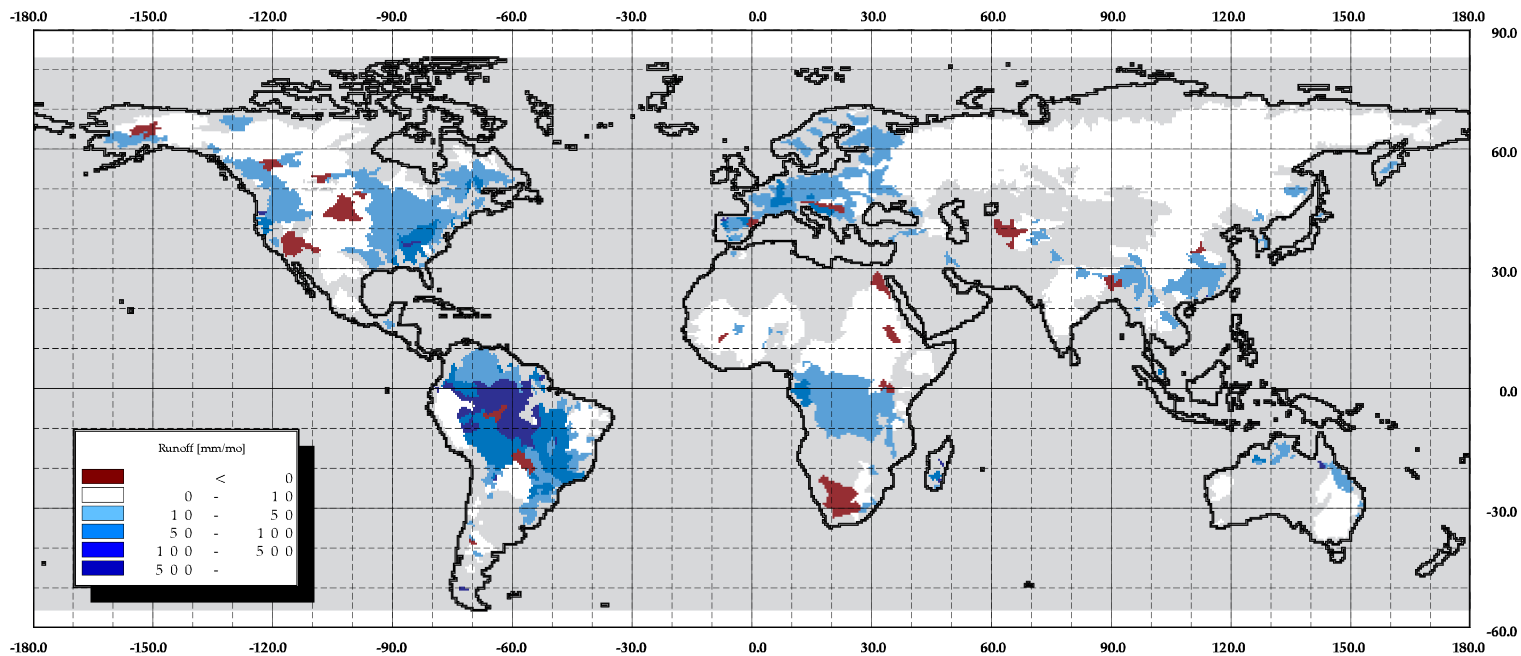
GRDC-Observed January Runoff

30-minute spatial resolution



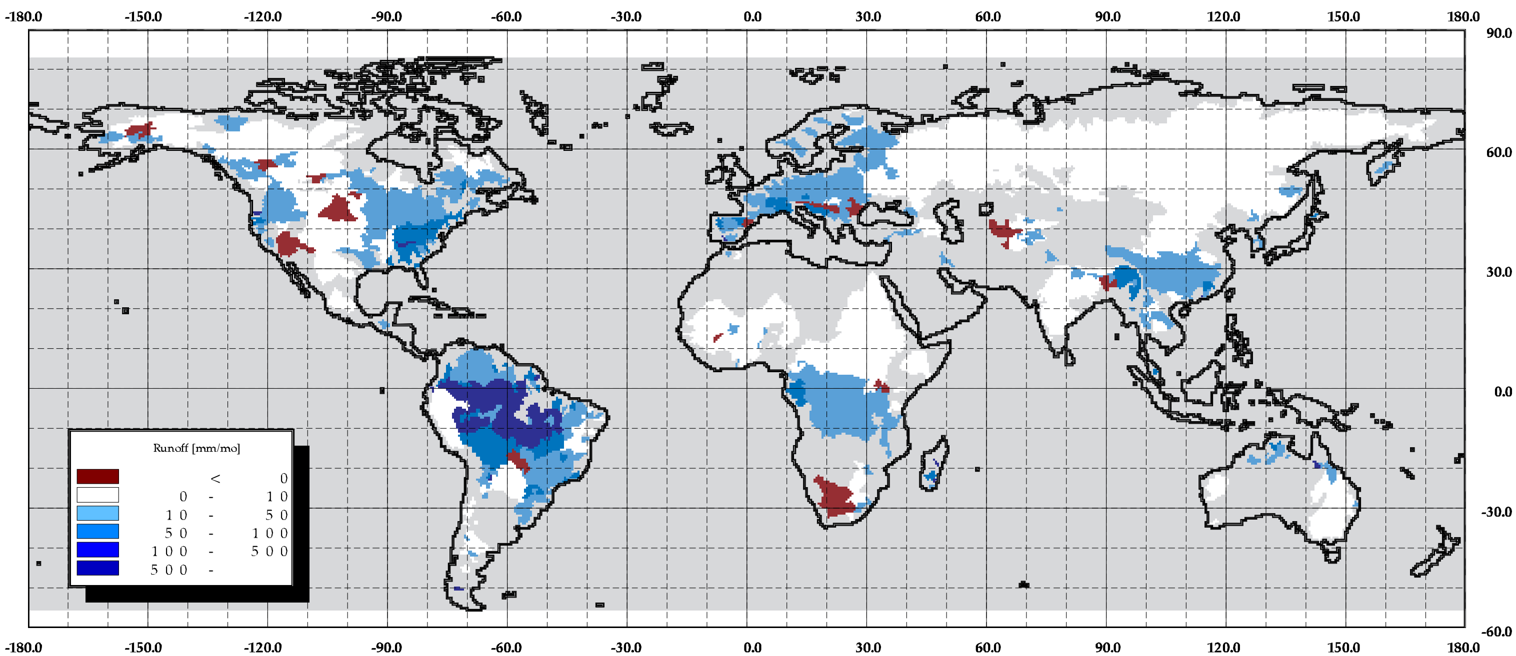
GRDC-Observed February Runoff

30-minute spatial resolution



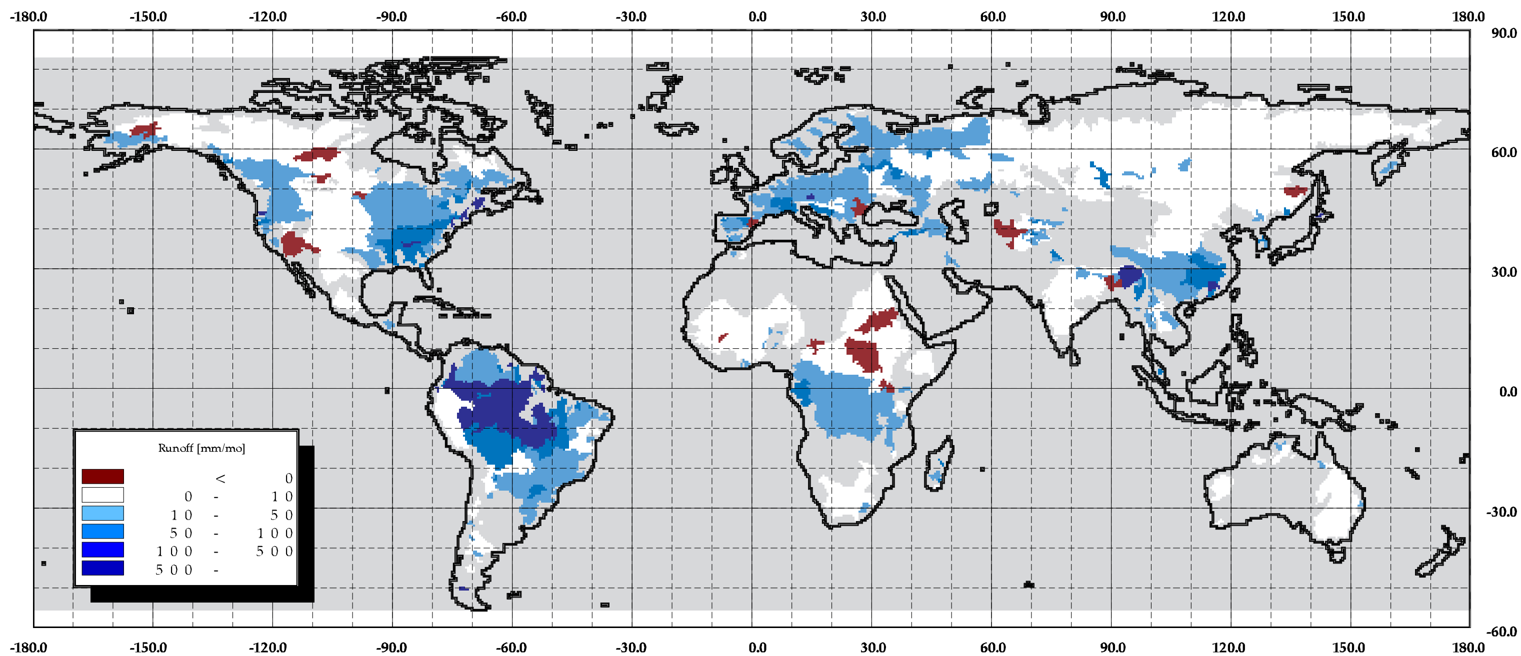
GRDC-Observed March Runoff

30-minute spatial resolution



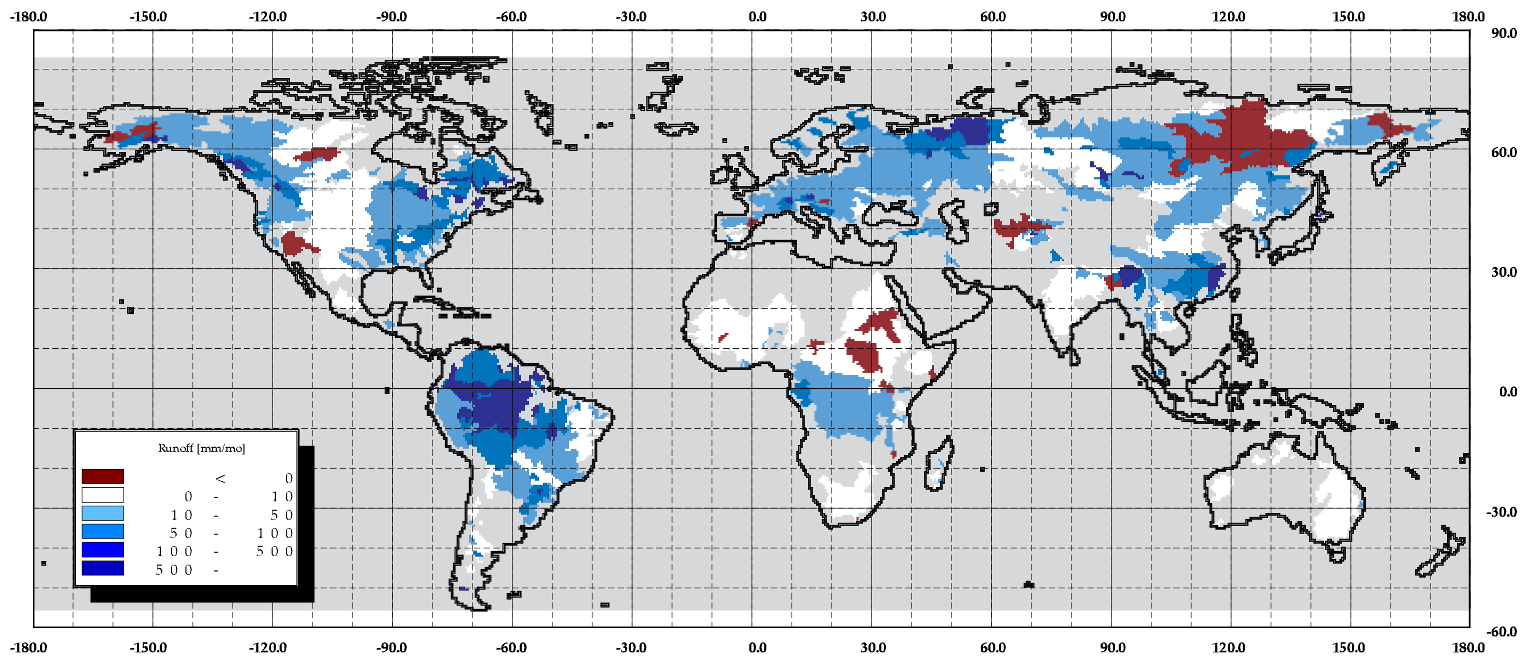
GRDC-Observed April Runoff

30-minute spatial resolution



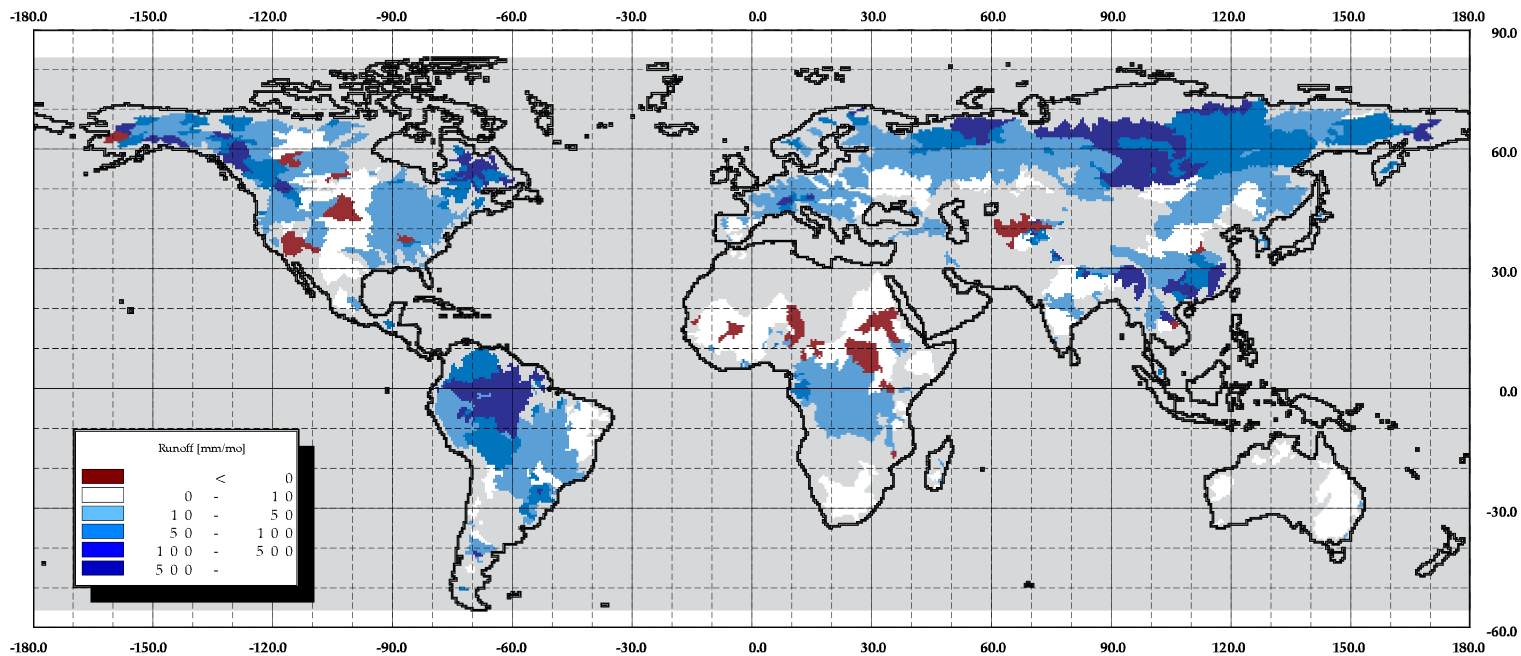
GRDC-Observed May Runoff

30-minute spatial resolution



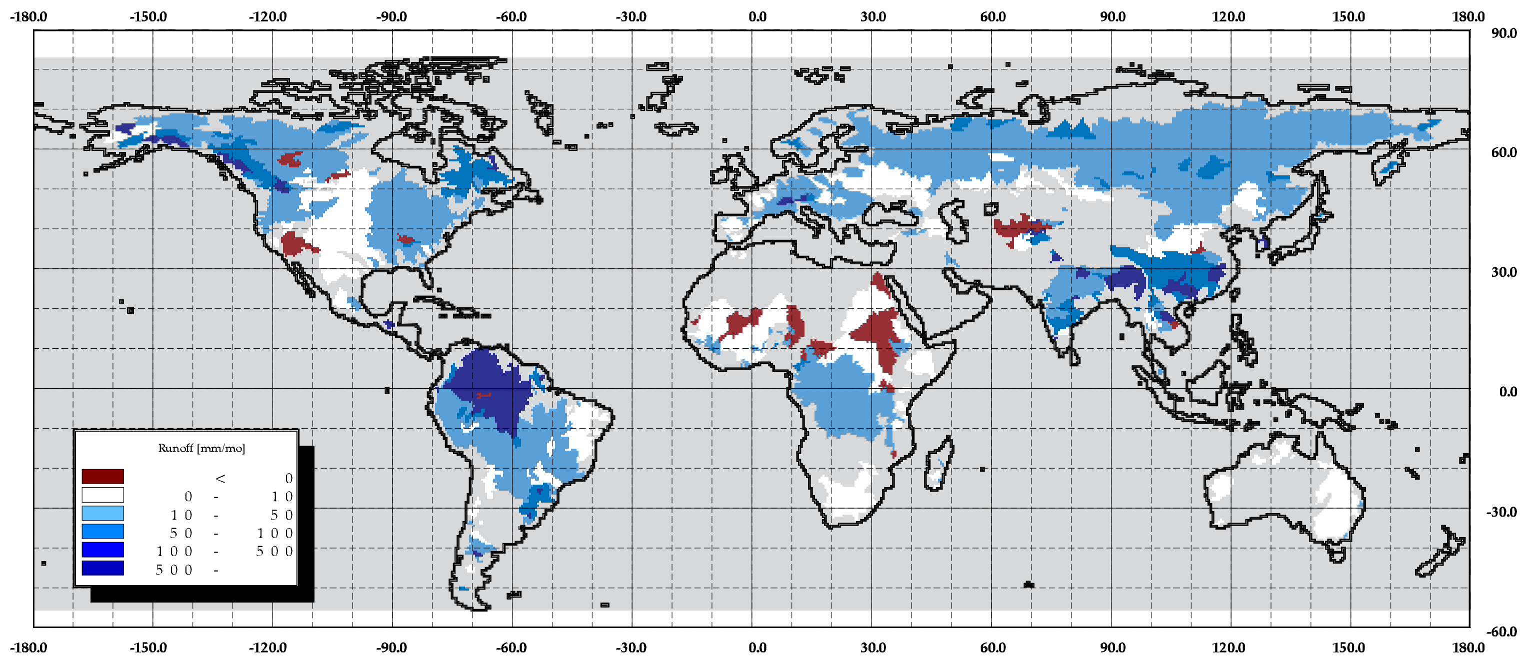
GRDC-Observed June Runoff

30-minute spatial resolution



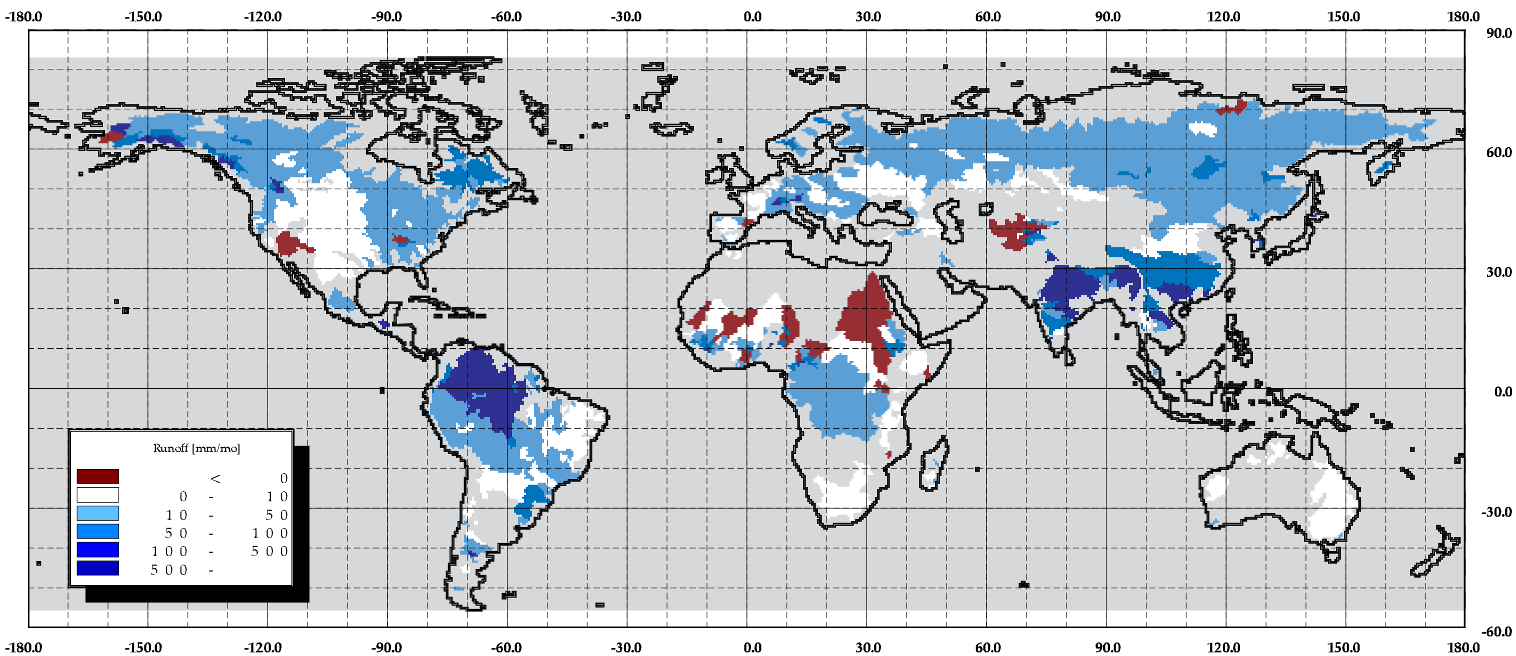
GRDC-Observed July Runoff

30-minute spatial resolution



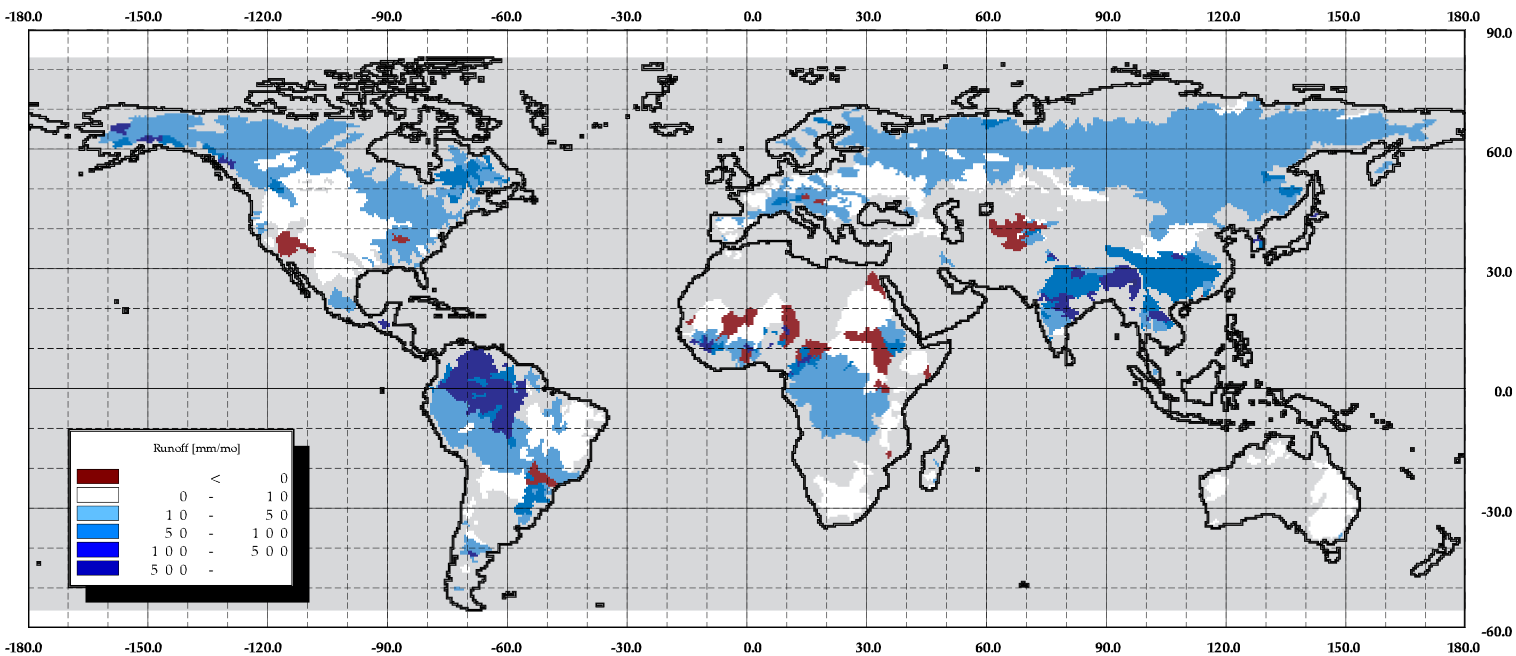
GRDC-Observed August Runoff

30-minute spatial resolution



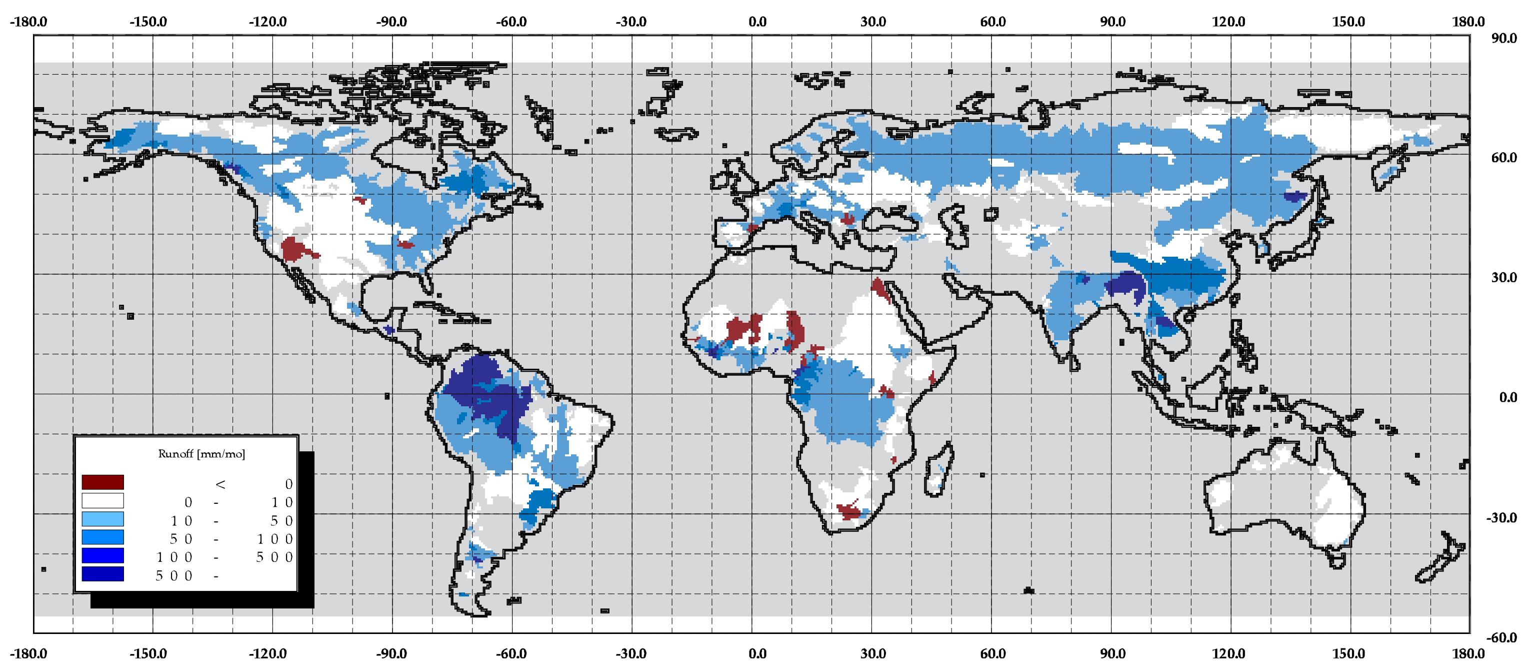
GRDC-Observed September Runoff

30-minute spatial resolution



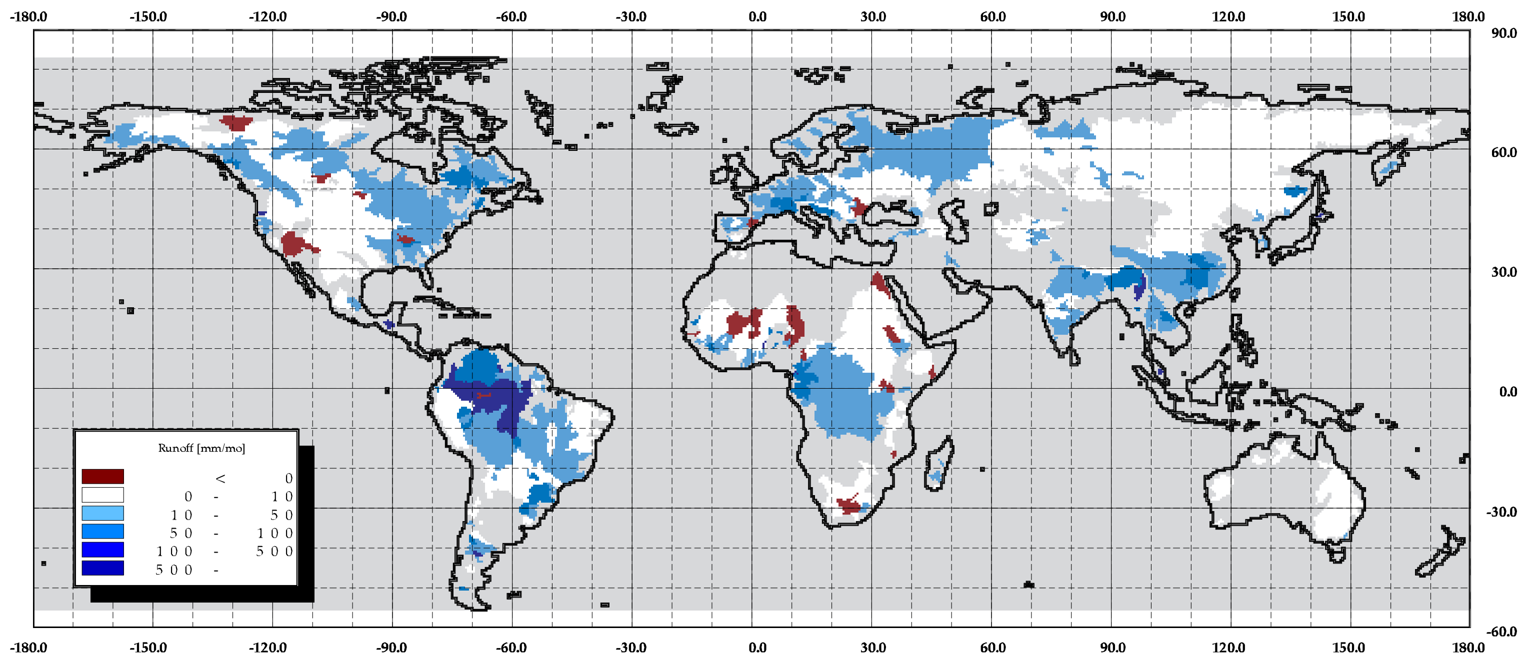
GRDC-Observed October Runoff

30-minute spatial resolution



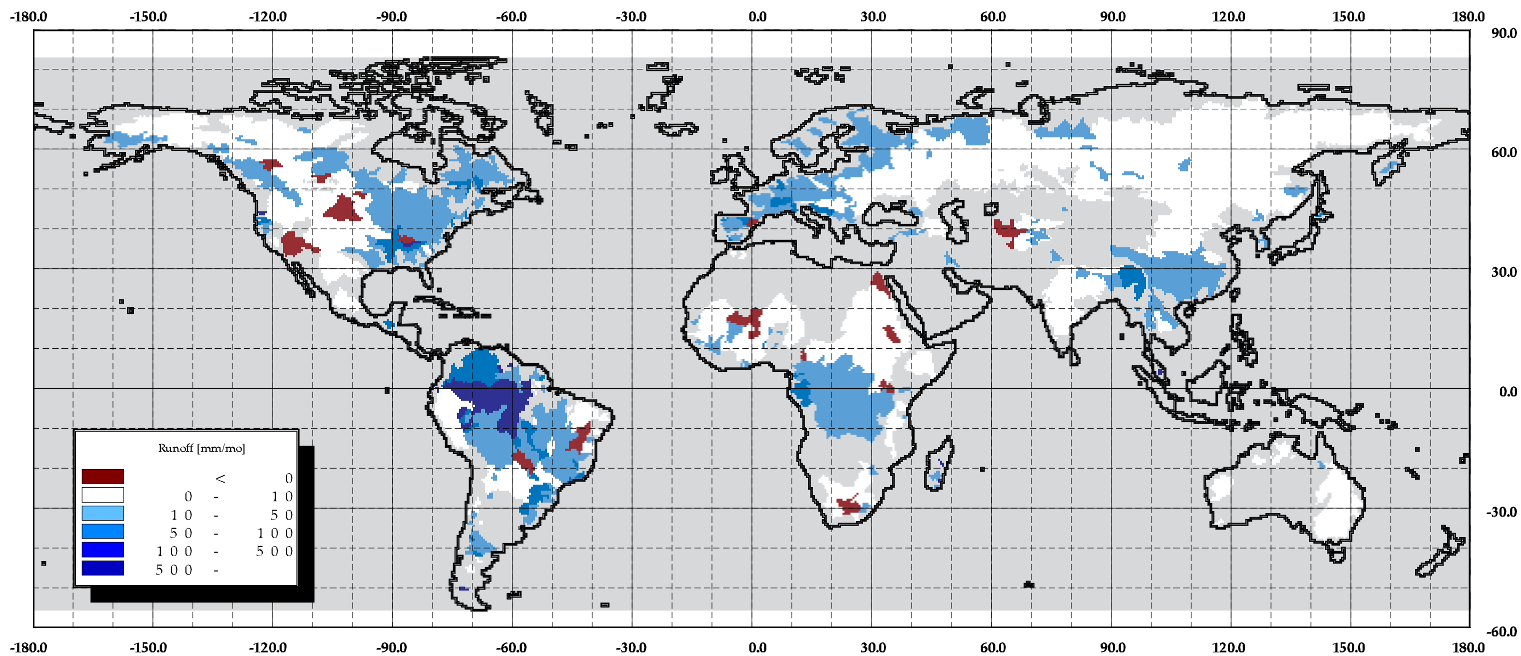
GRDC-Observed November Runoff

30-minute spatial resolution



GRDC-Observed December Runoff

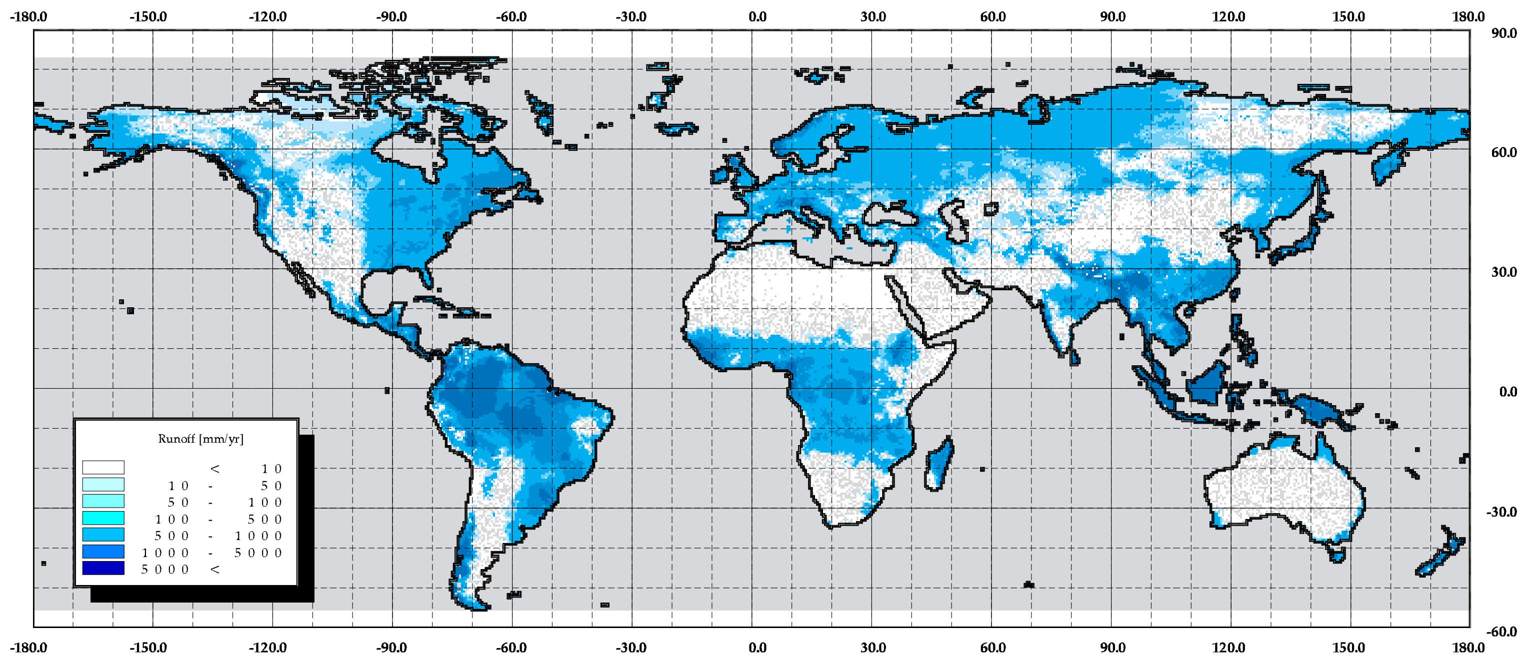
30-minute spatial resolution



G Appendix: WBM Simulated Annual and Monthly Runoff Fields

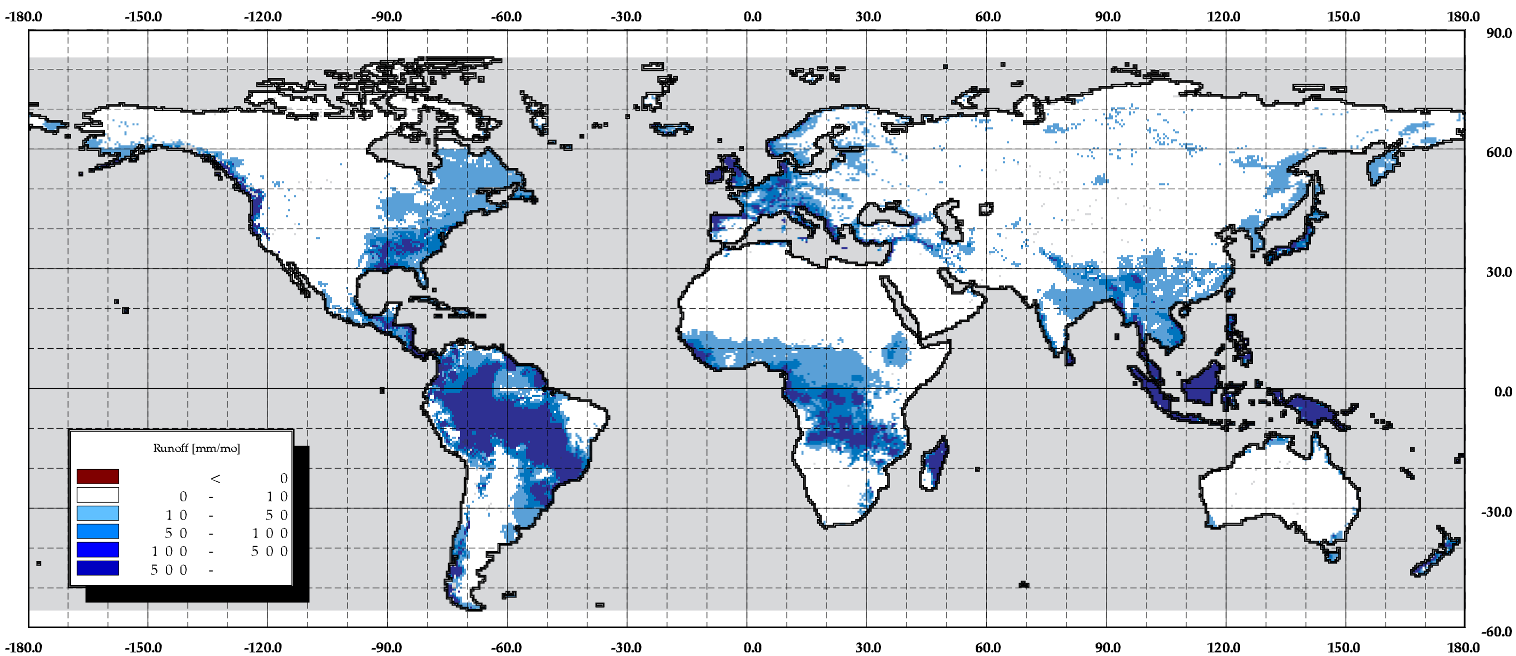
WBM-Simulated Mean Annual Runoff

30-minute spatial resolution



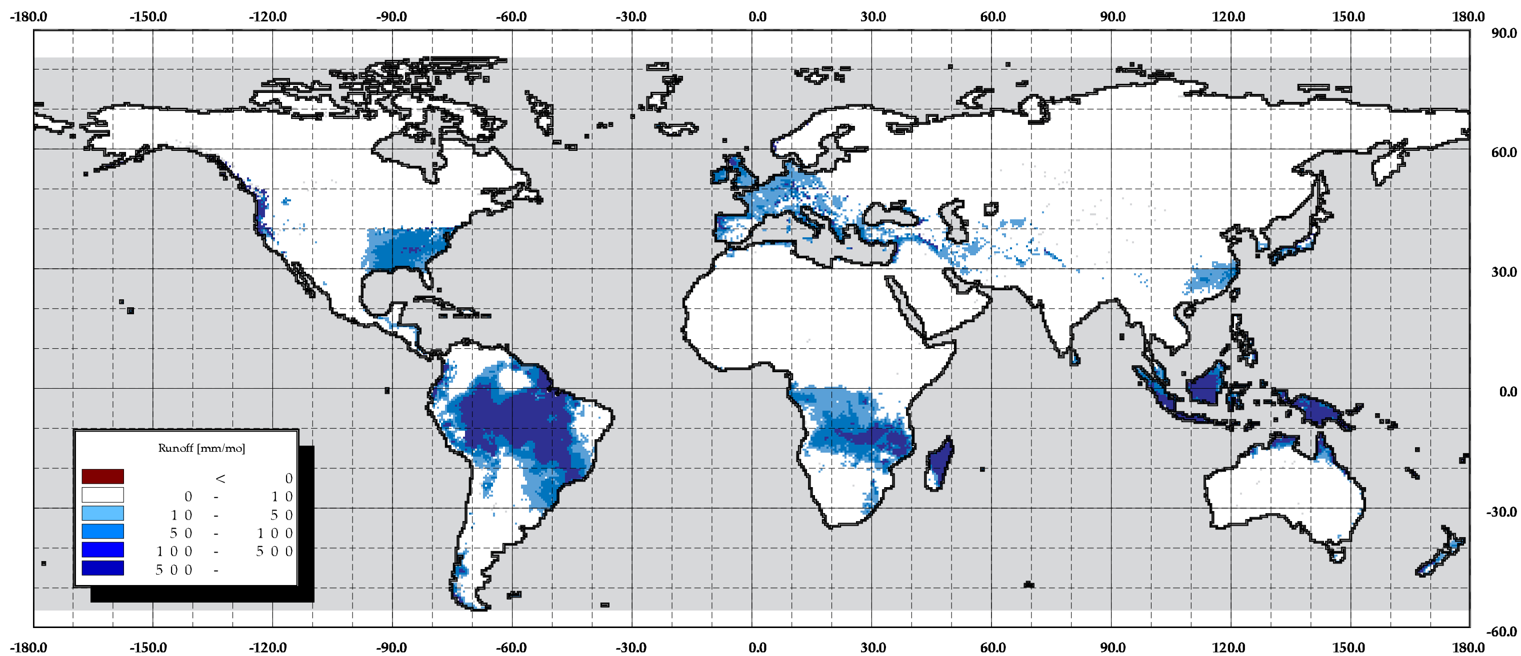
WBM-Simulated January Runoff

30-minute spatial resolution



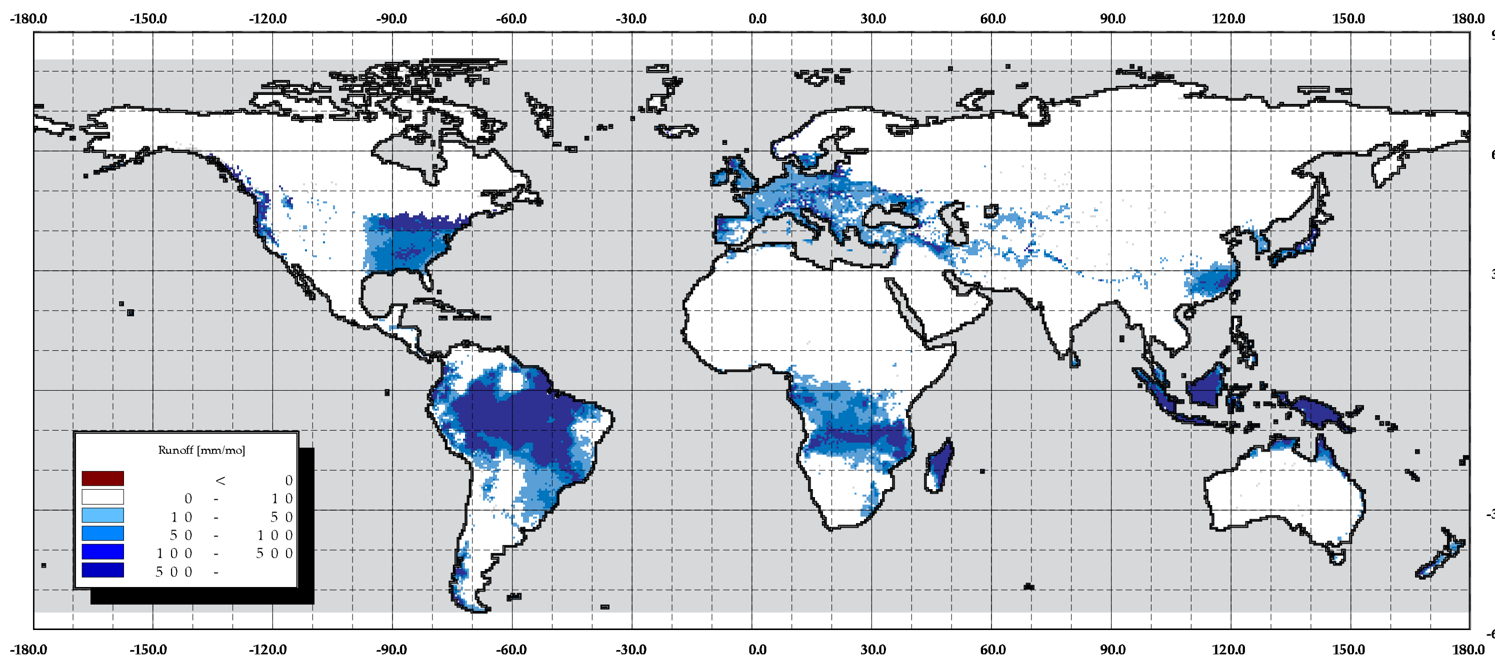
WBM-Simulated February Runoff

30-minute spatial resolution



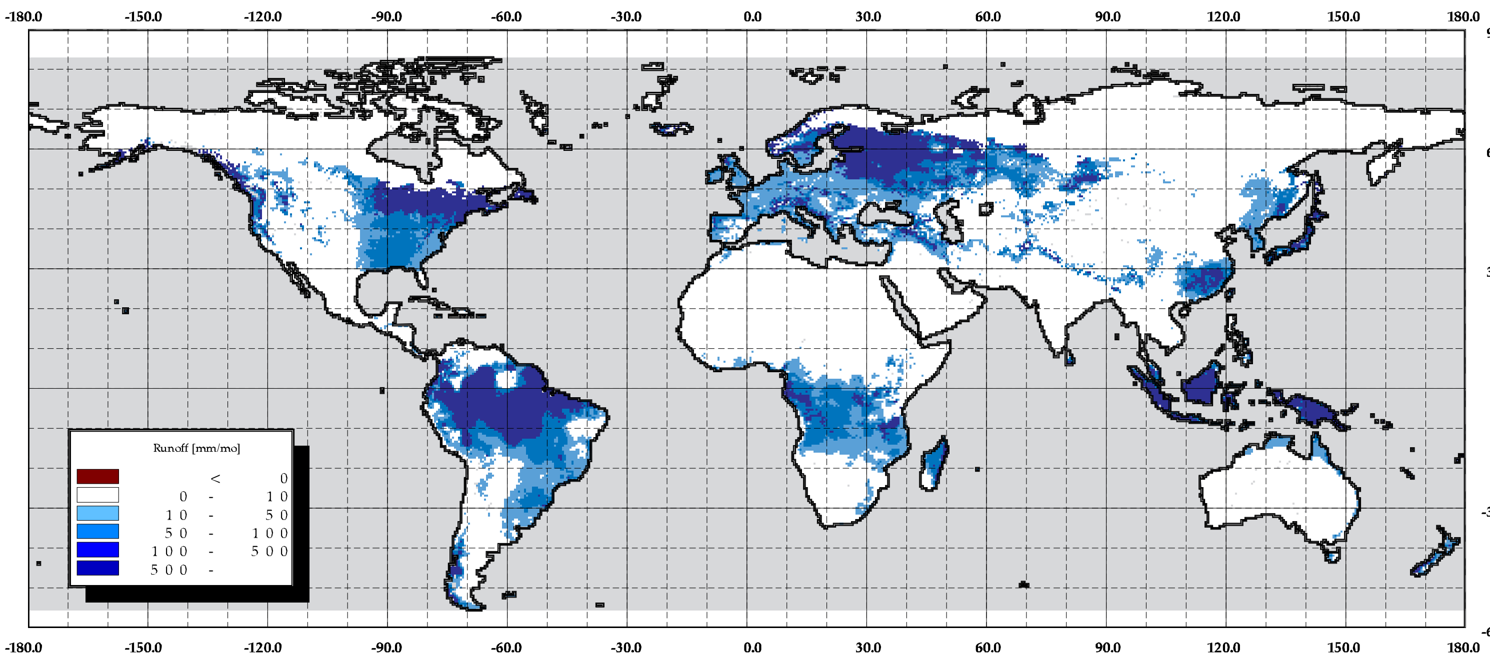
WBM-Simulated March Runoff

30-minute spatial resolution



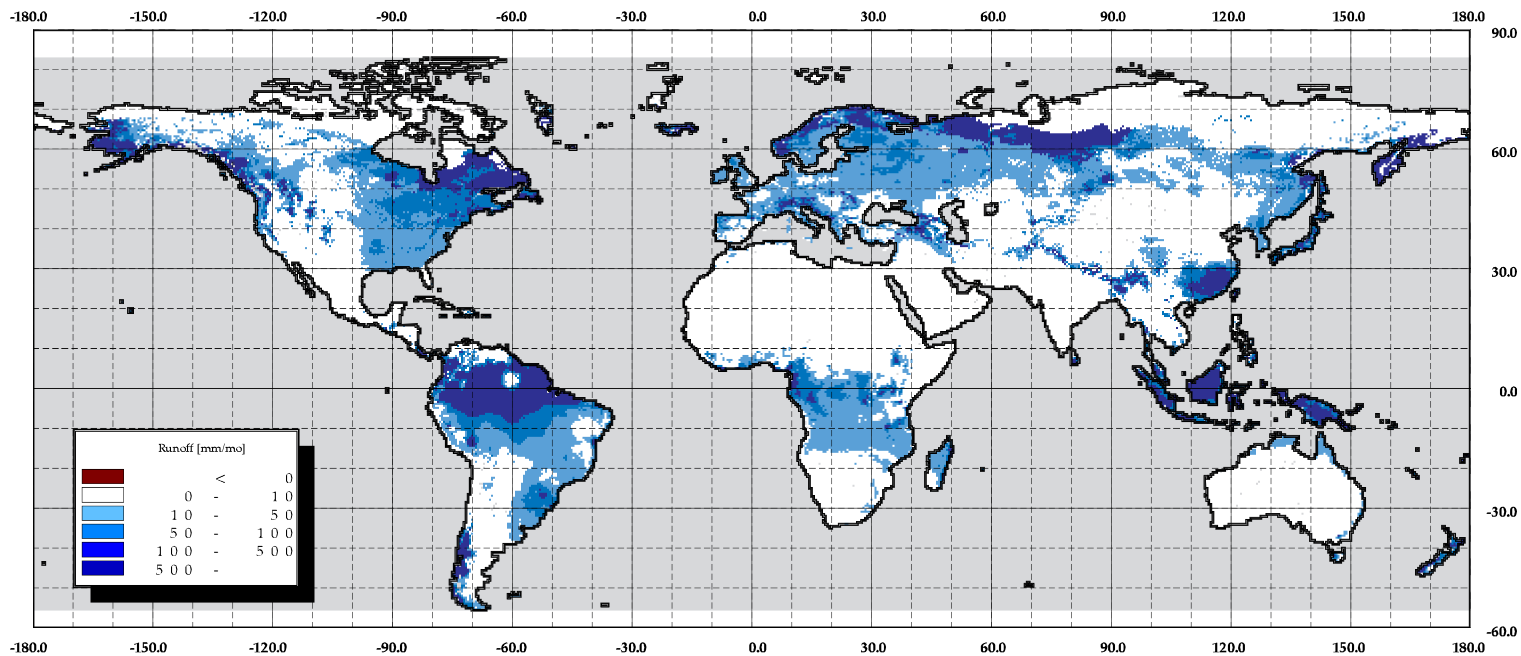
WBM-Simulated April Runoff

30-minute spatial resolution



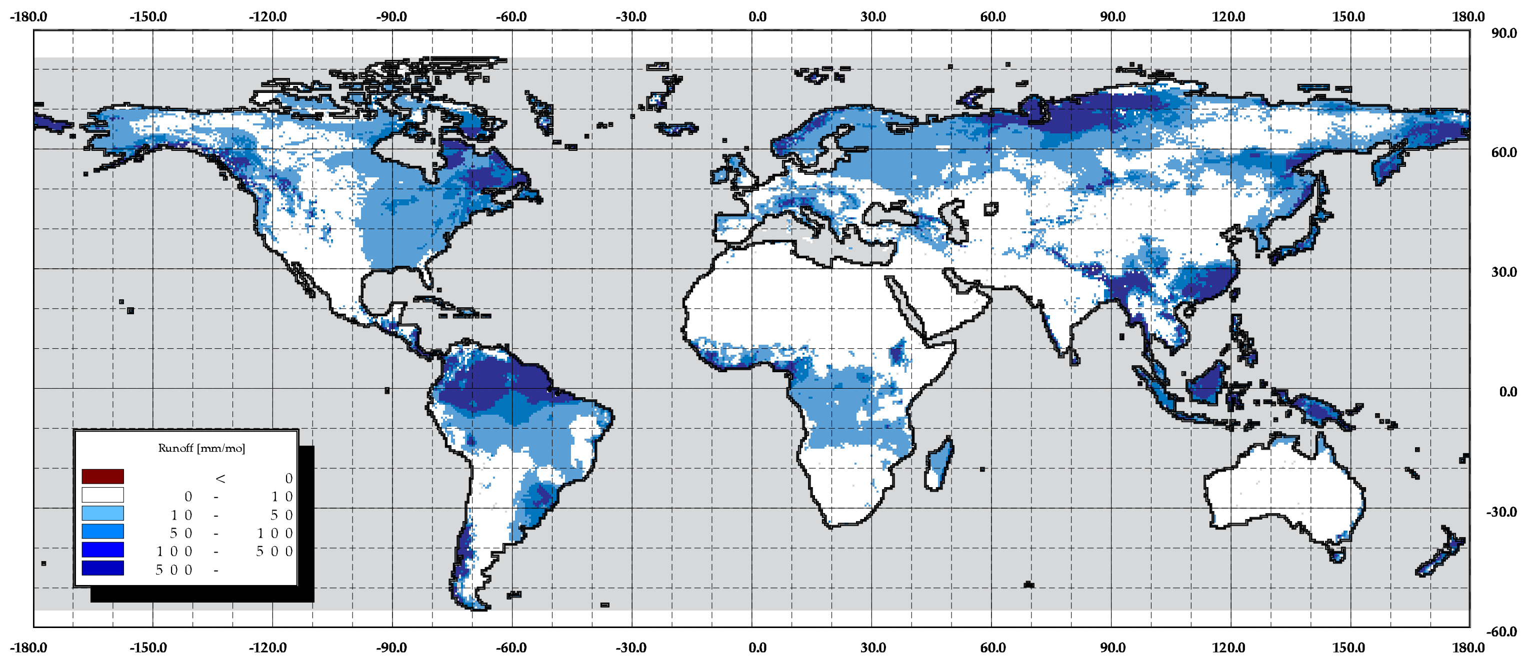
WBM-Simulated May Runoff

30-minute spatial resolution



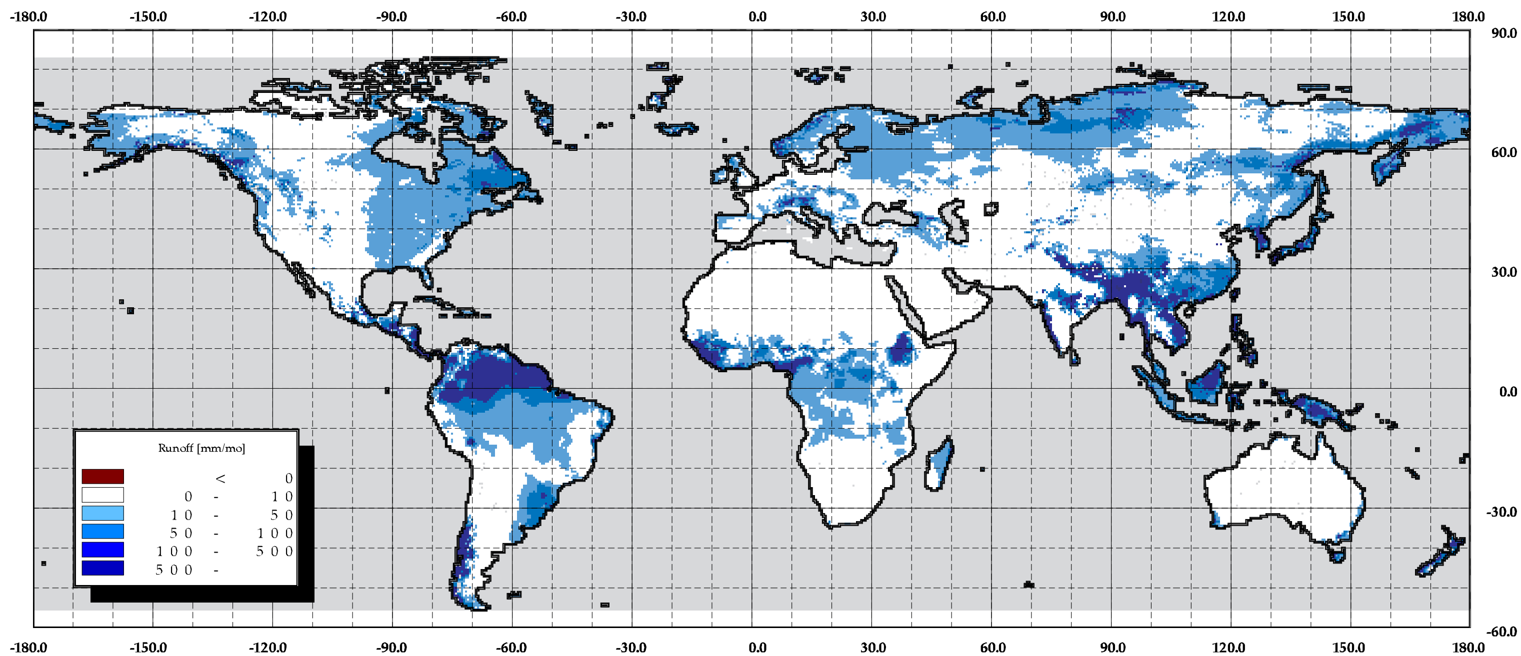
WBM-Simulated June Runoff

30-minute spatial resolution



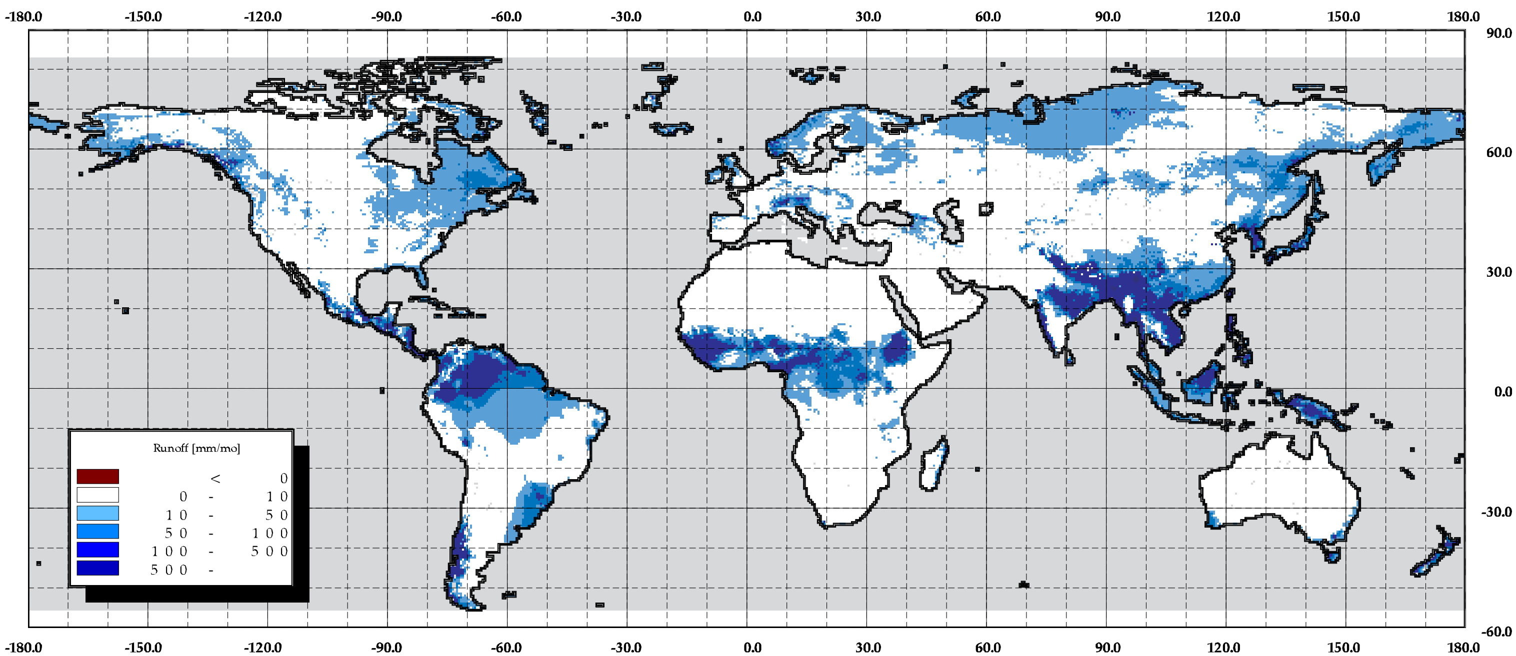
WBM-Simulated July Runoff

30-minute spatial resolution



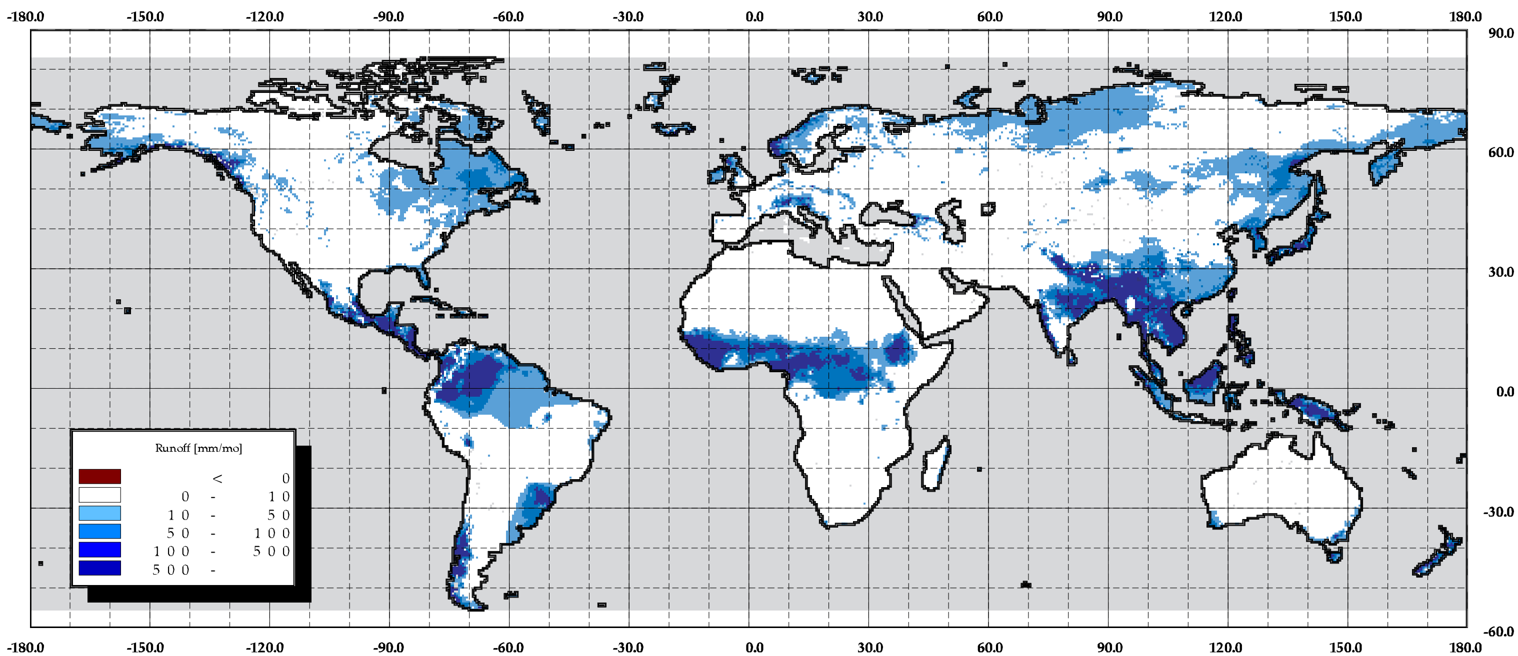
WBM-Simulated August Runoff

30-minute spatial resolution



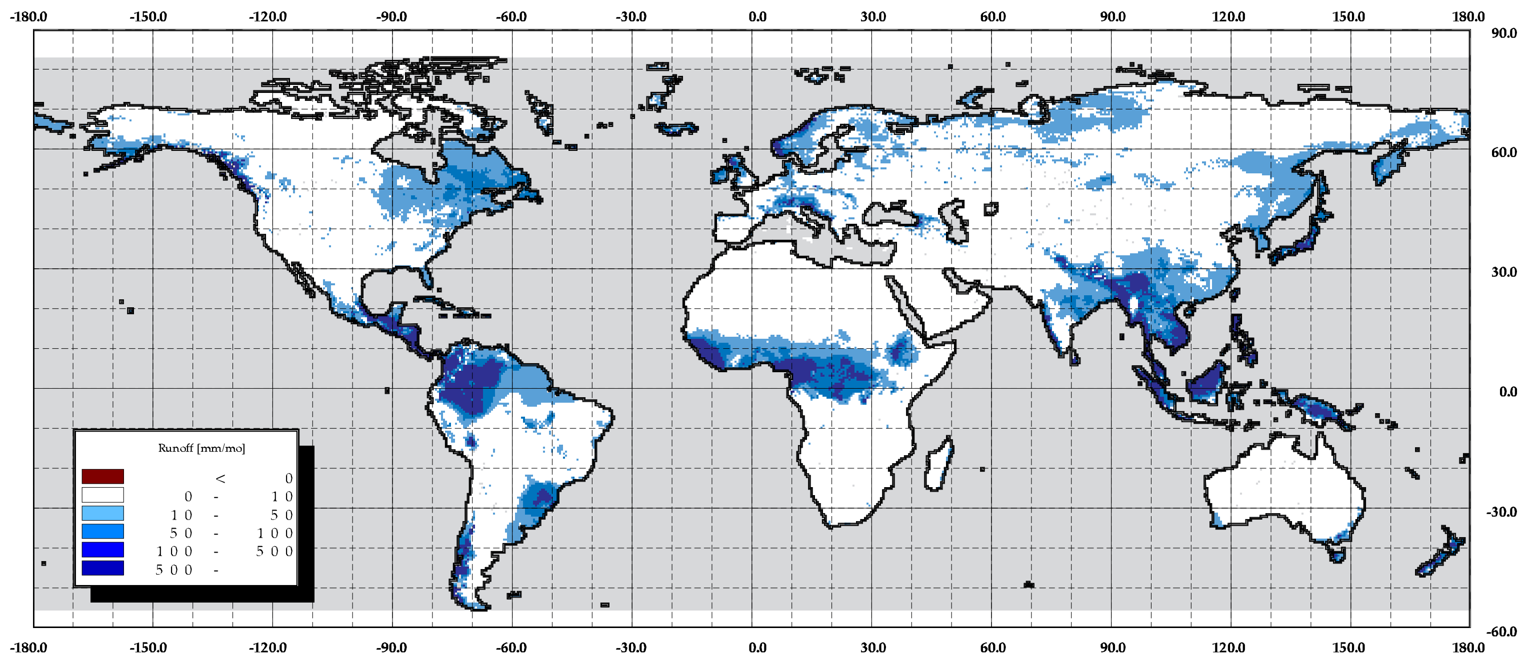
WBM-Simulated September Runoff

30-minute spatial resolution



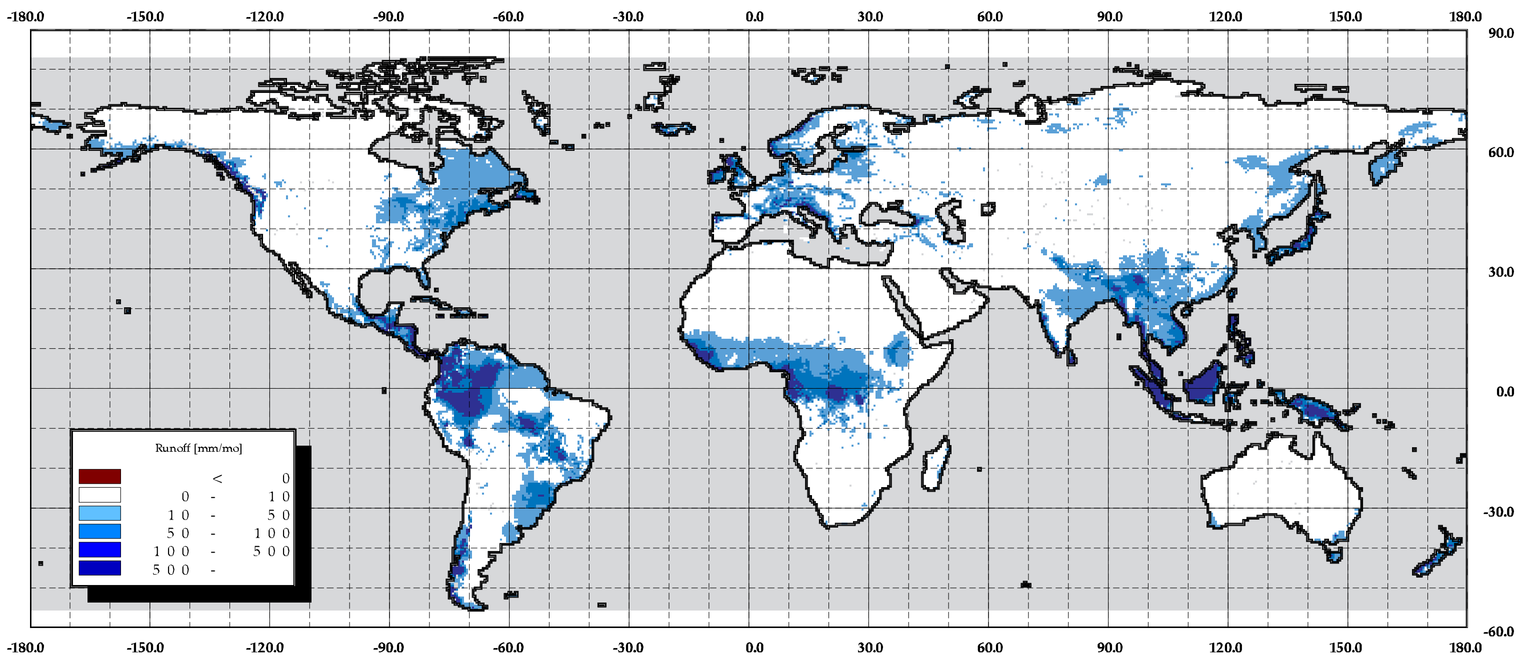
WBM-Simulated October Runoff

30-minute spatial resolution



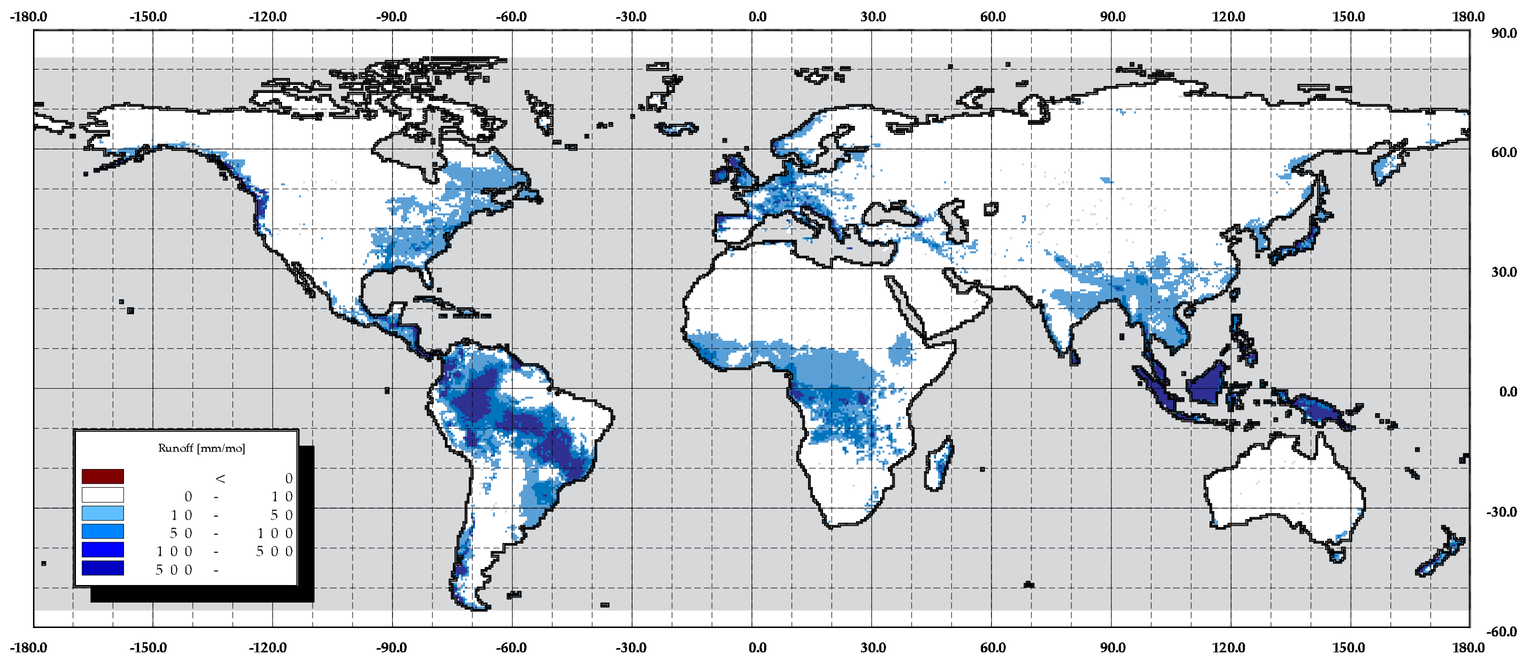
WBM-Simulated November Runoff

30-minute spatial resolution



WBM-Simulated December Runoff

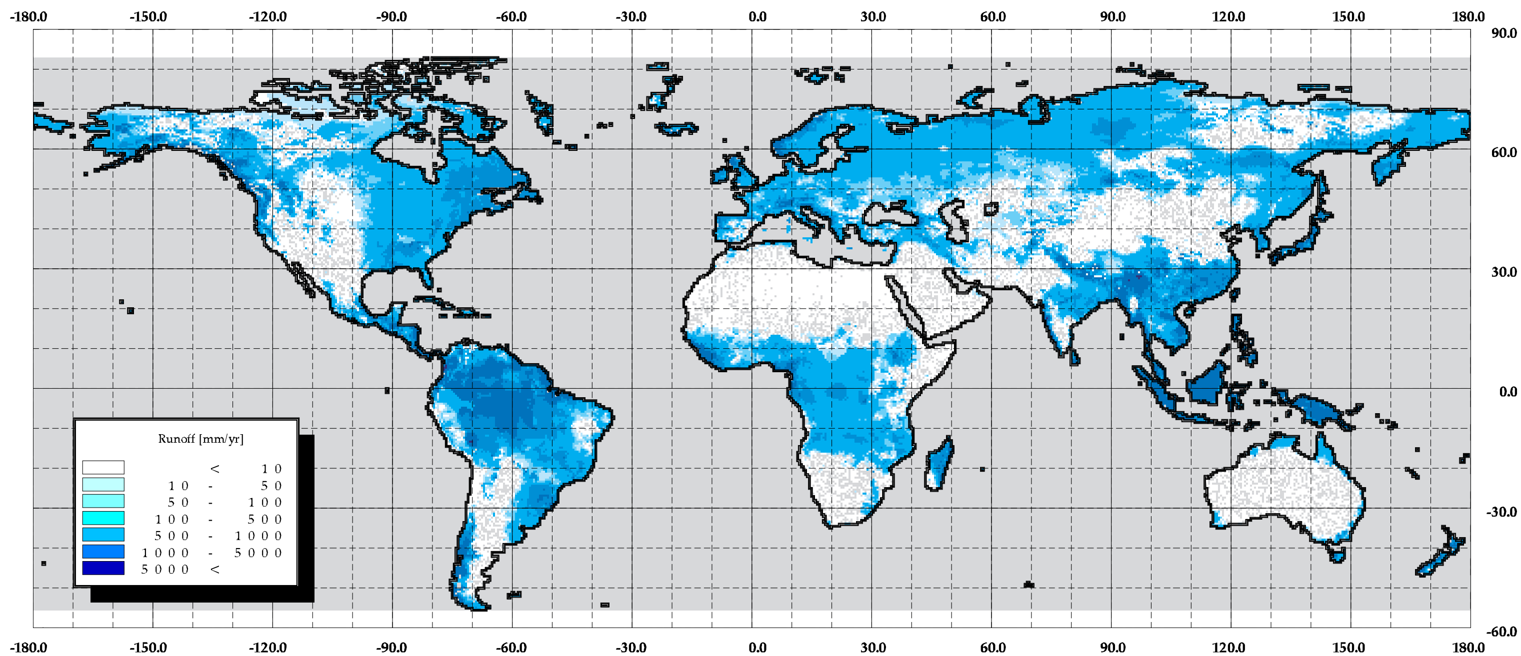
30-minute spatial resolution



H Appendix: Composite Monthly Runoff Fields

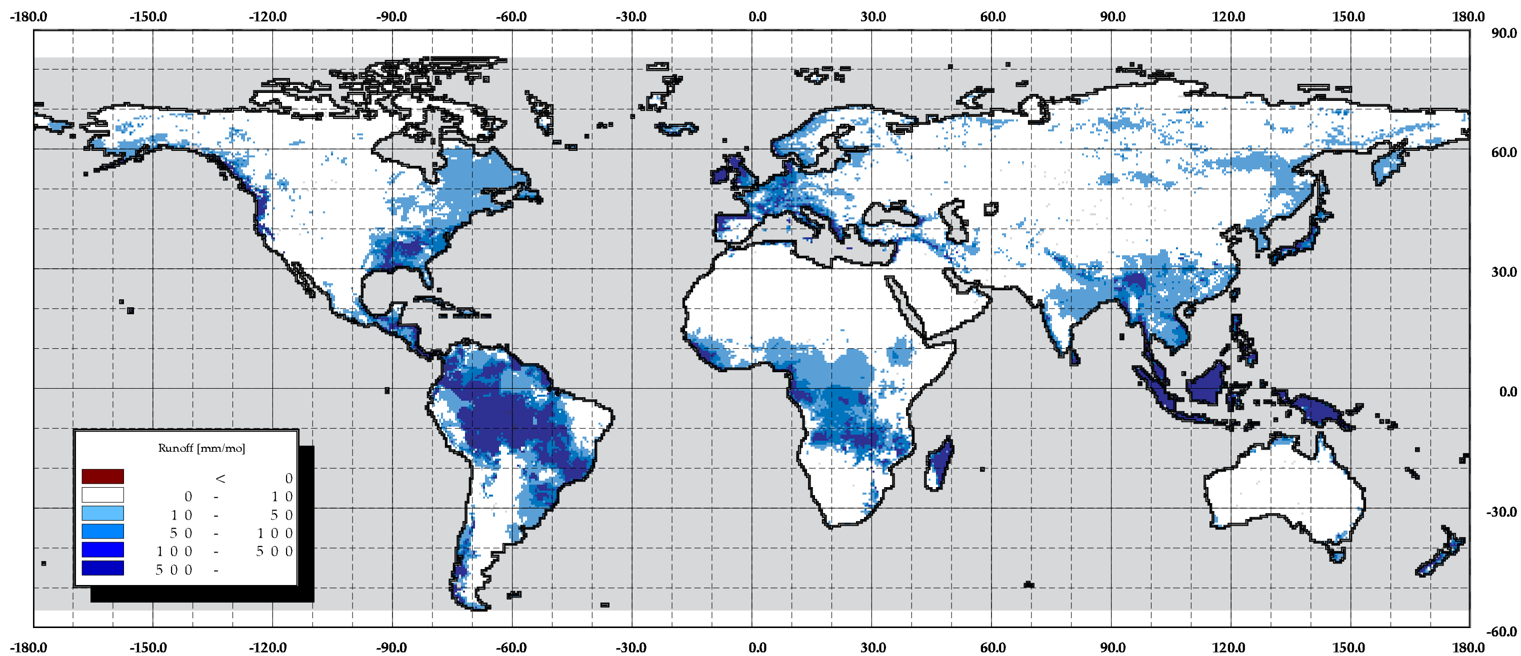
Composite Mean Annual Runoff

30-minute spatial resolution



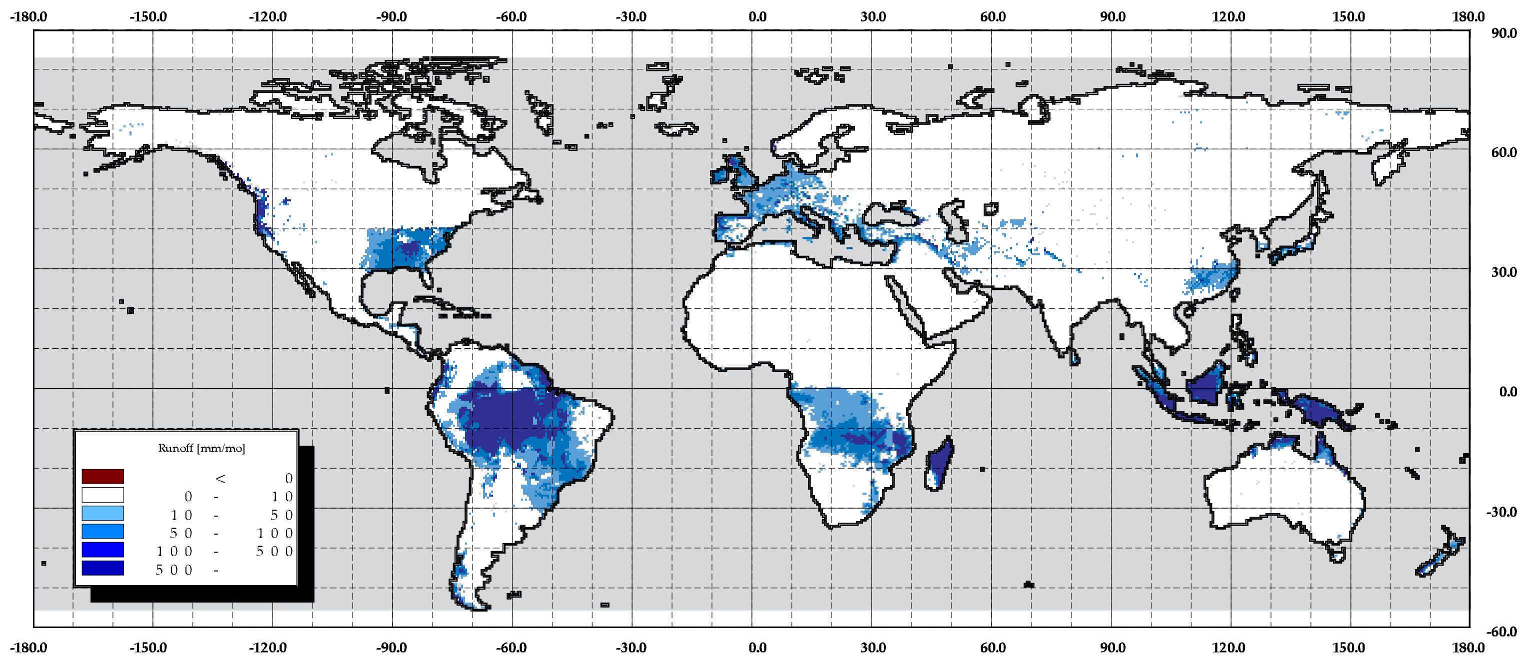
Composite January Runoff

30-minute spatial resolution



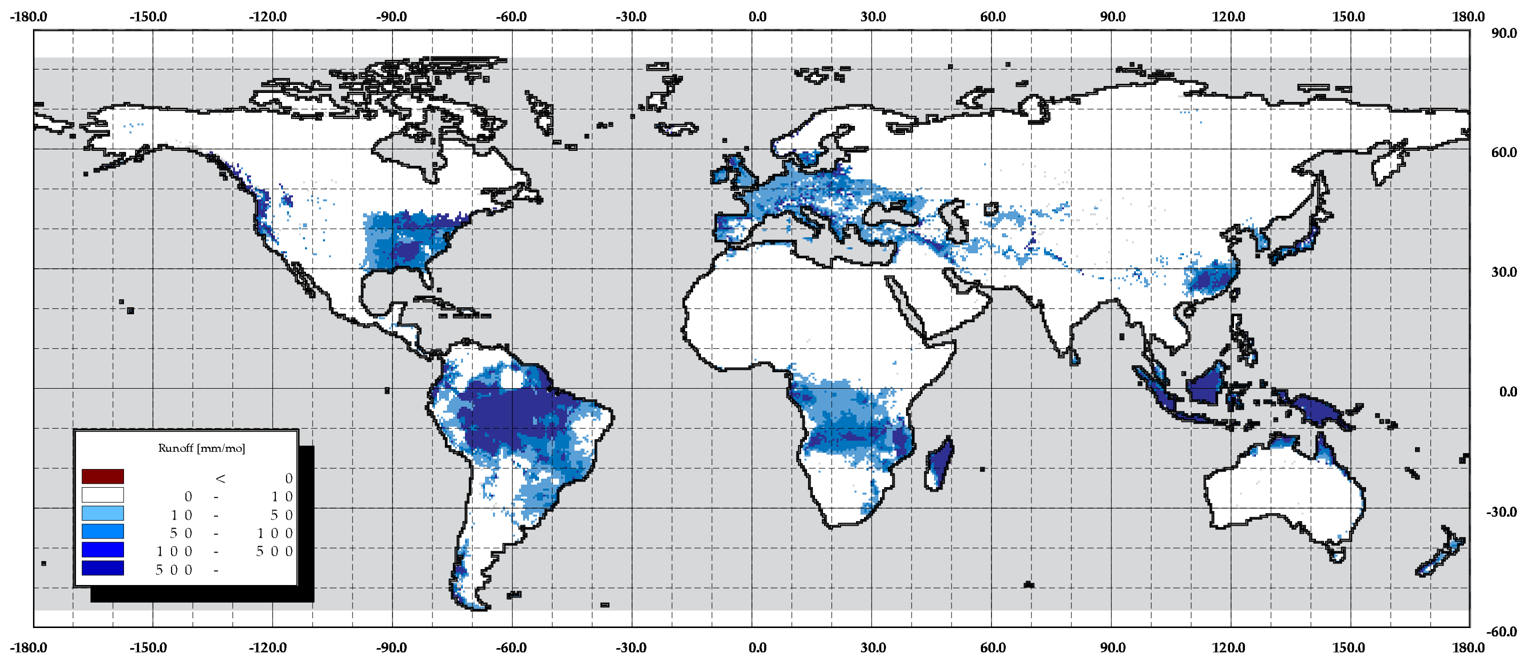
Composite February Runoff

30-minute spatial resolution



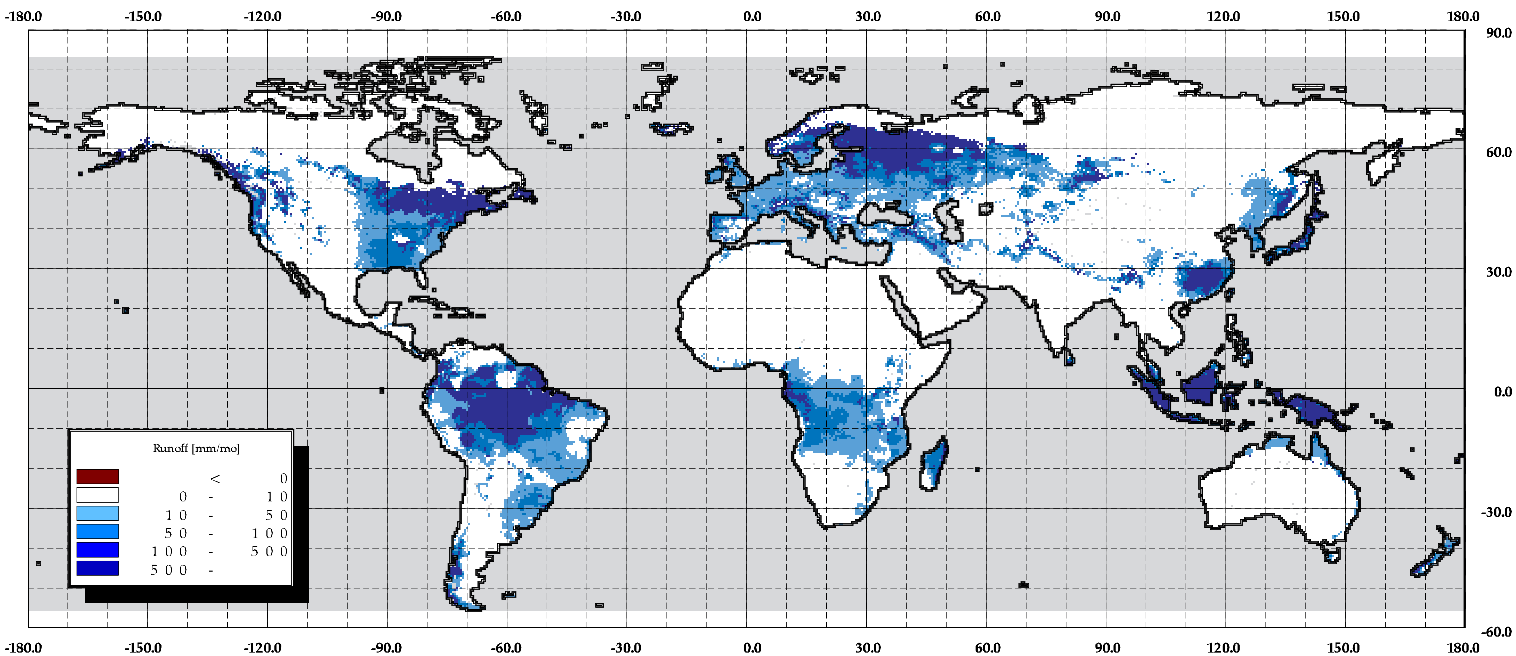
Composite March Runoff

30-minute spatial resolution



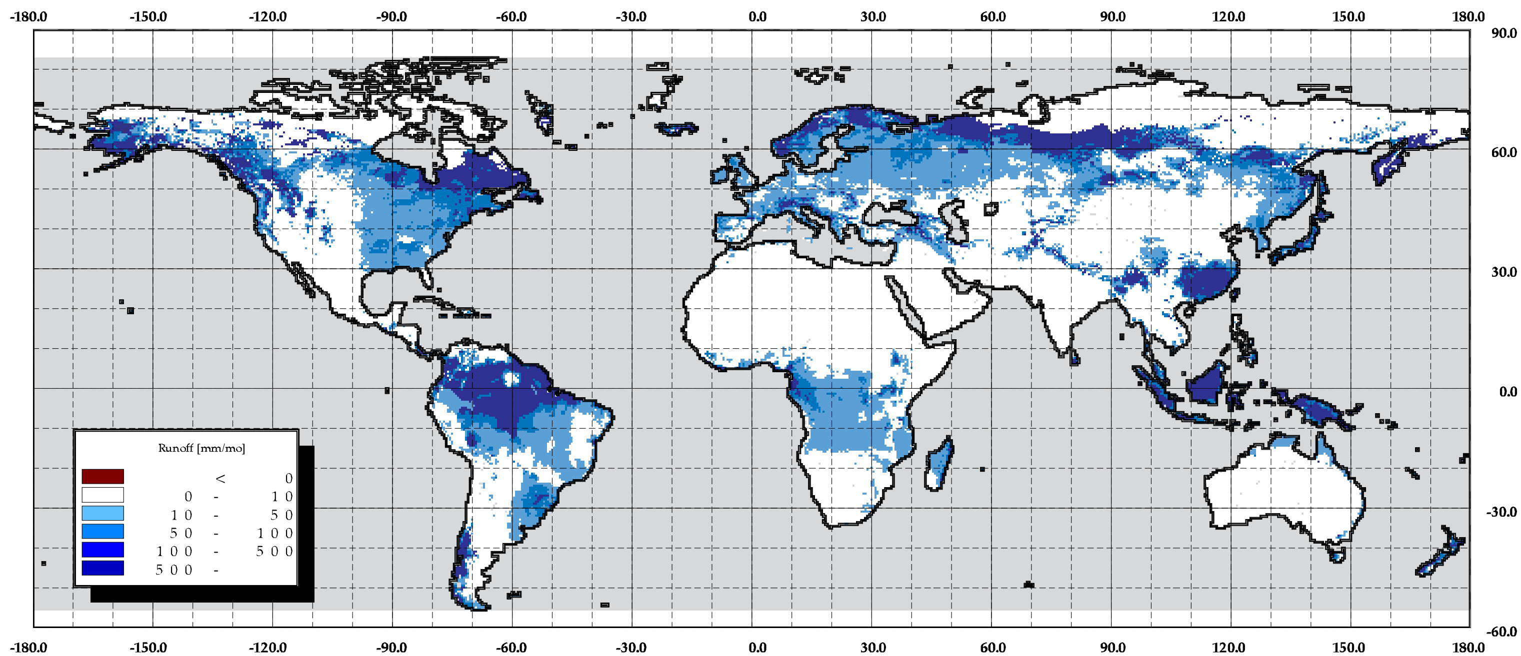
Composite April Runoff

30-minute spatial resolution



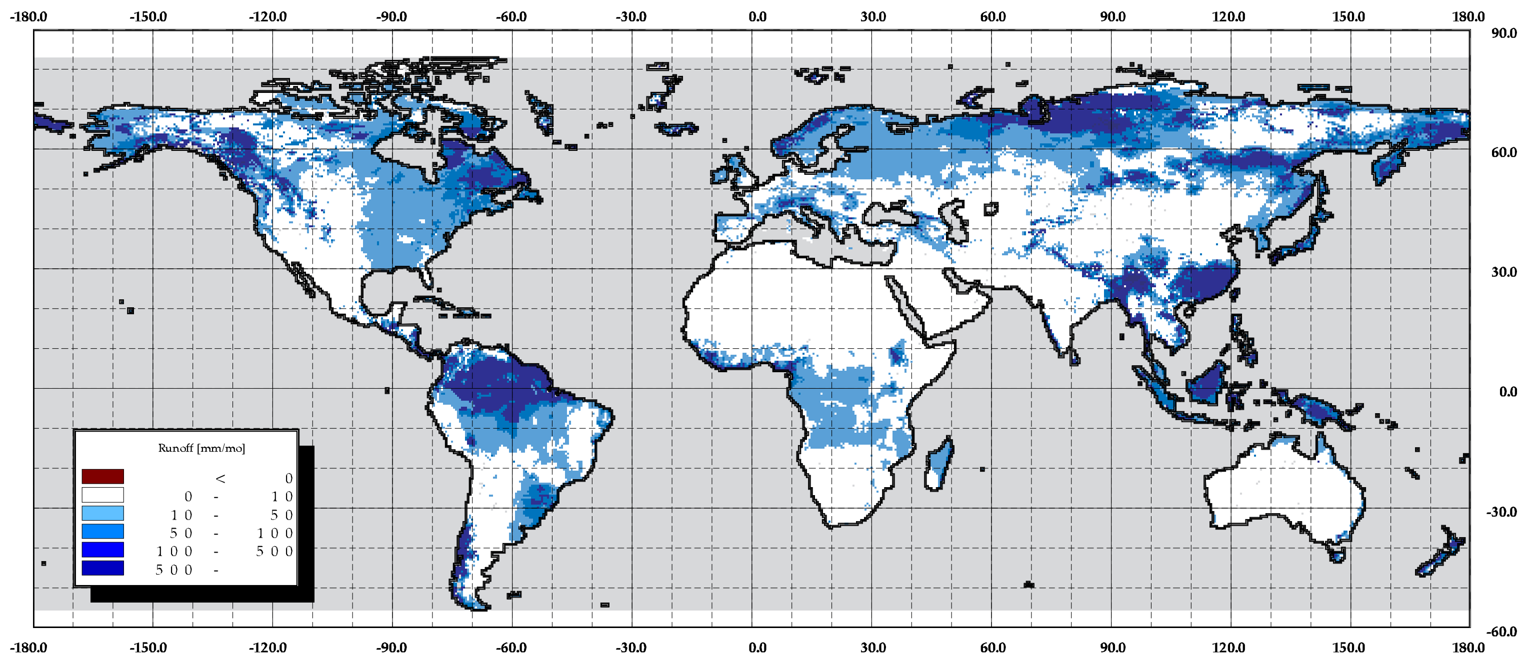
Composite May Runoff

30-minute spatial resolution



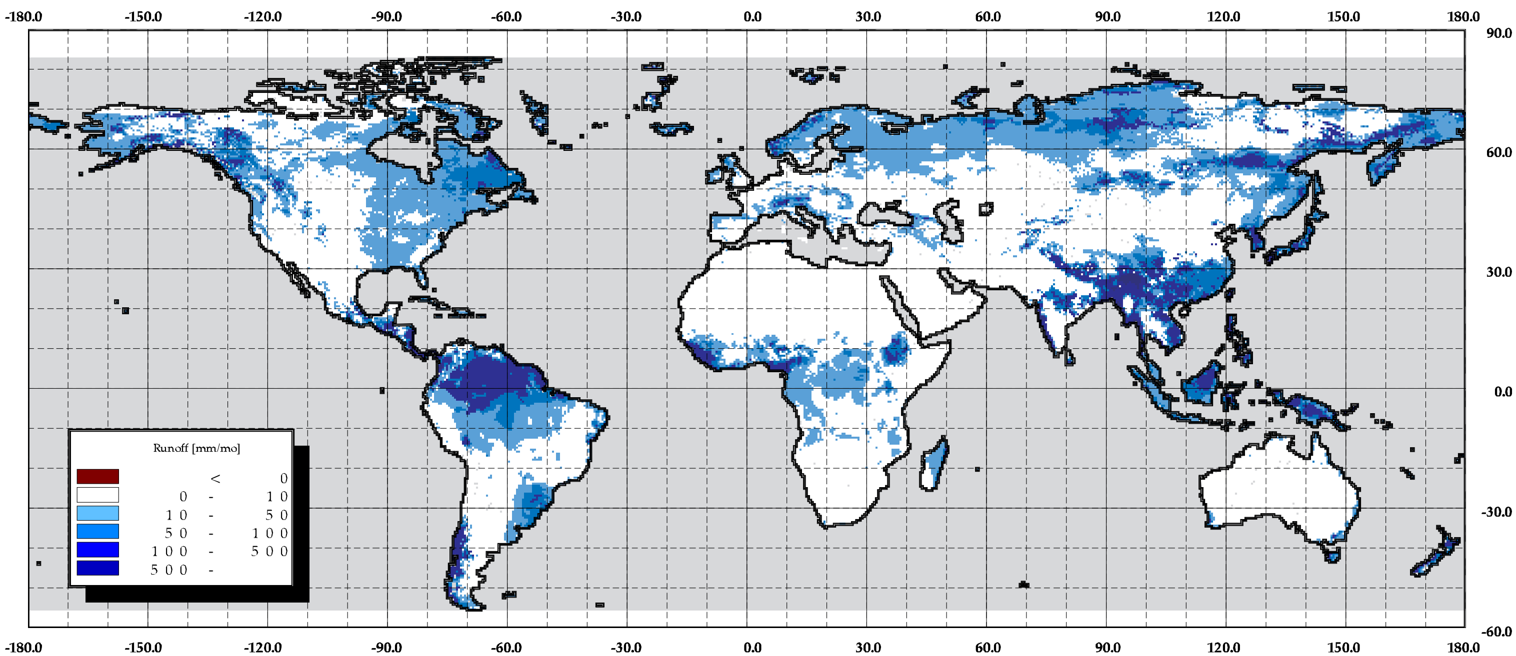
Composite June Runoff

30-minute spatial resolution



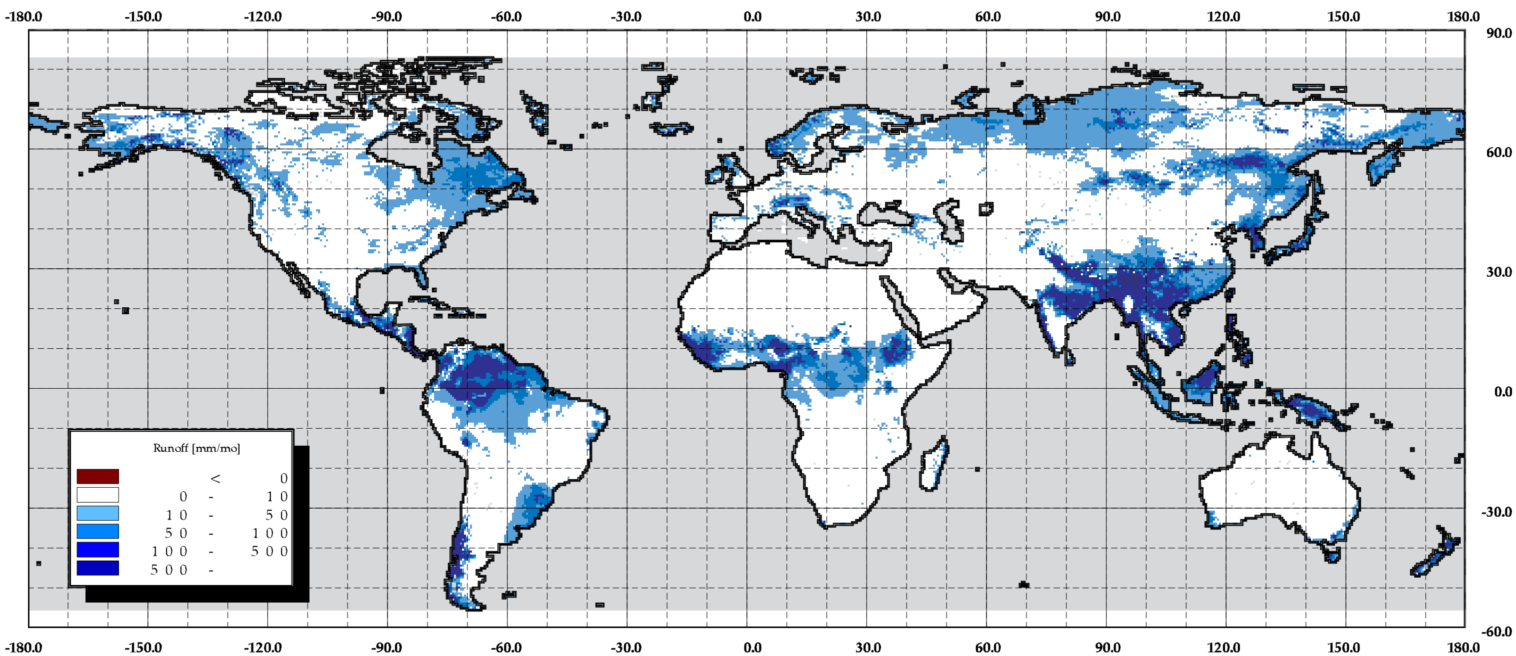
Composite July Runoff

30-minute spatial resolution



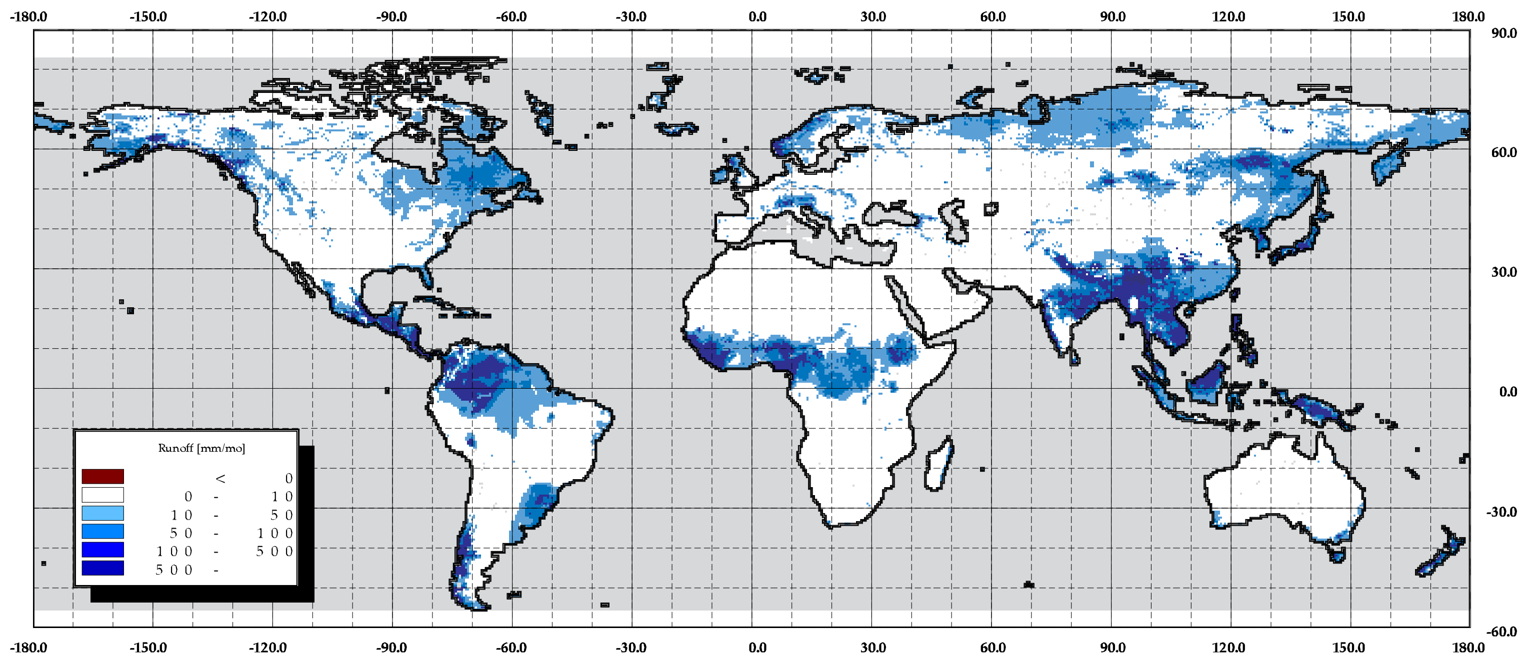
Composite August Runoff

30-minute spatial resolution



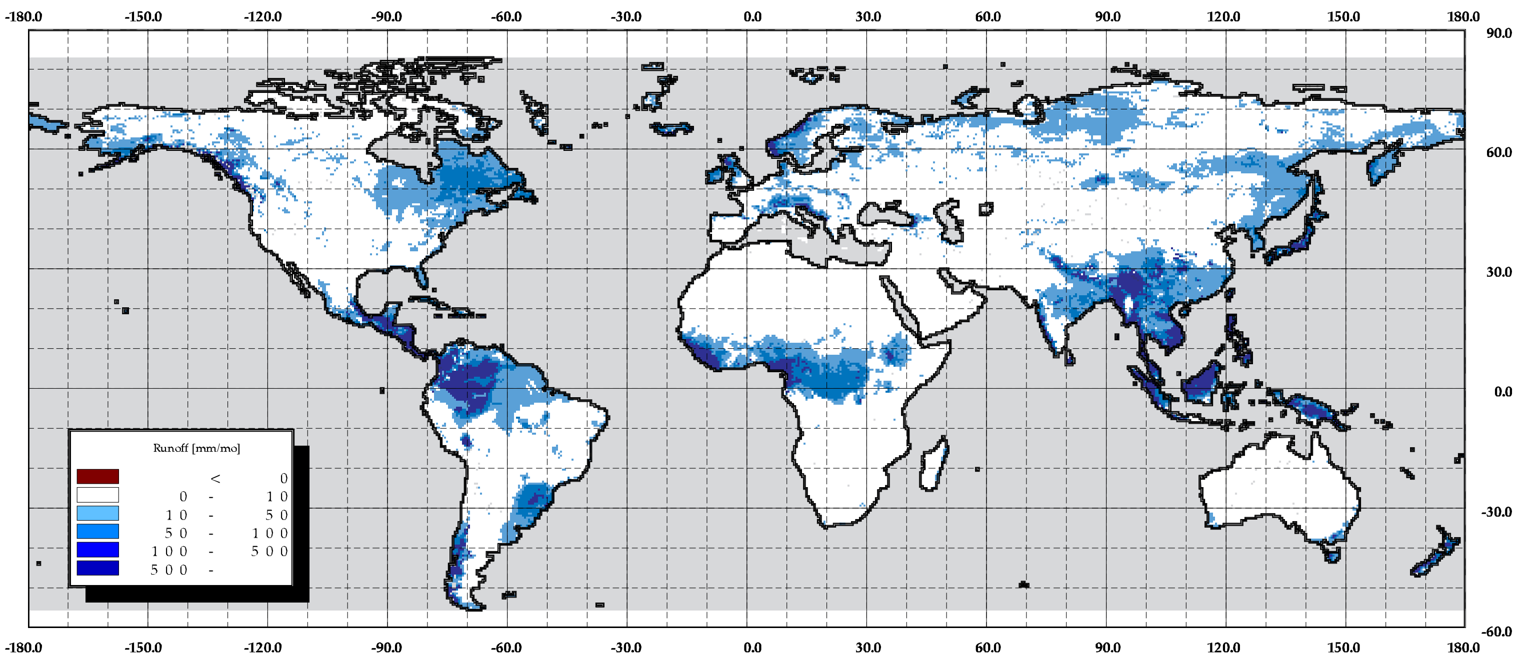
Composite September Runoff

30-minute spatial resolution



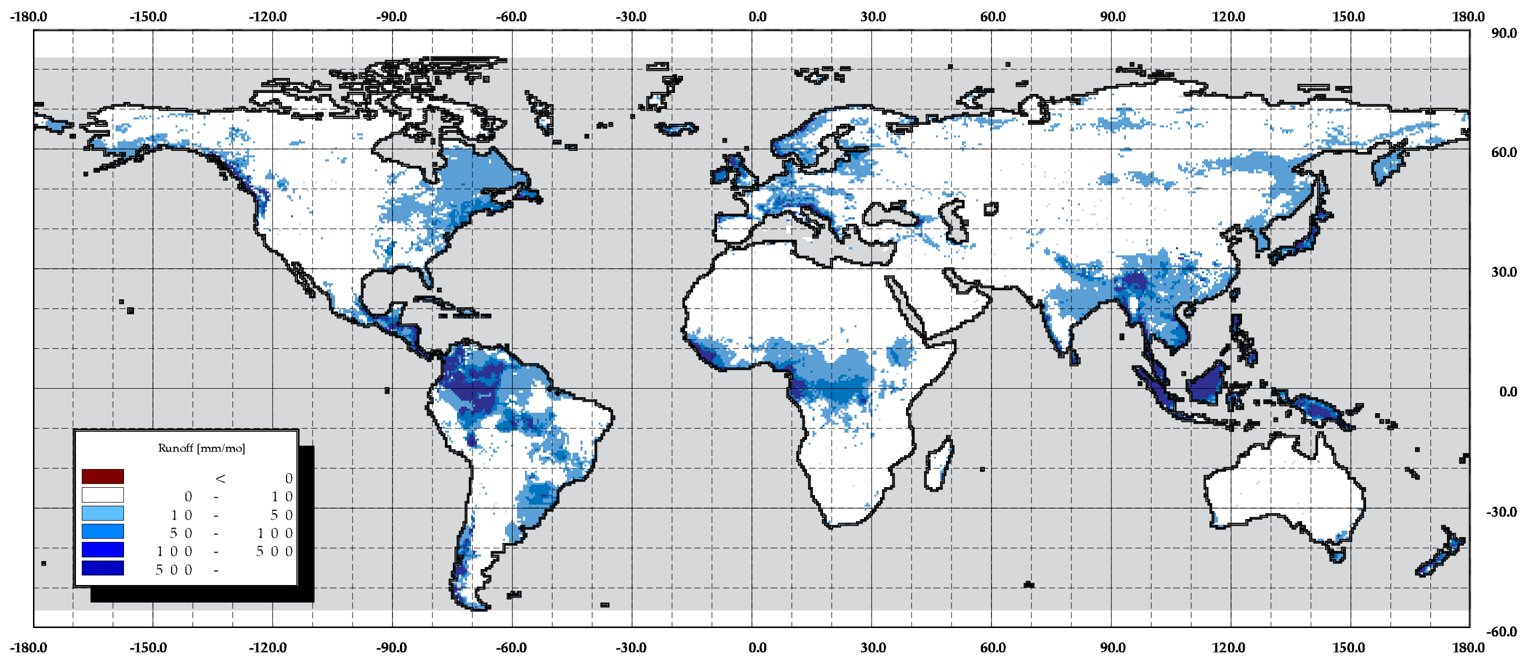
Composite October Runoff

30-minute spatial resolution



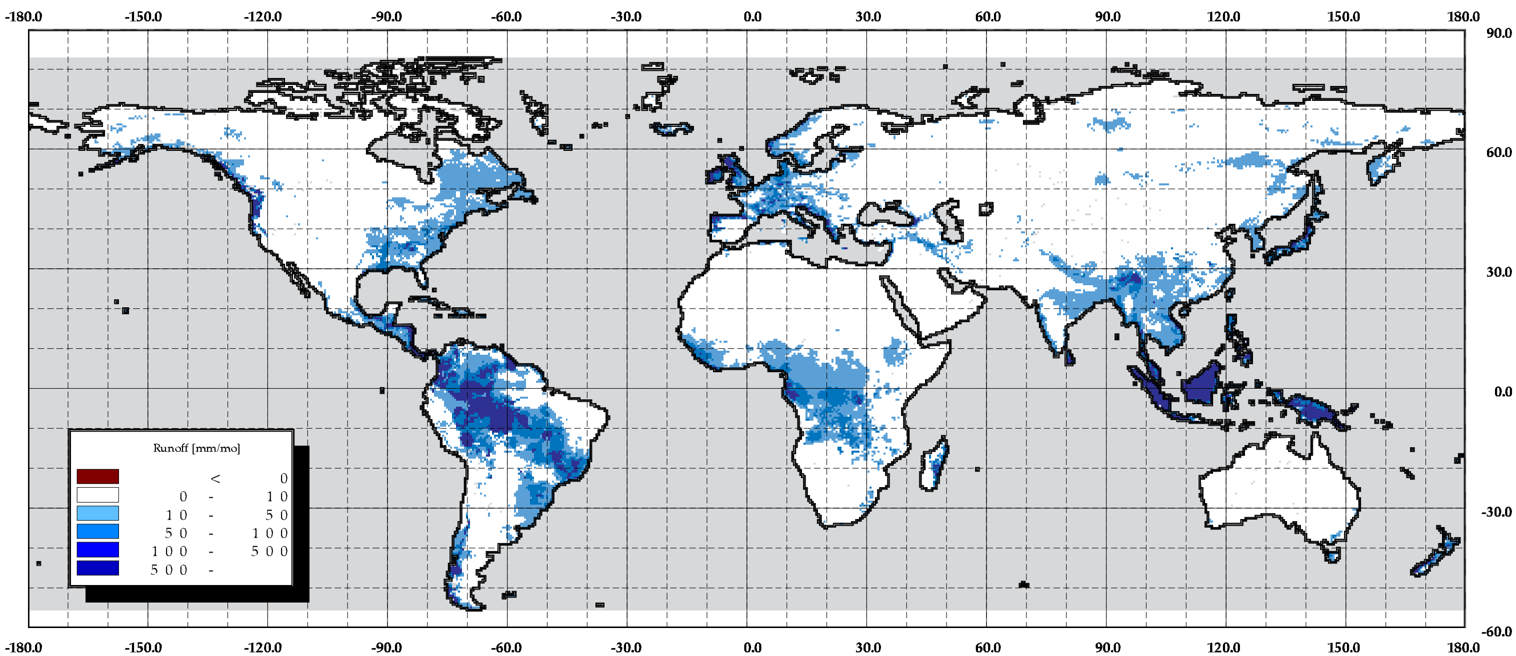
Composite November Runoff

30-minute spatial resolution



Composite December Runoff

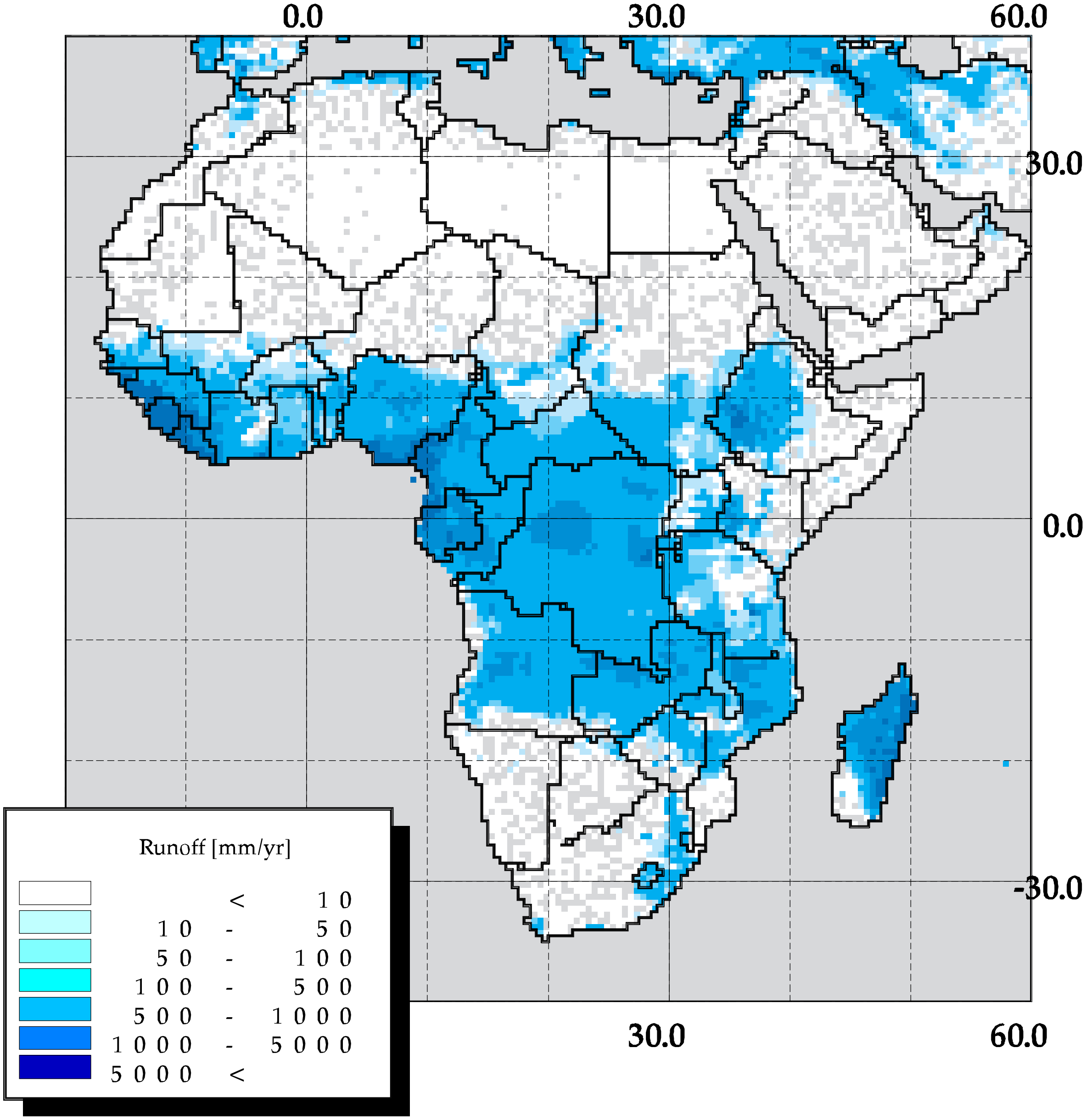
30-minute spatial resolution



I Appendix: UNH-GRDC Composite Annual Runoff Fields by Continents

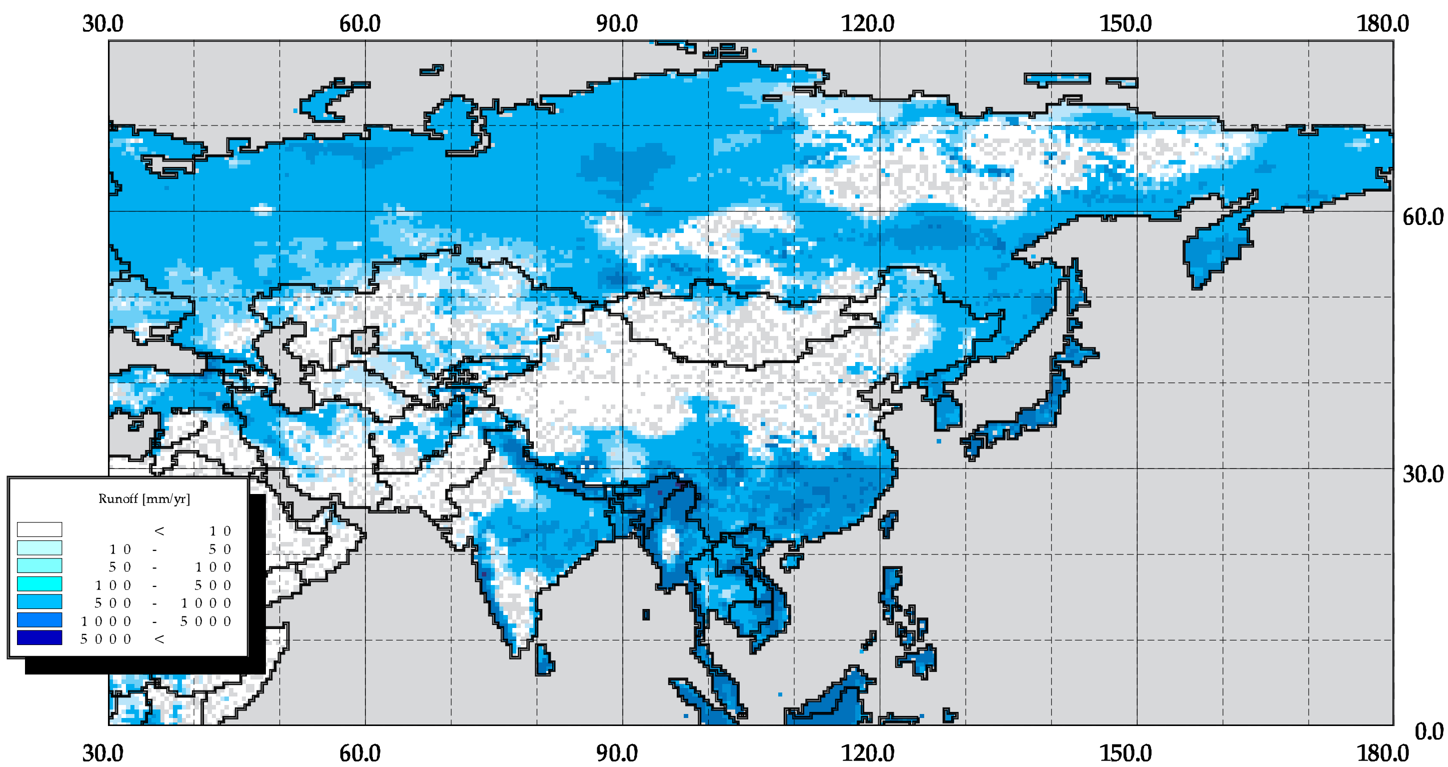
Composite Mean Annual Runoff

Africa



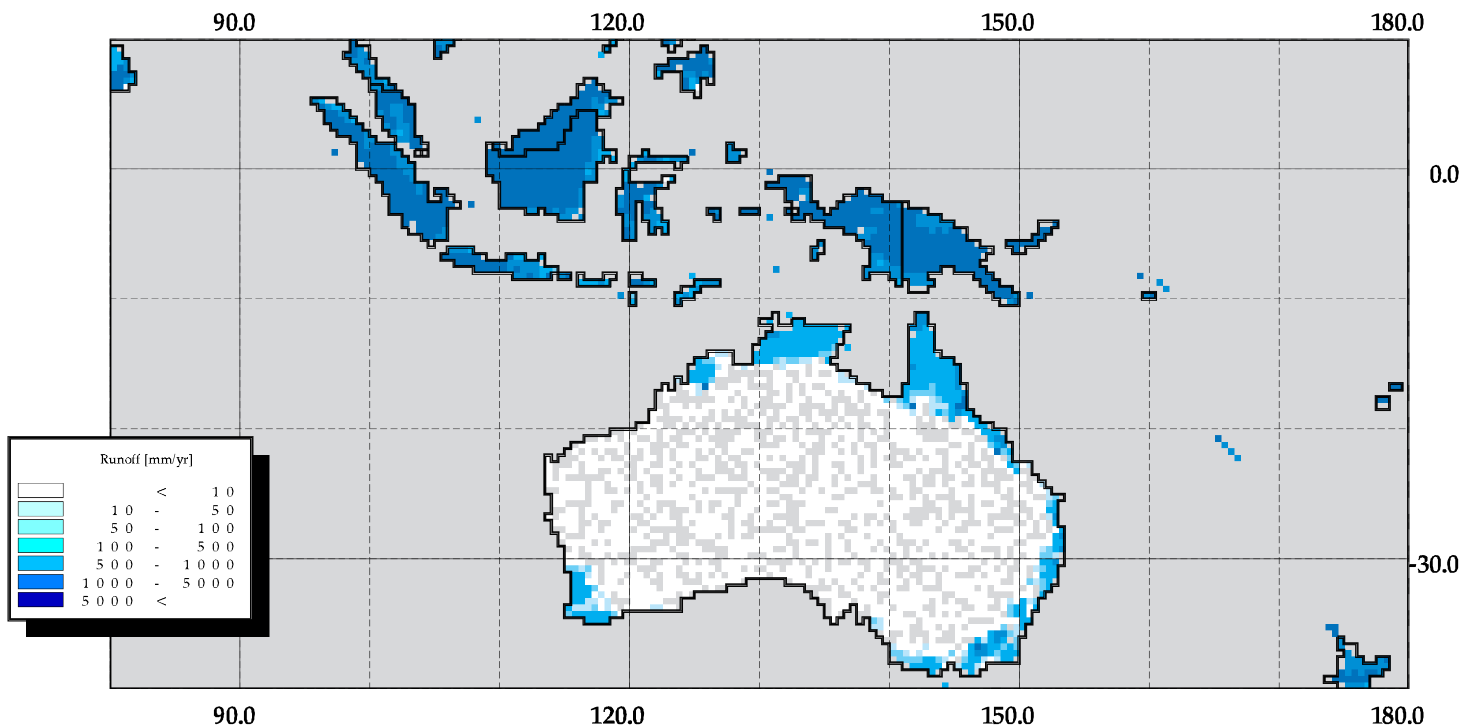
Composite Mean Annual Runoff

Asia



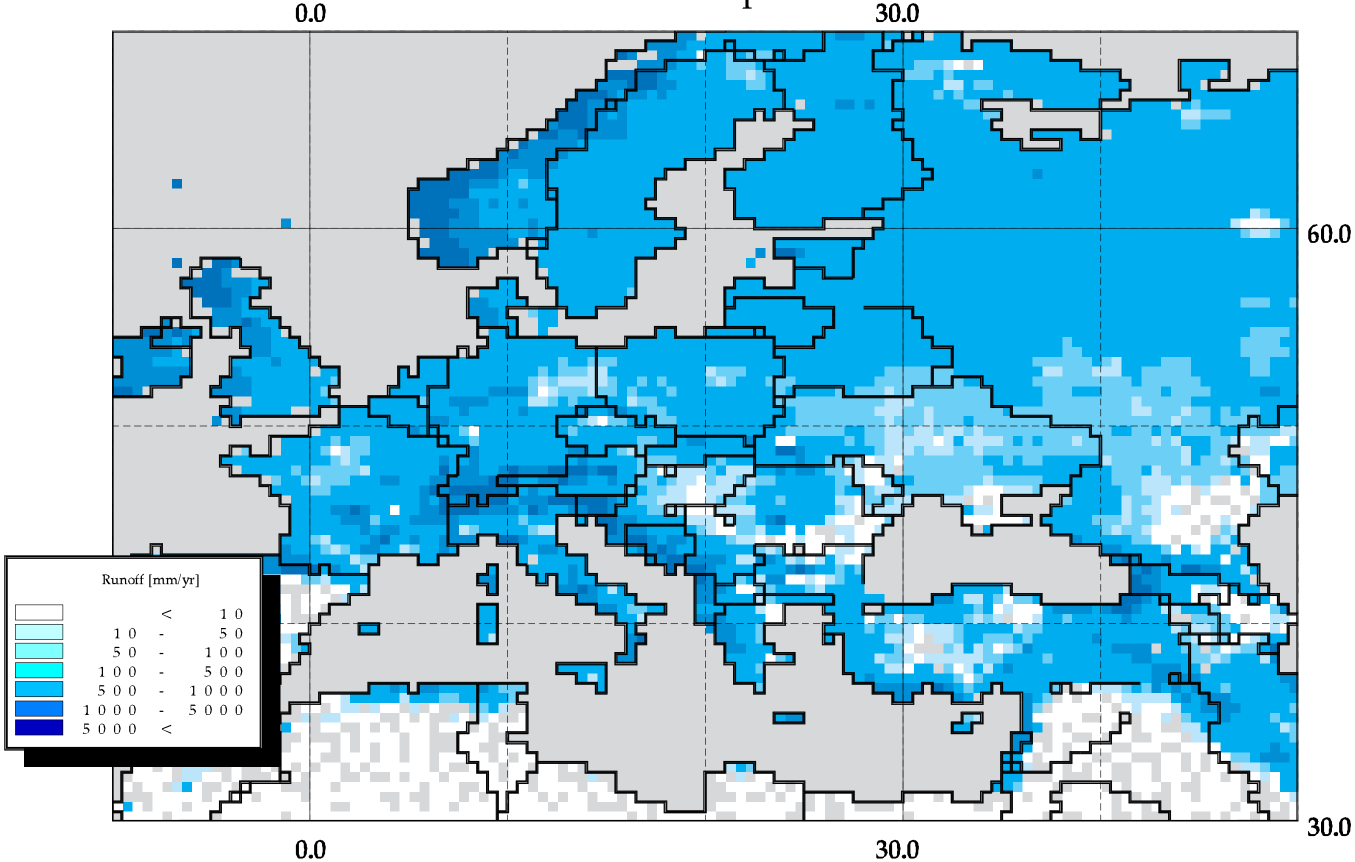
Composite Mean Annual Runoff

Australasia



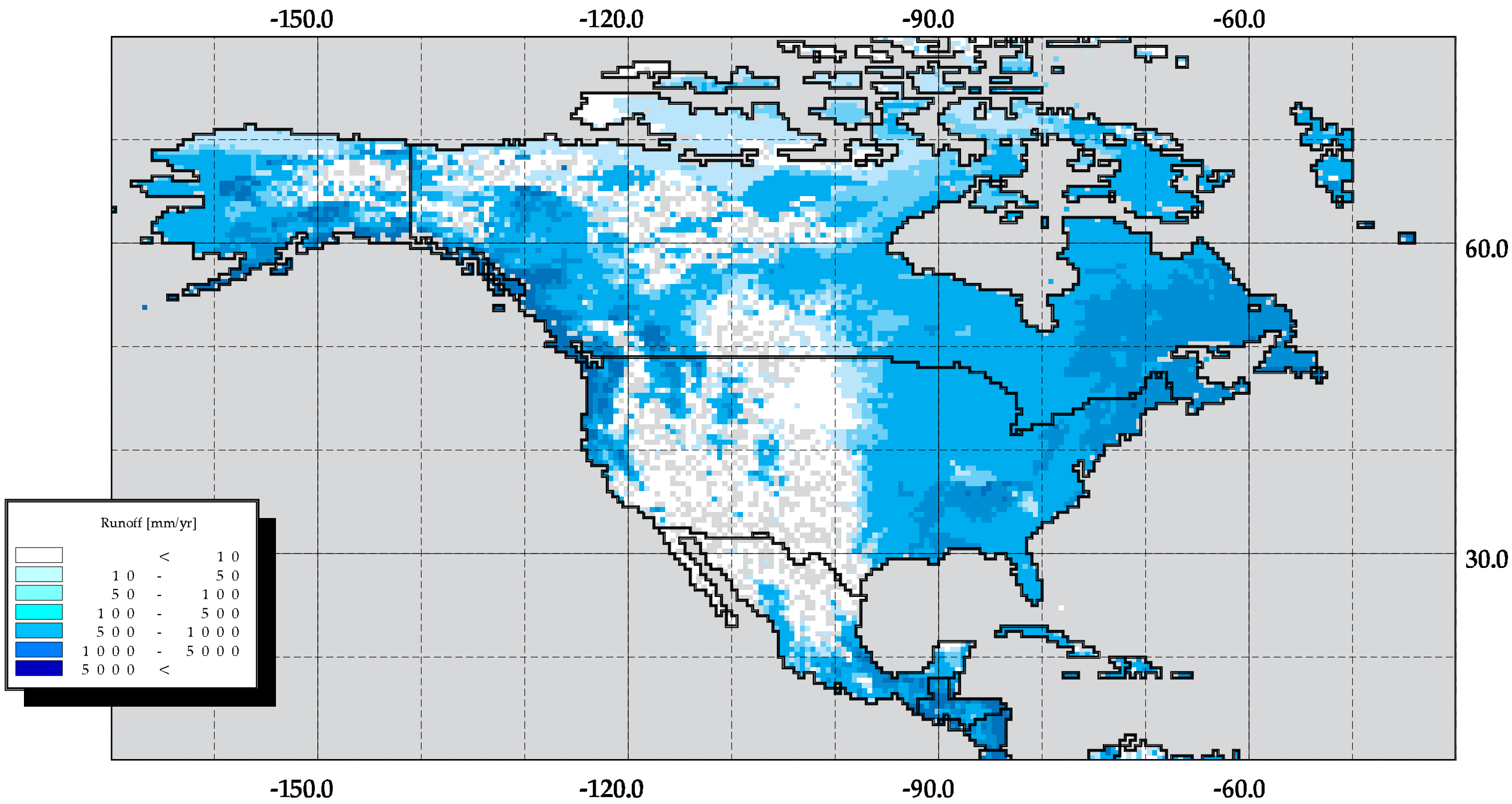
Composite Mean Annual Runoff

Europe



Composite Mean Annual Runoff

North America



Composite Mean Annual Runoff

South America