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Analysis of long runoff series of selected rivers of the Asia-Pacific region in relation with climate change and El Niño effects

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Forword

Probably the most widely published climate anomaly effects are those of El Niño; however, little is known about hydrological responses. Because of the outstanding impact of El Niño on national and regional economies, this report focusses on long-term trends in discharge time series and their possible relationship with El Niño effects. In this regard, the 1997/98 El Niño event has shown evidence that reliable seasonal forecasts of weather patterns as a result of El Niño activitiy are not far ahead. The prediction of major climate trends on a seasonal basis has a very high potential to forecast the hydrological response of rivers. Long-term forecasts help to reduce or mitigate adverse impacts such as floods and droughts on vital sectors i.e. agriculture, hydropower production and drinking water supply. The detection of structural changes in long time series of discharge is of prime importance to analyze cause-effect relations between climate anomalies including climate change and the response of river systems. In this study, the statistical evaluation of long time series of discharge and the linkage of variations in the discharge behaviour to the Southern Oscillation Index are a means to identify regional patterns of discharge response to El Niño anomalies.

The Asia-Pacific region has been chosen for this study because of its high dependancy on surface water for irrigated agriculture, power generation and water supply of large cities. Regional response patterns were detected using about 80 selected gauging stations with sufficiently long time series. The results of this study contribute to the objective of the detection of changes in river flow due to climate anomalies and change. This is one step towards a long-term forecast of river flow, once large scale hydrological models have been tested for their operational use and a better coupling of the El Niño phenomena and hydrological variables is achieved in the near future.

It is apparent, that this kind of research requires a large amount of high quality hydrological information to enable the regional analysis of hydrological responses to climate anomalies and change. The Global Runoff Data Centre (GRDC) therefore calls upon national hydrological services and the scientific community to supply hydrological data and information to the Centre.

GRDC has a standing invitation to visiting scientists to assist the Centre in the scientific exploitation of its database for a wide range of relevant topics. I am particularly grateful to Professor Daniel Cluis, University of Quebec, Canada, for his valuable contribution during his three months stay at the GRDC and WMO for the support of this research project.

Wolfgang Grabs
Head, GRDC

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Executive Summary

The **Global Runoff Data Centre** (GRDC) in the Federal Institute of Hydrology in Koblenz (Germany) collects and stores a large database of streamflow records for world wide hydrological studies. In this report, runoff records originating from **77** rivers within the **Asia-Pacific region** with long monthly runoff series and geographically distributed in the whole area have been extracted from the database and selected for study. Given the nature and extent of the database, regional patterns were sought more than individual specific behaviours.

The study was conducted in two directions:

Firstly, in the context of climate variability and change, the series were submitted to a trend analysis in order to assess if changes in levels of runoff occurred during their length of record. **Secondly**, the same series were studied to assess the possible relationships between the levels of runoff and the occurrence of the different phases of the **El Niño** phenomenon.

Long-term trend detection:

For each of the selected rivers, three time series were constructed and analysed: the mean yearly, the maximum and minimum monthly discharges. These series were submitted to a two-tier analysis; first, a **segmentation** procedure developed by Hubert was applied to assess their stationarity; this procedure truncates the series into an optimal number of segments with significantly different constant levels; then, the series that had been segmented by the previous procedure were submitted to a specialized trend detection software; this software uses of the **Information Content** concept developed by Lettenmaier and others, to adapt the classical non-parametric trend detection techniques, which are robust to outliers and non-normal distributions, to persistent and seasonal time series; it contains a complete set of non-parametric tests for monotonic and stepwise trend detection adapted to the cases of dependent/independent, seasonal/non-seasonal time series .
The results show that the monthly minimum runoffs exhibited more changing levels (36/77) than the mean (25/77) and maximum (19/77) ones, about two-third of the series having remained stationary during their years of record. Most of the changes occurred during the sixties and seventies, which constitutes a period of rapid demographic expansion and urbanization in Asia and where irrigation and other water uses were developed, especially in tropical areas. During the same period and within the studied area, a number of large dams and reservoirs were completed and put in operation; these anthropic interventions could be at the origin of the detected trends in runoff.

Influence of El Niño phenomenon on runoff:

To characterize the different phases of the **E**l **N**iño **S**outhern **O**scillation (ENSO), the values of the **S**outhern **O**scillation **I**ndex (SOI) were used; this index which relates to the strength of the Walker circulation at the origin of the phenomenon is published and updated regularly by the Australian Bureau of Meteorology; it is computed according to a method developed by Troup as a standardized anomaly of the monthly **M**ean **S**ea **L**evel **P**ressure (MLSP) differences, measured at Papeete (Tahiti) and Darwin (Australia). After some smoothing, negative values of the index (<-5) correspond of the warm phase (low SOI) of the phenomenon, often referred as the **El Niño**

phase, whereas positive values (>+5) correspond to the cold phase (high SOI) of the phenomenon, often referred as **La Nina phase**; intermediate values correspond to periods referred as normal or **neutral**.

Yearly analysis: The calendar years were first classified according to their mean SOI index as belonging to one of the three previously defined phases of the ENSO. Then the quantile distributions (10, 30, 50, 70 and 90 percentiles) of the runoff have been computed. In the Oceania-Pacific area, these distributions are shown to be numerically very differenciated according the ENSO phases; in order to assess differences in mean values parametric and non-parametric **ANOVA** procedures, followed by the **Duncan test** for the equality of several means were performed on the three previously defined runoff series (mean yearly, monthly maximum and monthly minimum); the results confirmed significant differences in the yearly values, between the three defined modalities, particularly in the Oceania-Pacific area.

Monthly analysis: Using a more selective monthly time interval to define the runoff values belonging to each of the three phases of the ENSO, the mean monthly discharges were tested for difference with the corresponding compounded value for the same month. These results specify which river runoffs are influenced by either El Niño, La Nina, both or none of the phases of the phenomenon; they also allow to specify which months are affected, what is the expected magnitude of this effect and what is the geographical extent of this **teleconnection**. Two-third of all the studied stations, mostly located South of a line joining the North of Japan to the Caucasus, were shown to be significantly influenced during at least one month by either one or both extreme phases of the ENSO

Direction for further work: Given the fact that SOI values are known and published almost in real time, it is interesting, from an operational point of view, to try to forcast the discharges from these SOI values; but even if some significant correlations (in some cases, up to 50% of explained variance) between synchronous values of runoff and SOI may exist, this can hardly be exploited in a regressive way for forecasting purposes: For a specific time interval, the magnitude of the standard deviation (scatter of the errors of the linear model unexplained by the regression) relative to the mean expected value leads to **very wide confidence intervals** around the regression line; In these conditions, it seems very doubful that **lagged** values of the SOI might improve decisively the forecasts and narrow significantly these confidence intervals. But if the discharges were **also** available almost in **real time**, then instead of using the lagged regression analysis technique with the sole SOI values as regressors, it would be possible to use **for each series** the classical Box & Jenkins technique, with first the identification of their **internal structure**s, and then the estimation of the **optimal transfer function** between them, in order to devise a **one-step-ahead** forecasting model. Should this model prove to be a good predictor for the monthly runoff (i.e. explaining most of the variance), then the working interval could be widened to two or three months and tested for the remaining (reduced) forecasting power in the resulting model; Such models with wider intervals would lead of course to increased **operational** benefits as they could allow for some needed lag-time between the forecast and the event itself, for mitigation measures to be taken.
Should the Box & Jenkins **monthly** model be unsatisfactory, then there will be no need to pursue in this direction: Some other type of external information would be needed to try to build a better forecasting model; let's remind here that no information related to the precipitation, neither in amount nor in timing, was introduced in this study.

1. Introduction

The **Global Runoff Data Centre** (GRDC) in the German Federal Institute of Hydrology (BfG), Koblenz, (Germany) operates under the auspices of the World Meteorological Organization (WMO). One of its objectives is to collect discharge time series of the rivers of the world, to store them in a unified data bank with a consistent format and to disseminate this acquired information for scientific use. This exchange of data allows interesting regional syntheses to be made, exploiting information otherwise disseminated at the country level. Such an availability of regional data leads to a better global knowledge of the river regimes (mean values and seasonal distribution of discharges), as well as of the availability of surface water resources which constitute an important part of the terrestrial hydrologic cycle.
On the scientific front, this data bank constitutes a major contribution to the water budgets of the world oceans and to Global Circulation Models (GCM) which are an increasingly important tool to provide a better insight and understanding of phenomena driving the Earth's climatic environment. In this period of apprehended climatic changes and of devastating "El Niño" effects, it provides an unbiased reference against which hypotheses can be statistically tested and assessed.
In a more practical way, water availability constitutes for many countries a vital but scarce and dwindling resource which limits their actual and future food self-sufficiency possibilities. For these mostly tropical and equatorial countries, any change in the long-term availability of water will be, both economically and politically of basic survival importance for their future well-being.

1.1 Purpose of the study

The purpose of the study was to investigate the long-time behaviour of selected Asian and Oceanian river discharges chosen in WMO regions II and V (Figure 1), in two directions:

- **Section 1:** First to examine and test the eventuality of structural changes (trends) in the discharge data, related to possible modifications either of regional climatic changes or in land and water uses within the river basins.

- **Section 2:** Second, to assess a possible relationship between a temporal ENSO Index and regional discharges of rivers, by studying for example, the relative levels of yearly discharges for Niño and non-Niño years, as well the existence of a possible lagged relationship between such an index and discharges as a teleconnected signal of the ENSO outside of its region of origin.

1.2 Data selection

The data were directly selected from the GRDC data bank using the GRDC Catalogue Tool software (Version 2.1 for Windows 95-NT). This software allows to query for data according to specific successive selection criteria:

- request for daily or monthly data series
- by WMO regions (6 continental entities) or sub-region numbers (regional entities or watersheds).

- by river name or GRDC station number.
- by country code.
- by range of operational years.
- by size of river basins.

Once the query file for stations is completed, the GRDC database system extracts the required selected data and provides them to the user as an ASCII file. In this case, stations with **monthly** records from WMO regions 5 (Oceania-Pacific) and 2 (Asia) were extracted from the GRDC database. A working data set of about 80 stations was obtained by using the following criteria, used as selection guidelines:

- Length of operation: The selected stations present a record of a minimum of 25 years of continuous operation until recent years, with less than 5% missing data.

- Regional representativity: The selected stations should drain large areas, making them representative of their climatic regions and less sensitive to local meteorological events. As far as possible, their watershed should be free from seasonal water storage resulting from dam or reservoir operation, from large water derivations and from significant changes in land and water uses.

- Geographical distribution: The chosen stations are distributed within the whole Asia-Pacific region according to the availability of long time series within the database and to the adherence to the selection criteria. They are grouped into five regional geographical subsets to allow possible regionalisation of the obtained results. These 5 subsets are: Oceania-Pacific (19), South-East Asia (9), Far East Asia (25), Indian Subcontinent (11), Central Asia (13). The location of the gauging stations is shown in Figures 2 to 6.

According to the GRDC procedures, the countries provide their discharge data for storage in the database and are solely responsible for the quality of these data. Lacking information about the quality and homogeneity of the data, non-parametric trend detection techniques as described and used later in this report seem to be the most appropriate techniques even if some detection power is lost and traded for robustness; on the other hand, very little is known about the land and water uses of the water basin areas controlled by the stations; this is also true for historic changes within the river basin, human interventions, derivations or impoundments that might have occurred during the whole extend of the discharge records. These uncertainties need to be considered in the interpretation of the results obtained in this study and for decisions to be eventually derived. Generally speaking, the results should be interpreted in a regional context and not for individual stations.

The selected stations of the Asia-Pacific region used for this study are presented for each subset on Tables 1 to 5. The tables present, for each river, its GRDC station number, the country code of its location, the name of the river and of the related gauging station, its longitude and latitude, the watershed area, the first and last full year of operation, the percentage of missing data and the total length of record in years. The data extracted from the database and used throughout the analysis are the monthly discharges from which yearly values were compounded.

2. Section 1: Assessment of structural changes

2.1 Homogeneity of the series and long-term trend detection

As a preliminary analysis, a **segmentation procedure** was applied to yearly series. First the few monthly missing values were completed using the long-term monthly mean values as fill-ins; this procedure was generally applied with the exception of the cases where such a synthetic value would become a yearly maximum or minimum; in such a case, an interpolated value calculated between successive months was preferred as to generate an occasional missing monthly value; then 3 series of yearly values were created for analysis:

- A **mean yearly** series obtained from the 12 monthly values,
- A yearly series of monthly maximum values, abbreviated as **maximum monthly** series,
- A yearly series of monthly minimum values, abbreviated as **minimum monthly** series.

The first series should allow the detection of temporal change in the mean level of the series, and the two last series reflect the change in levels of extreme (high or low) events over time.

2.1.1 The segmentation procedure

The segmentation procedure was developed by Hubert et al. (1989) and has found many applications, especially for testing the homogeneity and stationarity in the mean of West African precipitation and discharge records.

Essentially, this procedure determines for a record of a given length, the optimal segmentation of this series into 2, 3, 4 etc. segments of constant levels (stepwise change); "Optimal" is meant here in the sense that the Root Mean Square Error between the measured data and the model (the different levels of each segment) is minimal.

For a series of length **n**, the number of possible segmentations into **m** segments **N(n,m)** can be expressed as the number of combination (m-1) to (m-1) of (n-1) objects:

$$\mathbf{N(n,m)= (n-1)!\ /\ [\ (m-1)!\ (n-m)!\ ]}$$

This number becomes quickly very large and the authors have developed an optimization algorithm based on arborescences that allows to avoid testing the bulk of the possible combinations. The search for the optimal segmentation is completed by a constraint applied to the produced segmentations; segments will only be accepted if the means of contiguous segments are significatively different; this can be tested using the contrast concepts introduced by Scheffé (1959) and presented by Dagnelie (1970). The Scheffé test allows to limit the order of the segmentations. Once the optimal segmentation is obtained, the residuals (differences between data values and the local segmentation level) are tested for independence (Wald-Wolfowitz, 1943).

This procedure makes no hypothesis about the distributional or persistence structure of the data; The authors have tested the fiability of their procedure using Monte-Carlo simulations on constructed stationary series and found that the Scheffé test on the absence of contrast was often rejecting falsely the stationarity hypothesis, i.e. oversegmenting stationary series. In fact, the significance level of the procedure is not related in a simple manner to that of the Scheffé test itself. For this reason the procedure has been and can be successfully used as an exploratory analysis.

2.1.2 Results

We used the segmentation software developed and provided by the authors and ran it on the 3 yearly series of interest : the mean, maximum and minimum monthly series. It was applied to the discharge data of the selected rivers of the Asia-Pacific region as described on Tables 1 to 5. For these runs, the significance level of 0.01 for the Scheffé test was used and, in addition, we limited the investigation to a maximum of 3 segmentations for a record.
The results are presented on Tables 6 to 8 for the Oceania-Pacific area, on Tables 9 to 11 for the Far East Asia area, on Tables 12 to 14 for the South-East Asia area, on Table 15 to 17 for the Indian Subcontinent area and on Tables 18 to 20 for the Central Asia area.
On these tables, one can see that about **half** of the series are **not segmented at all** during their period of record. The least segmented series is the **yearly** series of **monthly maximum** which presents generally the relatively larger standard deviations, followed by the series of **yearly means** and then by the series of **monthly minimum**. One can note that, from the three studied yearly series (yearly means, monthly maximum and monthly minimum), the series of the monthly minimum are the ones that are **mostly truncated into segments**, which makes sense as low flow values as the most prone to reflect **local anthropic interventions** as flow diversions for irrigation purposes in the dry season. Also to be noted is the **large** magnitude of the historical changes in levels demonstrated during the analysis by some Australian rivers; it is also apparent that, on the **Indian Subcontinent** and **in South-East Asia**, many rivers have exhibited a steady **downwards** trends starting at the **end of the sixties until now, possibly reflecting** an increased water use for irrigation, industrialization or municipal uses (Tables 12 and 15). Also, on Table 18, one can clearly appreciate the historical fate of the rivers **Amu-Darya and Syr-Darya**, flowing into the **Aral sea**, but lately largely **diverted** for a widespread irrigation of cotton fields.

2.2 Non-parametric techniques

2.2.1 Weaknesses of parametric techniques with real world data

Most of the classical statistical tests and techniques have been developed with restricting hypotheses of normality and independence. It is well known that , for example, extreme values (such as **outliers**) have an determining impact on the results of a classical parametric linear regression and that variance-stabilizing transformations (such as Box-Cox) modify the relative weights of the data; after such transformation, the obtained results are only relevant to the transformed variables, not to the original ones.
Real-life data diverge from these theoretical considerations: Most natural resources data exhibit not normal, but generally positively skewed distributions; they present, often simultaneously, all three types of persistence: the short-term persistence, the annual seasonality and eventually some long-term trends. These 3 components are reflected and compounded by the autocorrelogram. To deal with this type of "**messy**" data (from the standpoint of the theoretician), which are more the rule than the exception in the nature, one has to look for **robust** techniques i.e techniques that give acceptable results, even if the basic theoretical hypotheses are not fully respected. This has to be quantified: What kind of non-normality, what kind of persistence gives still valid results for tests that require normality and independence? What is the loss of **power** of robust techniques versus classical ones? This is generally quantified by Monte-Carlo simulations where samples constructed with a known contaminated

structures are submitted to both types of tests.

Robust techniques can be divided into two classes : the non-parametric and the parametric ones; they constitute an active field of investigation for statisticians as oddly structured data are a fact of life and should also be statistically exploited.

Non-parametric techniques are based on the **ranks** of the data within the sample; As such, they are, from the start, unaffected by the shape of the distribution, and are also robust to outliers, as each data has the same relative unit weight in any analysis.

Montgomery and Loftis (1987) studied the effects of non-normality, unequal variances, temporal persistence, seasonal fluctuations and unevenly spaced data on the results obtained using Student's t test; they showed that this test should not be used if the samples have different distributions, unequal variances or lengths. In addition, seasonal variations or temporal persistence invalidate the results. Helsel (1987) has described the advantages of non-parametric procedures over parametric ones for the treatment of messy data.

One has to note that most of the developments on non parametric procedures were obtained during the last 25 years to exploit the water quality data bases resulting from monitoring programs induced by environmental concerns. These data were the archetype of messy data: The series were short, unequally sampled, contained outliers as well as censured or truncated values and were drawn from non-normal distributions; they also contained the 3 types of intricated persistence: the short-term, the seasonal and the long term. Thus it was quite difficult to answer the very practical question whether the state of the environment was improving or deteriorating which was and remains a very actual question. .

2.2.2 Classical non-parametric techniques

Although classical non-parametric trend tests such as the Mann-Whitney and the Spearman tests are very useful for the detection of monotonic or stepwise trends, they do not address the problems of temporal persistence and of seasonal fluctuations often found in hydrological data. In the last 20 years, a number of authors have attempted to adapt non-parametric tests to allow trend detection, without being influenced by other types of short-term interdependences. The method can be considered as the reverse of the decomposition performed in the Box-Jenkins method, in which the short-term structure is obtained both with differentiation, a non-discriminating technique to make any series stationary and by the identification of the seasonal fluctuations. In non-parametric techniques, two particular types of trend are considered:

The first is a **stepwise** (or jump-in-the-mean) trend where, at some time point, a sudden change of levels occurs as the result of some intervention; mean levels before and after this date are compared using the **Mann-Whitney** test, or a suitable modification of it, to test if they are significantly different.

The second trend type is a progressive, **monotonic** evolution of the series level with time. In this case **Spearman**'s or **Kendall**'s test (or a suitable modification of them) can be applied, using time as the independent variable.

2.2.3 Persistence, Effective number of independent observations and the Information Content concept.

Testing for trend is related to testing on confidence levels related to the accuracy of the mean (Matalas and Langbein, 1962); This variance of the mean of a sample is related to the number of observations and to the variance of the sample. If for a fixed and given period , the number of samples rises, then, these observations become more and more dependent and autocorrelated. Physically, this means that each observation contains some part of the information already available in the previous and in the following ones. This property is called a **redundancy in information** which might be sometime useful for filling-in occasionally missing data. Conversely one can also define an equivalent number of independent observations **n***, lower than **n**, the actual number of observations, leading to the same variance of the mean of the sample. Thus each (dependent) observation has an Information Content **I= n*/n** . Then by definition, the variance of the estimate of the mean of an autocorrelated sample can be written:

$$\mathbf{var\ m = \sigma^2 / n^*}.$$

Bayley and Hammersley (1946) have demonstrated that this number n* can be related to the actual length of the series and to the correlation structure of the series:

$$\mathbf{1/n^* = [\ (1/n) + (2/n) \sum^{n-1}_{j=1} (n-j)\ r_j\ ]^{-1}}$$

where n* is the effective independent sample size, n the actual sample size and r_j the sample estimate of the lag j autocorrelation coefficient. In the case of a simple lag-1 autoregressive, Markovian process, Matalas and Langbein (1962) have reduced this equation to a form involving only the lag-1 autocorrelation coefficient. This formulation is important as most of the natural processes follow locally a Markovian-type structure reflecting the progressive loss of memory of the phenomenon:

$$\mathbf{n^* = n \left\{[(1+r)/(1-r)] - (2/n)\ [\ (r\ (1 - r^{\,n}))\ /\ (1 - r)^2]\ \right\}^{-1}}$$

The Table 21 presents the values of the **Information Content** of one single observation, according to the length of the sample **n** and of the estimated lag-1 autocorrelation coefficient $\mathbf{r_1}$: This shows, for example that, in a sample of length 100 and of lag-1 autocorrelation coefficient 0.6, each observation has an **Information Content** of 0.25, reducing the effective length of independent observations to 100 x 0.25 = 25, for what concerns tests related to the accuracy of the mean of the sample.

On the Table 22, this "**effective number of independent observations** " is presented for some combinations of autocorrelation coefficients $\mathbf{r_1}$ and series lengths **n**. For example, a series of length 100 and of correlation coefficient of 0.3 is equivalent, for application of trend detection tests, to a series of only 54 independent observations.

Lettenmaier et al. (1976) have studied, using Monte-Carlo simulations, the power of the Spearman' Rho test against linear trend and the power of the Mann-Whitney test against step trend for series presenting a Markovian (AR1) persistence structure. These authors have found

that the documented power curves obtained for the case of independent samples were relevant for the dependent sample case if an equivalent number of independent observations **n*** was used, instead of the actual length **n** of the sample.
After this breakthrough, Hirsch et al.(1982) investigated the case of the seasonal fluctuations present in the vast majority of hydrological series. Kendall's test (Lehman et al., 1975) is used for each recognized seasonal sub-series and the resulting statistics were added together. This property was exploited to assess if a global trend was present. Unfortunately this test could not be applied if both persistence and seasonality were simultaneously present in the series.
This last problem was investigated by Hirsch and Slack (1984) and by Van Belle and Hughes (1984), the latter presenting a new method for determining if a trend was caused by a particular season.

At this point, a **complete set** of non-parametric tests for monotonic and stepwise trend detection were available for independent/ dependent, seasonal/non-seasonal time series; the decision tree: for choosing the appropriate test according to the structure of the series and to the type of trend to test is presented on the Table 23.

This new set of non-parametric tests is well adapted to the real structure of hydrological data, but as they have been developed only lately, their power has only been partially established (Berryman et al.,, 1988) and often rely on Monte-Carlo simulations to validate performances. Nevertheless, Bradley (1968) has demonstrated that even under the worst case situations, the power of non-parametric procedures varied between 85% and 96% of that of their parametric counterparts. In fact, when tested with a whole range of asymmetrical distributions, their power generally exceeded that of traditional parametric techniques.

2.2.4 Practical use: The DETECT software.

To exploit on a practical way the new previously described non-parametric tests, an **interactive** software has been written (Cluis, 1988; Cluis et al. 1989) and accepted as a Canadian contribution to the HOMS programme (module K55.2.01) of the World Meteorological Organization (WMO). This software, written in Fortran 77, is composed of stand-alone modules which are executed in succession, using a series of intermediate data files to transfer interim results downstream from the first modules. It performs the following operations:

-Reading of the input data in an appropriate format; Display of the time-series; Interactive appraisal and elimination of obvious outliers.
-Analysis of the frequency of sampling; Anova on months; Interactive grouping of months into seasons and test on the equality of the means of the selected seasons (groupings of months).
-Choice of an equispaced working interval, seasonal or non- seasonal, with several options for filling-in missing data; Analysis of the persistence structure of the working series using significance levels for the sampled autocorrelation coefficient.
-Analysis with inertia graphics (Mass-curves and CUSUM functions, Cluis; 1983. Doerffet et al.; 1991) in order to assess the nature of a possible trend (stepwise or monotonic) and also its eventual time of occurrence. CUSUM (**Cu**mulative **Sum**) functions are graphical techniques used in Quality Control analysis to detect in real time changes within an industrial fabrication processes; their shapes (parabolic or segmented) reveal typical monotonic or stepwise changes. In our application, we used the technique retrospectively to determine the type of possible

changes and their date of occurrence; this interactive step can be considered to be the interactive counterpart to the search for an optimal segmentation as performed in batch by the procedure developed by Hubert et al.(1989) and previously described.
- Given the previous information, the software performs the trend test adapted to the data, tests the significance of the results and calculates the parametric values pertaining to each segment; The correspondence between the trend model and the data is computed as a RMSE (Root Mean Square Error), which has to be minimized in order to retain the best fitted alternative. In a single time-series, the software may have to be rerun several times whether there were more than one change in level during the length of the record or if computing for either monotonic or stepwise structures lead to non clearly discriminating RMSE. All the choices made by the user are written in a report file for further analysis of the statistical results related to the different options run for the same series.

2.3 Results

All selected series that had been segmented as described on Tables 6 to 20 by following Hubert's procedure were submitted to the specialized non-parametric tests included in the DETECT software; This software takes into account the seasonal and/or persistence structures of the series and redirects the treated series towards the adapted test. In fact, these characteristics (reduced seasonal sub-series lengths, effective number of independent observations n*) are at the root of the recognized over segmentation properties (falsely rejecting the stationarity hypothesis) of the procedure developed by Hubert et al. (1989).

The results pertaining to the Oceania-Pacific area are presented on Tables 24 to 26; one can see that 4 minimum monthly discharge series that had been previously segmented were **revisited** by this actual step as exhibiting no trend (in the mean) after having been submitted to the non-parametric tests. In a similar way, the results pertaining to Far East Asia are presented on Tables 27 to 29; these related to South East Asia, to the Indian Subcontinent and to Central Asia are shown on Tables 30 to 32, on Tables 33 to 35 and on Tables 36 to 38 respectively.
In numerous cases, The RMSE criteria to discriminate between step and monotonic trend types are often too close to pass a definitive judgement. In this situation, both alternatives are presented on the tabular results.

2.4 Discussion and synthesis

The Table 39 regroups by area the results obtained by the segmentation procedure and by the non-parametric trend detection tests. On this table, possible multiple level changes for a single series have be counted, **including** the alternate possibilities (i.e. upwards step trend **and** monotonic upwards trend), when results are not discriminating. It shows that almost 80% of the studied series exhibited no change in their mean, minimum or maximum levels during their period of record.

One can also see that the runoff of the rivers of South East Asia that have exhibited trends decreased with time. For all the regions, it is also clear that minimum monthly runoffs were much more prone to changing levels than the mean and maximum ones; this reflects the fact that even small impoundments constructed for various water usages such as irrigation, municipal or industrial uses can significantly change the levels of the low flows. Conversely, dams and

reservoirs can be managed and operated in such a way to guarantee a residual minimal flow in the river at all times, as for navigation or ecological purposes.
The Table 40 synthesizes by region, the number of occurrence of shifts in levels by decades as compounded for all the considered series (mean yearly, maximum monthly and minimum monthly discharges). It provides the count of series for which levels shifted during a given decade. One can see that most of the changes occurred **during the sixties and the seventies**, a period with a rapid demographic expansion and consequently where irrigation was developed, especially in tropical regions.
During the same period, a large number of dams and reservoirs were completed (Vörösmarty et al., 1997; ICOLD, 1984 and 1988), modifying the historical regimes of rivers. This has been the case within the watersheds of some of the larger rivers studied here: The Murrubidgee river (1956) and the Darling river (1960) in Australia, the Nan river (1972) in Thailand, the Godavari river (1976) and the Krishna river (1974, 1982 and 1984) in India, the Syrdaria river (1957 and 1965) and the Ural river (1958) in Kazakhstan, the Yenisei river (1967) and the Ob river (1957) in Russia, the Narin river (1978) in Kirghiztan, the Beijiang river (1973), the Dongjiang river (1974) and last but not least, the Yellow river or Huanghe (1960 and 1968) in China. Some of these **interventions** could be at the origin of the results presented here.
On the other hand, if one looks only at **the most recent changes** having occurred in the **mean yearly** runoff, then the **downwards** trends are clearly predominant as can be seen on the Table 41: Out of 77 series, 52 exhibited no trend, 6 exhibited an upwards trend and 19 exhibited a downwards trend during their length of record. The geographical distribution of these latest changes in mean yearly runoff is presented in Figure 7.

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3. Section 2: Influence of El Niño on runoff of rivers of the Asia Pacific area.

3.1 Introduction

It was a time where nuclear tests were reputed to be responsible for all climatic mishaps; nowadays, a South-Pacific phenomenon called **El Niño**, a warm water up welling occurring in the Pacific ocean along the Peruvian shores is blamed by the media for practically any unusual weather and all local extreme meteorological events (e.g. floods, droughts, forest fires, hurricanes, tornadoes, freezing rains) occurring almost anywhere in the world. . It is well known that news media and television in particular, present repeatedly to the general public views of catastrophic images of disasters occurring as consequences of extraordinary local meteorological events.

In the context of climate variability and change, much research is currently undertaken into the El Niño Southern Oscillations (ENSO) whose frequency of occurrence is reported to have increased in the recent years. But even with the hypothesis of stationarity (no climate change), it has always been difficult to evaluate the "normality"and the return period of extreme events, as the length of the historically recorded hydrological series rarely exceeds one or two centuries at most, a duration which constitutes a very short period to assess the tail distributions of the underlying parent population. Another question is also the object of numerous investigations: Given the global nature of the atmospheric long-range circulation of air masses at the origin of meteorological events, what is the geographical extent of the influence of the ENSO phenomenon? Which regions of the world are directly or indirectly influenced by it ? This "**teleconnection**" can by far exceed the South-Pacific region. Meteorological events attributed to El Niño are generally very localized and only a few publications (see literature review) have demonstrated a change in the distribution of the volume of precipitation and of runoff during some part of the year. .

In this report, advantage is taken of the availability, at the **Global Runoff Data Centre** (GRDC), of a very large database of historical long-time series of runoff of numerous rivers of the world to try to compare these runoff (and especially their high and low values) according to their belonging to different phases of the ENSO; e.g the significance of the differences in discharge distributions for normal and El Niño years will be tested for significance. It is believed the relative magnitude of runoff is a good integrated index for a possible **teleconnection** as it results from the magnitude and from the time of occurrence of precipitation over the whole basin, as convoluted during its transportation within the terrestrial part of the hydrologic cycle.

This study will investigate if the different years can be statistically differentiated on their runoff responses to an SOI index. . Currently, El Niño is monitored **almost in real time** and forecasts are made regularly on its development; thus, if the regions under El Niño influence were to be known, as well as the temporal pattern of the discharges (relative magnitude and timing of occurrence for "normal" and El Niño years), this could be of definite **practical** interest, in the field of agriculture, selection of the next crop, for example) and in **operational hydrology** (management of the levels for dams and reservoirs).

3.2 Literature review

There is large body of literature devoted to the monitoring, understanding, modeling and forecasting of the spatio-temporal evolution of ENSO in its different phases. More scarce is the literature related to the actual operational applications of the acquired understanding of ENSO triggered anomalies. In most cases the relationships between the SOI and hydro meteorological episodes of interest (precipitation, discharge, floods and droughts) are established with **empirical** methods, researching for **categorical** events, the eventuality of significantly different parameters such as their mean value, time of occurrence, etc. With such an approach, Shukla and Paolina (1983) have related the **rain** conditions for India (drought, below-average rain, above average rain, very wet) to the phase (warm, cold) of ENSO.
Ropelewski et al. (1995) have computed the **quantile distributions** (10, 30, 50, 70 and 90 percentiles) of **precipitation** amounts occurring during different types of events (warm, neutral and cold) of the Southern Oscillation phases, for different regions of the world with demonstrated SOI-precipitation relationships. In this regard, it was found that the link between ENSO, rainfall and streamflow is statistically significant in most part of Australia (Chiew et al., 1998), but not sufficiently strong to consistently allow to predict rainfall and streamflow accurately. In all these studies, what has been put in relation was indices, cumulative number of events, cumulative precipitation amounts according to their belonging to empirically-defined phases of ENSO. In fact, the state of the knowledge acquired by TOGA and other programmes, about the practical consequences of ENSO is still blurred and certainly uncomplete (NRC, 1996) in what regards the geographical extent of ENSO related precipitation anomalies; thus, it is not strange for surface water runoff anomalies, directly related to abnormal rain amounts, timing or distributions, to be even less defined.

3.3 The Southern Oscillation Index (SOI)

The El Niño Southern Oscillation (ENSO) is a phenomenon which affects the large-scale meteorological behaviour of the tropical Pacific Ocean; this oscillation can be characterized by indices based either on variations of sea-temperatures (Sea Surface Temperature anomalies-SST-such as the Kaplan values available for the Niño3 area) or on differences of barometric pressures measured at sea level. In this report, the Southern Oscillation Index (SOI) will be used to quantify the strength of the Walker circulation across the Pacific at the origin of the phenomenon. This index is published and updated regularly by the Australian Bureau of Meteorology and is computed, using a method developed by **Troup** (1965), as the standardized anomaly of monthly **M**ean **S**ea **L**evel **P**ressure (MSLP) differences, measured at **Papeete**, Tahiti (149.6° W, 17.5° S) and **Darwin**, Australia (139.9° E, 12.4° S). It is calculated as follows:

$$\mathbf{SOI = 10 * [P_{diff} - P_{diffave}] / SD(P_{diff})}$$

where: P_{diff} = Tahiti MSLP - Darwin MSLP
$P_{diffave}$ = long term average (1951-1981) of P_{diff} for the month
$SD(P_{diff})$= standard deviation of P_{diff} for the month.

Table 42 presents the monthly SOI indices for the years 1877 to 1997, as computed by the preceding method and published by the Australian Bureau of Meteorology. Other indices have been proposed by the Climate Prediction Center of NOAA-NCEP, Washington DC, USA (Ropelewski and Jones, 1987), by the Climate Diagnostics Center of NOAA-CIRES, Boulder CO, USA (Wolter and Timlin, 1998) and others. Their differences is quite limited to the number of variables taken into account, by the period of reference and by an eventual normalization.

With this representation, negative values of the index (<-5) correspond to the **"warm"** phase (low SOI) of the ENSO index, referred often as an **El Niño event**; positive values (>+5) correspond to the **"cold"** phase (high SOI) of the ENSO index, also called **La Nina event** (Philander, 1990). **El Niño** and **La Nina years** are identified by smoothing the monthly SOI values by an 11-point moving average and selecting **years** with 5 consecutive months or more with smoothed SOI values lower than -5 or higher than +5 respectively, and lasting at least 3 seasons. **El Niño** and **La Nina months** are identified by smoothing the monthly SOI values by an 5-point moving average and selecting **strings of 5 consecutive months or more**, with smoothed SOI values lower than -5 or higher than +5 respectively, and lasting at least 3 seasons. In the literature, no precision is given about the definitions of either the year or the seasons, both characteristics being related to the particular climate and regime of the region under study. Under these circumstances, Table 36 presents the labeling of years and months used for this study according to the previously defined criteria, with the restriction that it uses calendar years and disregards the number of seasons that should be present to constitute an event. Periods that were **not labelled** as belonging to either El Niño or La Nina events were considered as **normal or neutral** conditions and used as reference.
One can also note that some researchers, recognizing the fact that some El Niño events were lasting more than one year, have tried to differentiate the months of the first year or rising limb by a subscript 0, from the months of the second year or sinking limb subscripted +1; in this study, no such differentiation was attempted.

3.4 Preliminary analysis: a yearly appraisal

Using the previously defined labeling of the years, a preliminary analysis was conducted in order to try to discriminate which areas and which river stations responded significantly to the El Niño/La Nina signals. Three populations of years were created (El Niño, La Nina and Neutral years) and **percentiles** (10%, 30%, 50%, 70% and 90%) of the runoff **distributions**, belonging to these populations were computed.
The results are presented on Tables 43 to 47; on the Table 43, as an example, one can see that, for the Murrumbidge River in Australia, the distribution of the yearly discharges varies from 74 to 2818 m^3/s for the 10% and 90% percentiles respectively, with a median value of 589 m^3/s for the years belonging to the La Nina phase. During the El Niño phases, the yearly discharges are distributed from 43 to 1656 m^3/s for the 10% and 90% percentiles, with a median value of 245 m^3/s. These values are fairly different: For a same recurrence period the values occurring during the El Niño phases are lower than the corresponding values during the La Nina phases; but a same yearly discharge can occur during either of the phases, but with different frequencies of exceedance. The same kind of behaviour occurs is other areas, but with less contrast than in the Oceania-Pacific area.
In the following part, some statistical techniques will be used in order to pinpoint which stations present statistically different discharges during the three phases of the ENSO; these techniques are applied to the 3 yearly series (mean yearly, monthly maximum and minimum).

3.4.1 Description and limitations of the discrimination techniques used

In this study, two statistical techniques were used: the classical **ANOVA** procedure and the **Kruskall Wallis** test. Both tests are used to test the same hypotheses :

$$\mathbf{H_0} : \mu_{Nina} = \mu_{Normal} = \mu_{Nino}$$

vs $\mathbf{H_1}$: At least two of the means are different

Where $\boldsymbol{\mu}_{\mathbf{Nina}}$, $\boldsymbol{\mu}_{\mathbf{Normal}}$ and $\boldsymbol{\mu}_{\mathbf{Nino}}$ are respectively the runoff means for La Nina, Normal and El Niño phases which are three **exclusive** modalities of the ENSO factor.The main distinction between these tests is the fact that **ANOVA** tests are parametric tests performed directly on measured values, while **Kruskall-Wallis** tests are non-parametric tests performed on the ranks associated to the measured values.

ANOVA procedure: The test underlying the ANOVA is a Fischer's test; the statistics **F** of the Fischer's test is a ratio of two mean squares, each of the mean squares being a sum of squares divided by the number of corresponding degrees of freedom.

In the present case, the first mean square is the mean square related to the ENSO factor **(CM_{EN}):**

$$\mathbf{CM_{EN} = \Sigma_i \, (y_{i.} - y_{..})^2 \, / \, (a\text{-}1)}$$

where $\mathbf{y_{i.}}$ is the mean of the observations for the modality **i** of the ENSO factor, **y..** is the mean of all the observations and a is the number of modalities of the ENSO factor (here a=3); one can note that the number of degrees of freedom is equal here to the number of modalities minus 1. One can note also that the more different from each others the means of the modalities ($\mathbf{y_{i.}}$) are, the larger $\mathbf{CM_{EN}}$ will be.

The second mean square used is the one associated with the error **(CM_E):**

$$\mathbf{CM_E = \Sigma_i \Sigma_j \, (y_{ij} - y_{i.})^2 \, / \, (N\text{-}a)}$$

where $\mathbf{y_{ij}}$ is the value of the **jth** observation of the **ith** modality, $\mathbf{y_{i.}}$ Is the mean of the observations for the modality **i** of the ENSO factor, **a** is the number of modalities (here a=3) and **N** is the total number of observations. In the present case, this mean square contains **all** sources of varibility which are **not** associated with the ENSO factor; one can note that the more different the observations are, within a modality of the ENSO factor, the larger $\mathbf{CM_E}$ will be.

The Fischer's statistics is then represented by the ratio $\mathbf{F = CM_{EN} / CM_E}$. One will conclude that the means of the three modalities of the ENSO factor are statistically different from each others, if the numerical values of the ratio **F** are large enough; the critical values of this statistics F are compiled in any good general-purpose statistical manual, such as Montgomery (1984). In conclusion, the effect of the ENSO factor is significant if the variability of the observations **between** the modalities of the factors is much **larger** than the variability of the observations **within** the modalities of the factors

Kruskall-Wallis test: In what concerns the Kruskall-Wallis' test, the method used is exactly the same (Fischer's test with the F statistics CM_{EN} / CM_E). The only difference is that each numerical observation is submitted to a "rank transformation" where values 1 to N are given to the N ordered observations. Thus the Kruskall-Wallis test is non-parametric, and as such quite robust to large outliers and non-normal distributions; when the ANOVA and Kruskall-Wallis' tests do not draw the same conclusion, the data can present particular characteristics invalidating one of the two methods. Generally speaking, large outliers or non-normal distributions could bring different conclusions from one method to the other: large outliers induce an increased variability in the ANOVA and the associated tests rarely conclude to a significant difference. When this is the case, Kruskall-Wallis' test is the most reliable method. When only the ANOVA rejects the null hypothesis, the interpretation is more difficult and ask for more detailed analyses of the data.

The tests results are summarized by their **p**-values. A p-value corresponds to the probability in repeated sampling of obtaining a statistic greater than the value actually observed if the null hypothesis (H_0) is true. In this case the null hypothesis is the absence of difference between levels of main effects (ENSO phases). We conclude to a significant effect of El Niño (or La Nina) phases, at the 5% significance level, if a **p-value is smaller than 0.05**.

As an **example**, one can read on Table 48, for the Darling River (mean yearly flows) that the **p**-values are respectively 0.0048 and 0.0017 for the ANOVA test and for the Kruskall-Wallis test; we thus conclude from the ANOVA and from the Kruskall-Wallis' tests that at least two of the three means are significantly different.

Duncan test: Since the alternative hypothese (H_1) of ANOVA and Kruskall-Wallis' tests does not produce clear conclusions, multiple comparison tests are performed to identify which means are significantly different from each other. This is a classical parametric test where the different modalities are compared two at a time; the results of Duncan's tests are summarized by letters in parentheses following numerical mean values. Two means with the same letter are not significantly different. Note that a code (AB) means A or B, so a level with this code is neither significantly different from a level with the code (A) nor from a level with the code (B).

Two words of **caution** about conflicting results:
Firstly, the Duncan's test is parametric and therefore is affected by outliers and non normal distributions. When Kruskall-Wallis' test and the ANOVA do not draw the same conclusion, Duncan's test should be considered with the same resevations as the ANOVA results.
Secondly, when the ANOVA results are not significant ($p>0.05$), Duncan's test results should not be considered. Duncan's test is **liberal** and may detect differences even if the ANOVA concluded that no significant difference exists. In this case the ANOVA test is more reliable in order to insure a global significance level of 5%.

As an **example**, on Table 48, for the Avoca River (mean yearly flows), the Duncan's test concludes that **La Nina** phases have mean runoff significantly **higher** than neutral periods, while El Niño phases are not significantly different from either La Nina or neutral phases.

3.4.2 Discrimination of the different phases of ENSO on a yearly basis

On Tables 48 through 52 the general results of the ANOVA and Kruskall Wallis' tests are presented for the same populations; runoff data (mean yearly, monthly maximum and monthly minimum) were tested for significance in their differences using the previously described statistical techniques: The classical parametric ANOVA, its non-parametric counterpart (Kruskall-Wallis) and the Duncan test for the equality of several mean values; with this later test, the results are presented not by a **p**-value of significance, but by adjacent letters allowing to see whether the 3 different mean values have been drawn from the same population; the (AB) code reflects a mean value that is not significantly different from either (A) or (B), which are themselves differentiated. On Tables 48 to 52, the significant differences are **shaded**.

From these tables, one can see that, for the 3 considered yearly discharge characteristics (mean, maximum and minimum monthly values), the **Oceania Pacific** area contains the most numerous rivers where the El Niño/La Nina signals have been detected; the **Far East Asia, South East Asia** and **Indian Subcontinent** present some **teleconnection** to the El Niño phenomenon whereas **Central Asia** presents none.

Generally, the El Niño years ("**warm**" events, with reference to the sea water temperature on the Southern Pacific Peruvian shore around Christmas, **low SOI**), when tested significantly different from other years, produce a **low hydraulicity** , e.g. less runoff than neutral, normal years and can thus be qualified as **dry**. At the opposite, La Nina years ("**cold**" events, **high SOI**) produce generally an **high hydraulicity**, e.g. more runoff than neutral, normal years and can thus be qualified as **wet**.

To this general situation, there is an interesting remarkable **exception** in New Zealand: The **Mataura River**; this river exhibits **higher** runoff during El Niño years that during Neutral years which are also themselves **higher** than during La Nina years, a situation **opposite** to the one prevailing for most influenced rivers within the areas under study. This makes the New Zealand situation a special case as the **Motu river** located at the North-East of the archipelago exhibits a **significant dry El Niño** signal, the **Mataura river**, at the South-West of the archipelago, a **significant wet El Niño** signal, and the 3 rivers in-between: the **Ongarue, Hurunui and Ahuriri** no **teleconnection** at all.This has to be verified by a confirmatory analysis on the finer monthly scale, but it is probably the results of some **orographic effects** and of differentiated local **wind directions**. In its Climate Impacts Database, the **Greenpeace Organization** states: "The effects of El Niño are being felt in New Zealand. In normal seasons between El Niño events, easterly and northeasterly winds predominate, bringing rain to the north and east of the country, and drier conditions to the west and south. During El Niño events such as the current protracted one, **drought** is common in the **north and east** of the country, while the **south and west** are likely to experience **heavy summer rain**. Until the Southern Oscillation returns to the La Nina state, this situation is likely to continue. ("Go south to duck El Niño dry period", New Zealand Farmer, 28 September 1994). One way to look at it is that the dry weather touring in the North Island would balance the wet weather in the south of the South Island. The South Island west coast is always wet anyway..."

3.5 Confirmatory analysis: a monthly evaluation

In the previous analysis, the populations were discriminated on the basis of entire calendar years as shown on Table 42. This definition was very approximate and rough, as an El Niño-labelled year could contain a few non El Niño-labelled months, or conversely, a few El Niño-labelled months could be part of some non El Niño-labelled years.
In this confirmatory analysis, 36 monthly populations were defined more accurately, using the smoothed SOI values given in on Table 42 to classify the months; the mean values of each monthly sub-population are tested for significance (p-value < 0.05) in differences with the ensemble mean value for the month. Global mean values for all the months belonging to the 3 studied sub-populations were also tested.

Tables 53 to 57 present these statistical results for El Niño/La Nina/Neutral months, e.g., for each month of each sub-population and for the ensemble set, the mean values, the standard deviations, the numbers of observations used to define the subpopulation and the p-value related to the equality of the means of the sub-populations. On the tables, monthly means that are significantly different from the general mean appear in **shaded areas**; the monthly seasonal evolution of the 3 types of years can also be easily compared either for their relative magnitudes or for eventual systematic shifts or lags in the occurrence of high/low events (floods/ droughts). Most of the signals can be found in the Oceania-Pacific area and in the Indian Subcontinent; in these case one should note the **very large internal variability** of the monthly values, as quantified by the **standard deviation**: As an example, on table 53d, one can see that, for the Motu River, the monthly discharge for August si significantly different during the La Nina phase (mean value of 138 m^3/s with a standard deviation of 47.7 m^3/s) from the two other phases: El Niño (mean value of 65 m^3/s and standard deviation of 18.6 m^3/s) and Neutral (mean value 87 m^3/s with a standard deviation of 62.9 m^3/s). This large natural statistical variability is limiting, at this stage, the practical interest of categorical forecasting.

If one defines as **influenced** each river station for which **at least one** monthly runoff value is significantly different during El Niño/La Nina labelled events from its mean value for all years; then, the Table 58 presents a synthesis by region of the strength of the **teleconnection** between the ENSO phenomenon and runoff; it shows the number of stations related to the total number of stations in the area that are influenced by the different phases of the event.
The Figure 8 maps the geographical distribution of the stations teleconnected to the phenomenon and shows which phase of the ENSO relates to this signal.

3.6 Synthesis

The study shows that, in most areas of the Asia-Pacific region, a strong El-Niño-related signal can be found in the historical river runoff series stored at the Global Runoff Data Centre (GRDC). This signal is particularly strong in the Australian rivers whose regime in known to be highly contrasted. The Indian Subcontinent is also globally affected in its monsoon regime. On most stations, this effect consists mainly in an reduction/amplification of the seasonal fluctuations for El Niño/La Nina-labelled events, respectively.
In most instances in this part of the world, the **El Niño** phase of the ENSO is a relatively **dry phase** and the **La Nina** phase a relatively **wet phase** compared to the unlabelled normal phases, but there are some exceptions. At the working interval of one month, **no systematic shift** (at the

scale of a subregional area) was detected in the normal occurrence timing of either high or low flows. During El Niño/La Nina episodes, the amplitude of the **high flows** (floods) can significantly be modified, whereas **low flows** are much more stable, probably because of the **buffering** capacity and of the **delaying** effect of the groundwater reserve contribution to runoff.

In this study, the **SOI** was used to **categorize** the different events; despite numerous attempts, it was not possible to establish significant linear regressive relationships between the successive values of the SOI , either **synchronous or lagged**, and the measured runoffs, that could be used to quantitatively forecast the runoff, given the actual and past SOI values; some signicant correlations (representing up to 50% of the total variance) were found, but they related to stations of the Oceania-Pacific area where the intrinsic variability (represented by the ratio of the standard deviation to the mean value) was very high, giving way to **very wide confidence intervals** around the linear model and by the way limiting its practical forecasting power, thus the amplitude of the discharge anomalies during an ENSO phase can not be deduced **in a simple way** from the successive values of the SOI; nevertheless, the **simple belonging** to a phase allows, in some cases, to make discriminated forecasts of the expected amplitude of runoffs to come; but the confidence intervals around these distinct expectations are generally (and regretfully) quite wide.
In Figure 8, one can see that most rivers of Australia, of the Indian subcontinent and surprisingly enough some rivers of the Northern East Siberia seem to be affected mainly by the **La Nina** phase of the ENSO phenomenon, whereas rivers in Eastern Australia, Japan, Taiwan and Central China seem more responsive to the **El Niño** phase. New Zealand exhibits a very mixed response, probably as the result of local orographic effects. A line joining southern Japan to the Caucasus can be seen as the **northern** limit of the ENSO influence.

3.7 Discussion and direction for further work

In the previous section, we have described our unsuccessful attempt to try to take advantage of the real time availability of the SOI to relate with linear lagged models the monthly discharge Q to the actual and past values of the SOI; such a linear model can be written:

$$\mathbf{Q}_m = \mathbf{a} \cdot \mathbf{SOI}_m + \mathbf{b} \cdot \mathbf{SOI}_{m-1} + \mathbf{c} \cdot \mathbf{SOI}_{m-2} + .. + \varepsilon$$

where **m** is a monthly time index and ε the remaining error; in this scheme, the relatively large magnitude of unexplained variance ε^2 is responsible for the fact that such a model can be of little practical forecasting use, even if some correlations between Q and SOI are significantly different from zero, the confidence intervals around the regression line being **widely apart**. There is often a significant correlation coefficient between $\mathbf{Q}_m$ and $\mathbf{SOI}_m$, but this correlation explains at most half of the variability, which is often very large.
An other approach would be to suppose that the discharges are **also** available almost in **real time**, then instead of using the lagged regression analysis technique with the sole SOI values as regressors, it would be possible to use **for each series** the classical **Box & Jenkins** technique, with first the identification of their **internal structure**s, and then the estimation of the **optimal transfer function** between them, in order to devise a **one-step-ahead** forecasting model:

$$\mathbf{Q}_m = \Theta\,(\mathbf{SOI}_m, \mathbf{SOI}_{m-1}, \mathbf{SOI}_{m-2}, \ldots, \mathbf{Q}_{m-1}, \mathbf{Q}_{m-2}, \mathbf{Q}_{m-3}, \ldots) + \varepsilon$$

This type of analysis, which is time-consuming, can not be performed as a batch treatment, but must be realized for each individual series at a time; as such it should not be attempted on the whole GRDC data base, but preferably on some problematic river basins of interest. Should this type of model model prove to be a good predictor for the monthly runoff (i.e. explaining most of the variance), then the working interval could be widened to two or three months and tested for the remaining (reduced) forecasting power in the resulting model; Such models with wider intervals would lead of course to increased **operational** benefits as they could allow to generate some needed lag-time between the forecast and the event itself for mitigation measures to be taken.
If the Box & Jenkins **monthly** model were proven to be unsatisfactory (too much residual variance), then there would be no need to pursue in this direction: Some other type of external information would be needed to try to build a better forecasting model; let's remind here that **no** information related to the precipitations, neither in amount nor in timing, was introduced in this study. Such information, possibly compounded as a regional precipitation index (PI), could be used in a regression relating the actual discharges to the past values of the SOI and of the PI:

$$\mathbf{Q}_{m} = \Theta\,(\,\mathbf{SOI}_{m}\,,\mathbf{SOI}_{m-1}\,,\mathbf{SOI}_{m-2}\,,\ldots,\mathbf{PI}_{m-1}\,,\mathbf{PI}_{m-2}\,,\mathbf{PI}_{m-3}\,,\ldots)\;+\varepsilon$$

In addition, the precipitation index provides some lag-time before the delivery of the actual runoff at the gauging station (the concentration time of the watershed).

3.8 Operational conclusion

From the point of view of operational, the goal remains to be able to forecast months ahead the occurrence of abnormal high or low flows (floods/droughts) in order to mitigate the extent of possible damages. The previous results could be exploited as part of an agricultural or flood warning system, taking advantage of the fact that the development of the different phases of the ENSO is actually forecasted months ahead and with a good accuracy by the climatologists.
From a practical and **operational** point of view, Tables 53 to 57 could be used to compute, in the cases where differences are significant (shaded cells), the ratios between the expected monthly runoffs during El Niño and La Nina events and the global mean monthly values; As an example, one can see on Table 53a, for the Darling River which is highly influenced by the ENSO, that during the El Niño phase the lowest monthly runoff occurs in september (1575 m^3/s) whereas, for the same month, the expected runoffs are respectively 23040 m^3/s and 12425 m^3/s for the La Nina and the neutral phases. Thus one might think that it could be wise, in the case of an advertised El Niño phase to come, to store some water in reservoirs or dams during the high flow period, in order to be able to release it later to maintain a given level to the river for transportation purposes or to ensure more irrigation or other urban or industrial uses that could have been possible with the sole natural water supply.
Conversely, for the same river, the high flows occur, during the La Nina phase in August (81326 m^3/s) where, during the same month, only 8764 m^3/s and 9068 m^3/s are expected respectively during El Niño and neutral phases. In this situation, getting rid of some water stored in dams and reservoirs as soon as a La Nina phase to come is advertised seems to be a good strategy in order to make room for the expected high flow and minimize the damage related to flooding.
Even if the variability is quite large and some of the differences in runoff not quite statistically significant, the general direction of the mitigation strategies stays valid.
One should note that the values reported in this report are **not** related to the **strength** of the

actual SOI index, but to the **sole** belonging to a specific phase of the ENSO; as the forecasting power of the models relating the runoff to the SOI and other explaining factors will improve, the mitigating strategies shall be able to be refined and fine tuned.

3.9 References of the second section

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4 Conclusions

The database of world river runoffs maintained at the Global Runoff Data Centre (GRDC) was exploited to address two questions pertaining to selected rivers of the Asia-Pacific region:

The first one dealt with the detection and classification of changes over the duration of their historical records, in the mean yearly runoffs of rivers. It has been found that most of the changes occurred during the **sixties** and the **seventies**, a period where most of the large reservoirs were completed.

The second one was exploring the **teleconnection** between the ENSO phenomenon and the recorded historical runoff, in order to assess the magnitude and timing of the impact on river discharges as well as the geographical extent of the influence of the ENSO-generated signal. It was found that its influence exceeded largely the south Pacific area and that all studied areas were more or less affected with the notable exception of the most continental part of Asia.

In both cases, the availability of a large runoff database allowed to perform global analysis, downplaying local singularities whose explanation would have demanded a detailed (and lacking) knowledge of the historical background of each river and water basin.

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Table 1: **Characteristics of the selected Rivers of the Oceania-Pacific area.**

GRDC number	River	Station	Country code	Latitude	Longitude	Watershed area	Begin year	End year	% missing data	Duration (years)
5204255	Darling River	Bourke Town	AU	3009S	14594E	386000	1944	1993	2.9	49
5101301	Fitzroy	The Gap	AU	2310S	15010E	135860	1965	1995	2.5	30
5708145	Daly	Mount Nancar	AU	1383S	13241E	47000	1970	1995	3.4	25
5101161	Herbert River	Ingham	AU	1863S	14613E	8805	1916	1996	1.4	80
5708185	Mary River (1)	Mount Bundy	AU	1292S	13165E	5700	1957	1995	0.6	38
5101381	Mary River (2)	Miva	AU	2595S	15250E	4830	1910	1995	0	85
5302242	Mitchell River	Glenaladale	AU	3775S	14737E	3900	1938	1987	2.4	49
5304080	Avoca River	Coonooer	AU	3644S	14330E	2670	1890	1993	1.3	103
5803600	Huon River	above Frying Pan Creek	AU	4304S	14684E	2097	1949	1994	0.9	45
5204105	Murrumbidgee River	Mittagang Crossing	AU	3618S	14909E	1891	1927	1993	1.1	66
5202040	Nymboida River	Nymboida	AU	2998S	15272E	1660	1909	1993	2.6	84
5606145	Serpentine River	Serpentine Falls	AU	3237S	11601E	769	1911	1992	0.9	81
5762050	Tipindje	Ouen-Kout	NC	2078S	16499E	247	1956	1984	1.4	28
5762700	Riviere Des Lacs	Goulet	NC	2223S	16685E	69	1958	1984	0	26
5868300	Mataura	Gore Hbr	NZ	4610S	16895E	3465	1961	1993	0	32
5864150	Motu	Houpoto	NZ	3786S	17765E	1393	1958	1990	1.7	32
5865550	Ongarue	Taringamutu	NZ	3886S	17524E	1075	1963	1994	0	31
5867500	Hurunui	Mandamus	NZ	4279S	17255E	1070	1957	1990	4.2	33
5868200	Ahuriri	Sth Diadem	NZ	4447S	16973E	557	1964	1994	0	30

Table 2: **Characteristics of the selected Rivers of the Far East Asia area.**

GRDC number	River	Station	Country code	Latitude	Longitude	Watershed area	Begin year	End year	% missing data	Duration (years)
2588550	Tone	Kurihashi	JP	3613N	13970E	8588	1938	1986	6.1	48
2587100	Ishikari	Ishikari-Ohashi	JP	4312N	14153E	12697	1954	1986	6.3	32
2589500	Shinano	Ojiya	JP	3730N	13880E	9719	1965	1988	4.5	23
2588200	Yodo	Hirakata	JP	3480N	13563E	7281	1965	1988	4.2	23
2590100	Chikugo	Senoshita	JP	3353N	13080E	2315	1965	1988	4.2	23
2181800	Changjiang	Hankou	CI	3058N	11428E	1488036	1865	1986	1.2	121
2106500	Songhuajiang	Haerbin	CI	4577N	12658E	391000	1898	1987	4.4	89
2178300	Yongding	Guanting	CI	4023N	11560E	42500	1925	1988	6.6	63
2180500	Jinghe	Zhangjiashan	CI	3463N	10860E	43200	1933	1986	7.6	53
2181400	Wujiang	Gongtan	CI	2890N	10835E	58300	1939	1982	9.1	43
2180800	Huanghe(Yellow River)	Huayuankou	CI	3492N	11365E	730036	1947	1988	5.2	41
2186900	Beijiang	Hengshi	CI	2385N	11327E	34013	1954	1987	1	33
2186950	Dongjiang	Boluo	CI	2317N	11430E	25325	1960	1987	0	27
2998100	Yana	Dzanghky	RS	6967N	13533E	216000	1938	1984	1.8	46
2901300	Penzhina	Kamenskoe	RS	6242N	16603E	71600	1957	1984	3.6	27
2998400	Indigirka	Vorontsovo	RS	6958N	14735E	305000	1937	1994	1	57
2903420	Lena	Kusur	RS	7070N	12765E	2430000	1935	1994	0	59
2906200	Shilka	Sretensk	RS	5225N	11772E	175000	1897	1985	1.9	88
2902800	Kamchatka	Kluchi	RS	5643N	16105E	45600	1931	1984	0.8	53
2906700	Amur (1)	Khabarovsk	RS	4843N	13505E	1630000	1897	1985	0.9	88
2906900	Amur (2)	Komsomolsk	RS	5063N	13712E	1730000	1933	1990	0	57
2385760	Li-Wu	Lu-Shui	TW	2418N	12150E	435	1960	1993	0	33
2385500	Yufeng	Dahan	TW	2465N	12128E	335	1964	1989	0	25
2385400	Sandimen	Ailiao	TW	2270N	12063E	408	1964	1989	0	25
2385200	Xinfadaqiao	Laonong	TW	2305N	12065E	812	1964	1989	0	25

Table 3: **Characteristics of the selected Rivers of the South-East Asia area.**

GRDC number	River	Station	Country code	Latitude	Longitude	Watershed area	Begin year	End year	% missing data	Duration (years)
5654500	Pampanga	San Agustin	PH	1517N	12078E	6487	1946	1974	5.7	28
5654100	Bonga	Bangay	PH	1808N	12070E	534	1947	1976	6.1	29
5223100	Kelantan	Guillemard Bridge	MS	577N	10215E	11900	1950	1986	7.7	37
2969100	Mekong (1)	Mukdahan	TH	1653N	10473E	391000	1925	1991	0.4	66
2969150	Nam Chi	Yasothon	TH	1578N	10415E	43100	1954	1991	0.6	37
2969200	Nam Mun	Ubon	TH	1522N	10487E	104000	1956	1991	1.1	35
2964080	Nan	Sirikit Dam	TH	1777N	10055E	13300	1956	1988	2.9	32
2969010	Mekong (2)	Chiang Saen	TH	2027N	10010E	189000	1961	1991	1	30
2969095	Mekong (3)	Nakhon Phanom	TH	1740N	10480E	373000	1962	1991	3.3	29

Table 4: **Characteristics of the selected Rivers of the Indian subcontinent area**

GRDC number	River	Station	Country code	Latitude	Longitude	Watershed area	Begin year	End year	% missing data	Duration (years)
2357500	Mahaweli Ganga	Peradeniya	SB	727N	8058E	1189	1950	1984	2.8	34
2357750	Gin Ganga	Agaliya	SB	618N	8020E	681	1928	1989	1.7	61
2548400	Karnali River	Chisapani	NE	2864N	8129E	42890	1962	1993	0	31
2549300	Kali Gandaki (1)	Setibeni	NE	2801N	8360E	6630	1964	1993	0.3	29
2549350	Kali Gandaki (2)	Kotagaon Shringe	NE	2775N	8435E	11400	1964	1985	4.2	21
2550500	Tamur River	Mulghat	NE	2693N	8733E	5640	1965	1986	0	21
2646200	Ganges R. (1)	Harlinge Bridge	BW	2408N	8903E	846300	1934	1989	2.1	55
2846800	Ganges R.(2)	Farakka	IN	2500N	8792E	935000	1949	1985	0	36
	Sapt Kosi	Barashetra	NE				1947	1978	0	31
2856900	Godavari	Polavaram	IN	1692N	8178E	299320	1902	1979	7	77
2854300	Krishna	Vijayawada	IN	1652N	8062E	251355	1901	1979	6.3	78
2853500	Narmada	Jamtara	IN	2302N	7993E	16576	1949	1974	0.3	25

Table 5: **Characteristics of the selected Rivers of the Central Asia area.**

GRDC number	River	Station	Country code	Latitude	Longitude	Watershed area	Begin year	End year	% missing data	Duration (years)
2917100	Amu-Darya	Chatly	UZ	4228N	5970E	450000	1931	1973	2.1	42
2917450	Zaravchan	Dupuli	TA	3938N	6777E	10200	1932	1994	1.3	62
2917700	Gunt	Khorog	TA	3753N	7152E	13700	1940	1985	0	45
2917900	Vakhsh	Tutkaul	TA	3833N	6930E	31200	1932	1967	1.6	35
2910470	Biya	Biysk	RS	5252N	8527E	36900	1895	1985	0	90
2912600	Ob	Salekhard	RS	6657N	6653E	2949998	1930	1994	0	64
2910490	Tom (1)	Novokuznetsk	RS	5375N	8710E	29800	1894	1985	0	91
2910300	Tom (2)	Tomsk	RS	5658N	8487E	57000	1965	1990	0	25
2912400	Tura	Tiumen	RS	5715N	6553E	58500	1896	1985	0	89
2909150	Yenisei	Igarka	RS	6748N	8650E	2440000	1936	1995	0	59
2916200	Syr-Darya	Tyumen-Aryk	KZ	4405N	6705E	219000	1930	1984	7	54
2919200	Ural	Kushum	KZ	5085N	5128E	190000	1915	1984	4.3	69
2916850	Naryn	Uch-Kurgan	KG	4117N	7210E	58400	1933	1990	0	57

Table 6 Segmentations of the mean yearly discharges (Oceania-Pacific area).

GRDC	River	Begin	End	1st Segment		Begin	End	2nd Segment		Begin	End	3rd Segment	
number		year	year	mean	s.d.	year	year	mean	s.d.	year	year	mean	s.d.
5204255	Darling River	1944	1993	11000	14500								
5101301	Fitzroy	1965	1995	165	174								
5708145	Daly	1970	1995	211	160								
5101161	Herbert River	1916	1973	107	58	1974	1977	217	112	1978	1996	79	57
5708185	Mary River (1)	1957	1995	49	30								
5101381	Mary River (2)	1910	1995	38	33								
5302242	Mitchell River	1938	1987	28	15								
5304080	Avoca River	1890	1894	317	167	1895	1987	6.4	6.9	1988	1993	440	241
5803600	Huon River	1949	1994	84	18								
5204105	Murrumbidgee River	1927	1949	976	450	1950	1955	1700	828	1957	1993	503	356
5202040	Nymboida River	1909	1993	2140	1290								
5606145	Serpentine River	1911	1970	6.3	3.8	1971	1992	0.17	0.46				
5762050	Tipindje	1956	1984	9.6	6.9								
5762700	Riviere Des Lacs	1958	1983	4.7	1.5								
5868300	Mataura	1961	1993	65	18								
5864150	Motu	1958	1990	90	20								
5865550	Ongarue	1963	1994	33	61								
5867500	Hurunui	1957	1990	51	11								
5868200	Ahuriri	1964	1994	23	4.3								

Table 7 Segmentations of the maximum monthly discharges (Oceania-Pacific area).

GRDC	River	Begin	End	1st Segment		Begin	End	2nd Segment		Begin	End	3rd Segment	
number		year	year	mean	s.d.	year	year	mean	s.d.	year	year	mean	s.d.
5204255	Darling River	1944	1993	43400	62100								
5101301	Fitzroy	1965	1995	1170	1400								
5708145	Daly	1970	1995	1340	1100								
5101161	Herbert River	1916	1996	536	360								
5708185	Mary River (1)	1957	1995	348	246								
5101381	Mary River (2)	1910	1995	216	234								
5302242	Mitchell River	1938	1987	83	45								
5304080	Avoca River	1890	1894	1240	594	1895	1987	32	35	1988	1993	2300	1100
5803600	Huon River	1949	1994	193	60								
5204105	Murrumbidgee River	1927	1949	3130	1630	1950	1956	5790	3250	1957	1993	1650	1280
5202040	Nymboida River	1909	1993	7660	5060								
5606145	Serpentine River	1911	1970	25.2	17.4	1971	1992	1	2.5				
5762050	Tipindje	1956	1984	43	31								
5762700	Riviere Des Lacs	1958	1983	15	5.6								
5868300	Mataura	1961	1993	129	47								
5864150	Motu	1958	1990	190	45								
5865550	Ongarue	1963	1994	74	21								
5867500	Hurunui	1957	1990	104	32								
5868200	Ahuriri	1964	1994	47	12								

Table 8 Segmentations of the minimum monthly discharges (Oceania-Pacific area).

GRDC	River	Begin	End	1st Segment		Begin	End	2nd Segment		Begin	End	3rd Segment	
number		year	year	mean	s.d.	year	year	mean	s.d.	year	year	mean	s.d.
5204255	Darling River	1944	1993	898	1130								
5101301	Fitzroy	1965	1995	1.8	2.9								
5708145	Daly	1970	1973	8	1.9	1974	1995	18.5	5				
5101161	Herbert River	1916	1949	5.1	4.5	1950	1950	27	0	1951	1996	5.2	4
5708185	Mary River (1)	1957	1995	0.02	0.07								
5101381	Mary River (2)	1910	1995	2	2.2								
5302242	Mitchell River	1938	1956	3.2	2.4	1957	1987	1.7	1.4				
5304080	Avoca River	1890	1894	3.2	4.5	1895	1987	0.02	0.14	1988	1993	6.7	3.2
5803600	Huon River	1949	1949	42	0	1950	1994	17.8	8.3				
5204105	Murrumbidgee River	1927	1949	92	79	1950	1959	162	51	1960	1993	57	32
5202040	Nymboida River	1909	1993	415	303								
5606145	Serpentine River	1911	1964	0	0	1965	1969	0.8	0.4	1970	1992	0	0
5762050	Tipindje	1956	1984	0.4	0.7								
5762700	Riviere Des Lacs	1958	1983	0.2	0.5								
5868300	Mataura	1961	1993	27	11								
5864150	Motu	1958	1990	25	11								
5865550	Ongarue	1963	1994	11	4.1								
5867500	Hurunui	1957	1990	23	7.2								
5868200	Ahuriri	1964	1994	11	2.7								

Table 9 Segmentations of the mean yearly discharges (Far East Asia area).

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
2588550	Tone	1938	1960	293	67	1961	1985	214	47				
2587100	Ishikari	1954	1985	467	97								
2589500	Shinano	1965	1966	903	294	1967	1988	496	70				
2588200	Yodo	1965	1966	493	228	1967	1988	251	51				
2590100	Chikugo	1965	1988	119	45								
2181800	Changjiang	1865	1953	23800	3280	1954	1985	22000	2430				
2106500	Songhuajiang	1898	1927	895	403	1928	1987	1360	404				
2178300	Yongding	1925	1948	39	16	1949	1962	58	15	1963	1988	25	13
2180500	Jinghe	1933	1986	61	22								
2181400	Wujiang	1939	1982	1140	213								
2180800	Huanghe(Yellow River)	1949	1968	16200	453	1969	1988	12300	336				
2186900	Beijiang	1954	1987	1080	298								
2186950	Dongjiang	1960	1987	755	188								
2998100	Yana	1938	1984	918	181								
2901300	Penzhina	1957	1984	695	160								
2998400	Indigirka	1937	1994	1590	322								
2903420	Lena	1935	1994	16600	2010								
2906200	Shilka	1898	1982	391	135	1983	1985	710	100				
2902800	Kamchatka	1931	1959	733	74	1960	1984	831	67				
2906700	Amur (1)	1897	1954	8230	1850	1955	1963	10800	1040	1964	1985	7700	1590
2906900	Amur (2)	1933	1990	9870	1960								
2385760	Li-Wu	1960	1993	3280	977								
2385500	Yufeng	1964	1967	1130	268	1968	1989	1810	411				
2385400	Sandimen	1964	1989	3310	1160								
2385200	Xinfadaqiao	1964	1989	7000	2270								

Table 10 Segmentations of the maximum monthly discharges (Far East Asia area).

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
2588550	Tone	1938	1960	748	264	1961	1986	538	218				
2587100	Ishikari	1954	1985	1260	357								
2589500	Shinano	1967	1988	1080	218								
2588200	Yodo	1967	1988	627	233								
2590100	Chikugo	1965	1988	365	158								
2181800	Changjiang	1865	1986	43800	6370								
2106500	Songhuajiang	1898	1931	2500	1260	1932	1987	3600	1810				
2178300	Yongding	1925	1962	127	90	1963	1988	55	31				
2180500	Jinghe	1934	1986	178	90								
2181400	Wujiang	1939	1982	3130	903								
2180800	Huanghe(Yellow River)	1947	1968	4050	1080	1969	1988	3060	1210				
2186900	Beijiang	1954	1987	3180	1160								
2186950	Dongjiang	1960	1987	1840	695								
2998100	Yana	1938	1984	4040	1010								
2901300	Penzhina	1957	1984	4080	1360								
2998400	Indigirka	1937	1994	6310	1390								
2903420	Lena	1935	1994	73900	10800								
2906200	Shilka	1898	1985	1250	525								
2902800	Kamchatka	1931	1959	1770	234	1960	1984	2010	311				
2906700	Amur (1)	1897	1954	20600	5720	1955	1961	28200	3430				
2906900	Amur (2)	1933	1990	22900	5050								
2385760	Li-Wu	1960	1993	10100	4090								
2385500	Yufeng	1964	1989	5790	2240								
2385400	Sandimen	1964	1989	14600	5500								
2385200	Xinfadaqiao	1964	1989	26500	11900								

Table 11 Segmentations of the minimum monthly discharges (Far East Asia area).

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
2588550	Tone	1938	1947	94	11	1948	1960	134	26	1961	1985	84	14
2587100	Ishikari	1954	1985	191	48								
2589500	Shinano	1965	1983	266	51	1984	1988	196	24				
2588200	Yodo	1965	1983	127	29	1984	1988	77	5				
2590100	Chikugo	1965	1974	36	10	1975	1988	46	6				
2181800	Changjiang	1865	1904	6340	1560	1905	1985	7260	1370				
2106500	Songhuajiang	1898	1944	107	53	1945	1953	217	29	1954	1987	320	118
2178300	Yongding	1925	1956	11	7	1957	1959	23	2	1960	1988	10	3.5
2180500	Jinghe	1933	1983	17	4	1984	1986	24	4				
2181400	Wujiang	1939	1982	279	71								
2180800	Huanghe(Yellow River)	1949	1957	574	61	1958	1981	340	129	1982	1988	513	100
2186900	Beijiang	1954	1969	201	33	1970	1987	271	88				
2186950	Dongjiang	1960	1973	209	68	1974	1987	360	113				
2998100	Yana	1938	1942	3.4	2.5	1943	1984	0.06	0.24				
2901300	Penzhina	1957	1984	21	5.9								
2998400	Indigirka	1937	1990	7.4	2.5	1991	1992	16	3.2	1993	1994	8.1	1.6
2903420	Lena	1935	1979	1120	247	1980	1987	1820	293	1988	1994	2250	271
2906200	Shilka	1897	1961	3.2	1.8	1962	1965	13	6	1966	1985	3	2
2902800	Kamchatka	1931	1946	331	23	1947	1960	377	20	1961	1984	415	25
2906700	Amur (1)	1897	1947	488	146	1948	1985	777	161				
2906900	Amur (2)	1933	1954	721	166	1955	1983	1070	246	1984	1990	2020	229
2385760	Li-Wu	1960	1993	1080	292								
2385500	Yufeng	1964	1989	429	139								
2385400	Sandimen	1964	1989	64	21								
2385200	Xinfadaqiao	1964	1989	1140	363								

Table 12 Segmentations of the mean yearly discharges (South East Asia area).

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
5654500	Pampanga	1946	1974	228	67								
5654100	Bonga	1947	1967	30	10	1968	1976	13	5.2				
5223100	Kelantan	1950	1986	554	128								
2969100	Mekong (1)	1925	1971	8330	958	1972	1991	7010	963				
2969150	Nam Chi	1954	1991	244	77								
2969200	Nam Mun	1956	1991	623	197								
2964080	Nan	1956	1988	175	52								
2969010	Mekong (2)	1961	1971	3000	435	1972	1991	2560	277				
2969095	Mekong (3)	1962	1990	7070	1080								

Table 13 Segmentations of the maximum monthly discharges (South East Asia area).

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
5654500	Pampanga	1946	1974	753	267								
5654100	Bonga	1947	1967	114	43	1968	1976	64	38				
5223100	Kelantan	1950	1986	1440	687								
2969100	Mekong (1)	1925	1973	24400	3540	1974	1991	20200	2970				
2969150	Nam Chi	1954	1991	827	282								
2969200	Nam Mun	1956	1991	2390	899								
2964080	Nan	1956	1988	690	281								
2969010	Mekong (2)	1961	1971	8350	1790	1972	1991	6170	962				
2969095	Mekong (3)	1962	1982	21400	3880	1983	1991	17100	2970				

Table 14 Segmentations of the minimum monthly discharges (South East Asia area).

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
5654500	Pampanga	1946	1974	24	11								
5654100	Bonga	1947	1966	1.9	1.1	1967	1976	0.8	0.8				
5223100	Kelantan	1950	1957	341	77	1958	1986	222	90				
2969100	Mekong (1)	1925	1950	1560	249	1951	1991	1410	183				
2969150	Nam Chi	1954	1966	5.6	2.6	1967	1991	39	18				
2969200	Nam Mun	1956	1966	13	5.5	1967	1991	68	22				
2964080	Nan	1956	1973	17	4	1974	1988	28	9				
2969010	Mekong (2)	1961	1970	761	79	1971	1991	844	60				
2969095	Mekong (3)	1962	1984	1490	218	1985	1991	1230	127				

Table 15 **Segmentations of the mean yearly discharges (Indian Subcontinent area).**

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
2357500	Mahaweli Ganga	1950	1984	66	15								
2357750	Gin Ganga	1928	1989	62	11								
2548400	Karnali River	1962	1993	1380	225								
2549300	Kali Gandaki (1)	1964	1969	253	25	1970	1976	311	34	1977	1993	245	31
2549350	Kali Gandaki (2)	1964	1968	546	57	1969	1985	448	68				
2550500	Tamur River	1965	1986	334	44								
2646200	Ganges R. (1)	1934	1989	11400	2130								
2846800	Ganges R.(2)	1949	1985	12500	2400								
	Sapt Kosi	1947	1967	1540	206	1968	1978	1800	204				
2856900	Godavari	1902	1979	3050	985								
2854300	Krishna	1901	1964	1780	445	1965	1979	1070	488				
2853500	Narmada	1949	1974	304	153								

Table 16 **Segmentations of the maximum monthly discharges (Indian Subcontinent area).**

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
2357500	Mahaweli Ganga	1950	1984	160	50								
2357750	Gin Ganga	1928	1989	135	37								
2548400	Karnali River	1962	1993	4390	815								
2549300	Kali Gandaki (1)	1964	1993	873	132								
2549350	Kali Gandaki (2)	1964	1985	1530	254								
2550500	Tamur River	1965	1986	998	138								
2646200	Ganges R. (1)	1934	1945	35300	5230	1946	1989	42600	767				
2846800	Ganges R.(2)	1949	1985	45900	9120								
	Sapt Kosi	1947	1969	4500	851	1970	1978	5580	783				
2856900	Godavari	1902	1979	13500	5100								
2854300	Krishna	1901	1970	7300	2280	1971	1979	4470	2320				
2853500	Narmada	1949	1971	1490	560	1972	1974	3580	3570				

Table 17 **Segmentations of the minimum monthly discharges (Indian Subcontinent area).**

GRDC number	River	Begin year	End year	1st Segment mean	s.d.	Begin year	End year	2nd Segment mean	s.d.	Begin year	End year	3rd Segment mean	s.d.
2357500	Mahaweli Ganga	1950	1983	13	7.2								
2357750	Gin Ganga	1928	1971	21	6	1972	1989	14	7				
2548400	Karnali River	1962	1993	317	61								
2549300	Kali Gandaki (1)	1964	1975	34	7	1976	1985	45	2	1986	1993	55	5
2549350	Kali Gandaki (2)	1964	1985	75	20								
2550500	Tamur River	1965	1986	50	14								
2646200	Ganges R. (1)	1934	1975	1960	357	1976	1989	1000	270				
2846800	Ganges R.(2)	1949	1985	1730	317								
	Sapt Kosi	1947	1978	342	35								
2856900	Godavari	1902	1924	40	40	1925	1969	72	36	1970	1979	146	59
2854300	Krishna	1901	1953	11	12	1954	1979	43	48				
2853500	Narmada	1949	1974	1.9	1.2								

Table 18 **Segmentations of the mean yearly discharges (Central Asia area).**

GRDC	River	Begin	End	1st Segment		Begin	End	2nd Segment		Begin	End	3rd Segment	
number		year	year	mean	s.d.	year	year	mean	s.d.	year	year	mean	s.d.
2917100	Amu-Darya	1931	1960	1500	260	1961	1973	1090	397				
2917450	Zaravchan	1932	1994	155	21								
2917700	Gunt	1940	1985	104	18								
2917900	Vakhsh	1932	1967	639	78								
2910470	Biya	1895	1901	375	104	1902	1985	487	94				
2912600	Ob	1930	1994	12500	1920								
2910490	Tom (1)	1894	1985	651	118								
2910300	Tom (2)	1965	1990	1050	177								
2912400	Tura	1896	1985	190	107								
2909150	Yenisei	1936	1973	17600	1230	1974	1995	18800	1430				
2916200	Syr-Darya	1930	1960	683	178	1961	1973	485	153	1974	1984	211	66
2919200	Ural	1915	1981	297	191								
2916850	Naryn	1933	1973	392	82	1974	1980	228	27	1981	1990	353	65

Table 19 **Segmentations of the maximum monthly discharges (Central Asia area)**

GRDC	River	Begin	End	1st Segment		Begin	End	2nd Segment		Begin	End	3rd Segment	
number		year	year	mean	s.d.	year	year	mean	s.d.	year	year	mean	s.d.
2917100	Amu-Darya	1931	1960	3540	889	1961	1973	2650	1050				
2917450	Zaravchan	1932	1995	467	84								
2917700	Gunt	1940	1985	342	91								
2917900	Vakhsh	1932	1966	1670	274								
2910470	Biya	1895	1985	1400	414								
2912600	Ob	1930	1994	33400	3740								
2910490	Tom (1)	1894	1985	2940	775								
2910300	Tom (2)	1965	1966	6700	1130	1967	1990	4450	1070				
2912400	Tura	1896	1985	849	779								
2909150	Yenisei	1936	1995	78100	12400								
2916200	Syr-Darya	1930	1960	1320	427	1961	1984	718	284				
2919200	Ural	1915	1981	1530	1230								
2916850	Naryn	1933	1973	1020	301	1974	1990	668	182				

Table 20 **Segmentations of the minimum monthly discharges (Central Asia area).**

GRDC	River	Begin	End	1st Segment		Begin	End	2nd Segment		Begin	End	3rd Segment	
number		year	year	mean	s.d.	year	year	mean	s.d.	year	year	mean	s.d.
2917100	Amu-Darya	1931	1956	517	86	1857	1965	255	52	1966	1973	49.5	109
2917450	Zaravchan	1932	1993	35	4								
2917700	Gunt	1940	1985	26	1.9								
2917900	Vakhsh	1932	1967	173	17								
2910470	Biya	1895	1902	37	8	1903	1985	56	11				
2912600	Ob	1930	1958	2800	281	1959	1992	3530	504	1993	1994	4880	1300
2910490	Tom (1)	1894	1919	55	9.5	1929	1985	74	21				
2910300	Tom (2)	1965	1982	115	29	1983	1990	159	20				
2912400	Tura	1896	1978	23	8.3	1979	1985	33	10				
2909150	Yenisei	1936	1968	3920	443	1969	1983	5880	586	1984	1995	7490	457
2916200	Syr-Darya	1930	1960	346	96	1961	1970	229	116	1971	1984	82	40
2919200	Ural	1915	1953	38	19	1954	1970	70	18	1971	1981	42	16
2916850	Naryn	1933	1987	131	40	1988	1990	218	14				

Table 21: Information Content of a single observation, according to the length of the sample n and of the estimated lag-1 autocorrelation coefficient r_1.

r_1 \ n	10	25	50	75	100	200	oo
0,1	0,84	0,82	0,82	0,82	0,82	0,82	0,82
0,2	0,7	0,68	0,67	0,67	0,67	0,67	0,67
0,3	0,58	0,55	0,55	0,54	0,54	0,54	0,54
0,4	0,47	0,45	0,44	0,43	0,43	0,43	0,43
0,5	0,38	0,35	0,34	0,34	0,34	0,34	0,33
0,6	0,31	0,27	0,26	0,25	0,25	0,25	0,25
0,7	0,24	0,2	0,19	0,18	0,18	0,18	0,18
0,8	0,18	0,14	0,12	0,12	0,12	0,11	0,11
0,9	0,14	0,08	0,06	0,06	0,06	0,06	0,05
0,95	0,12	0,06	0,04	0,03	0,03	0,03	0,03

Table 22: "Effective" number of independent observations for various combinations of autocorrelation coefficients r_1 and series lengths n.

r_1 \ n	10	25	50	75	100	200
0,1	8,4	21	41	62	82	164
0,2	7	17	34	50	67	134
0,3	5,8	14	27	41	54	108
0,4	4,7	11	21	33	43	86
0,5	3,9	8,8	17	25	34	67
0,6	3,1	6,8	13	19	25	50
0,7	2,4	5	9,3	14	18	36
0,8	1,8	3,4	6,1	8,9	12	23
0,9	14	2	3,2	4,5	5,8	11
0,95	1,2	1,5	2	2,6	3,2	5,7

Table 23: Set of non-parametric tests for monotonic and stepwise trend detection available for independent/ dependent, seasonal/non-seasonal time series.

TYPE OF TREND	PERSISTENCE	SEASONALITY	APPROPRIATE TEST
Monotonic trend	Markovian persistence	No seasons	Lettenmaier/Spearman
		With seasons	Hirsch and Slack
	No persistence	No seasons	Spearman/Kendall
		With seasons	Kendall seasonal
Stepwise trend	Markovian persistence	No seasons	Lettenmaier/Mann-Whitney
		With seasons	Hirsch and Slack
	No persistence	No seasons	Mann-Whitney
		With seasons	Kendall seasonal

Table 24 : Trends in mean yearly discharges (Oceania-Pacific area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Herbert River	period 1	1916	1960		113	59	9	...
5101161	period 2	1961	1970	Step trend	76	45	13	56
	period 3	1971	1996	Monotonic trend	171-39 (-5 / yr)	1.7 / yr	...	69
Avoca River	period 1	1890	1895		316	150	34	...
5304080	period 2	1896	1987	Step trend	6.4	6.9	0.4	34.5
	period 3	1988	1993	Step trend	378	254	49	67.8
Murrumbidgee River	period 1	1927	1960		1190	710	87	...
5204105	period 2	1961	1993	Step trend	457	308	37	545
	period 1-2	1927	1993	Monotonic trend	1270-370 (-14 / yr)	3.7 / yr	..	602
Serpentine River	period 1	1911	1970		6.2	3.8	0.59	...
5606145	period 2	1971	1992	Step trend	0.49	1.55	0.19	3.36

Table 25 : Trends in maximum monthly discharges (Oceania-Pacific area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Avoca River	period 1	1890	1895		1240	531	116	...
5304080	period 2	1896	1987	Step trend	32.6	34.4	1.7	125
	period 3	1988	1993	Step trend	2010	1220	226	327
Murrumbidgee River	period 1	1927	1960		3730	2250	301	...
5204105	period 2	1961	1993	Step trend	1480	1090	144	1760
	period 1-2	1927	1993	Monotonic trend	3990-1190 (-42 / yr)	3.7 / yr	..	1920
Serpentine River	period 1	1911	1970		29.1	17.4	1.5	...
5606145	period 2	1971	1992	Step trend	2.19	6	0.8	15.1
	period 1-2	1911	1992	Monotonic trend	30.6-6.8 (-0.3 / yr)	0.2 / yr	...	16.9

Table 26 : Trends in minimum monthly discharges (Oceania-Pacific area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Daly	period 1	1970	1973		8.9	0.91	0.53	
5708145	period 2	1974	1995	Step trend	17.9	5.5	1.1	
Herbert River 5101161	period 1	1916	1996	No trend	5.4	4.8	0.5	48
Mitchell River 5302242	period 1	1938	1987	No trend	2.24	1.94	0.16	
Avoca River	period 1	1890	1987		0.19	1.2	0.07	...
5304080	period 2	1988	1993	Step trend	5.7	3.6	0.84	1.46
Huon River 5803600	period 1	1949	1994	No trend	18.3	8.9	1.3	8.9
Murrumbidgee River	period 1	1927	1960		113	76.7	9.9	...
5204105	period 2	1961	1993	Step trend	55	31	4	58.3
Serpentine River 5606145	period 1	1911	1992	No trend	6.2	0.21	0.014	0.21

Table 27 : Trends in mean yearly discharges (Far East Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Tone	period 1	1938	1960		288	62	13	...
2588550	period 2	1961	1985	Step trend	222	58	11	60
	period 1-2	1938	1985	Monotonic trend	300-221 (-2/yr)	0.5 / yr	...	62
Shinano	period 1	1965	1988	No trend	530	143	29	143
2589500								
Yodo	period 1	1965	1976		316	112	34	...
2588200	period 2	1977	1988	Step trend	234	51	14	85
	period 1-2	1965	1988	Monotonic trend	351-191 (-1/yr)	2 / yr	..	81
Changjiang	period 1	1865	1953		23700	3160	272	...
2181800	period 2	1954	1985	Step trend	22300	2910	410	3090
	period 1-2	1865	1985	Monotonic trend	24300-22300 (-17/yr)	7/yr	..	3090
Songhuajiang	period 1	1898	1928		895	396	50	...
2106500	period 2	1929	1987	Step trend	1360	401	36	399
	period 1-2	1898	1987	Monotonic trend	962-1450 (5.5/yr)	1.7 / yr	...	433
Yongding	period 1	1925	1949		39	16	2	...
2178300	period 2	1950	1964	Step trend	50.3	15.9	2	15.9
	period 3	1965	1988	Step trend	21.1	10.8	1.5	13.9
	period 2-3	1950	1988	Monotonic trend	64.7-8.6(-1.5/yr)	1.6 /yr	..	11.7
Huanghe(Yellow River)	period 1	1947	1966		1610	450	103	...
2180800	period 2	1967	1988	Step trend	1260	345	75	399
	period 1-2	1947	1988	Monotonic trend	1670-1180 (-12/yr)	5.5 / yr	..	411
Shilka	period 1	1898	1982		398	148	12	...
2906200	period 2	1984	1985	Step trend	627	159	59	148
Kamchatka	period 1	1931	1959		736	74	14	..
2902800	period 2	1960	1984	Step trend	826	71	14	72
	period 1-2	1931	1984	Monotonic trend	707-850 (2.6/yr)	0.6/yr	..	74
Amur (1)	period 1	1897	1955	No trend	8370	1840	169	1840
2906700	period 2	1956	1985	Monotonic trend	10600-6640(-130/yr)	35/yr	..	1620
Yufeng	period 1	1964	1967		1110	265	153	...
2385500	period 2	1968	1989	Step trend	1780	413	86	398
	period 1-2	1964	1989	Monotonic trend	1430-1980(22/yr)	11 / yr	...	422

Table 28 : Trends in maximum monthly discharges (Far East Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Tone	period 1	1938	1962		742	255	52	...
2588550	period 2	1963	1985	Step trend	535	218	44	237
	period 1-2	1938	1985	Monotonic trend	761-517(-5/yr)	2.5 / yr	...	248
Songhuajiang	period 1	1898	1931		2500	1260	218	...
2106500	period 2	1932	1987	Step trend	3580	1780	236	1610
	period 1-2	1898	1987	Monotonic trend	2680-3690(11/yr)	7 / yr	...	1670
Yongding	period 1	1925	1962		126	89	15	...
2178300	period 2	1963	1988	Step trend	58.6	36	7	72
	period 1-2	1925	1988	Monotonic trend	148-47 (-1.5/yr)	0.5 /yr	..	74
Kamchatka	period 1	1931	1959		1780	231	43	..
2902800	period 2	1960	1984	Step trend	1990	311	61	272
	period 1-2	1931	1984	Monotonic trend	1730-2030(-5.5/yr)	2.5/yr	..	280
Amur (1)	period 1	1897	1953	No trend	20800	5590	740	5590
2906700	period 2	1954	1985	Monotonic trend	25300-16900(-262/yr)	100/yr	..	5390

Table 29 : Trends in minimum monthly discharges (Far East Asia area).

River and GRDC #		Start Ye:	nd Yea	type of trend	level	sd	sd (mean	RMSE
Tone	period 1	1938	1947	No trend	94	10	1.8	10.4
2588550	period 2	1948	1973		112	29	2.8	..
	period 3	1974	1985	Step trend	79	16	2.1	25.6
	period 2-3	1948	1985	Monotonic trend	138-64(-2/yr)	0.3 / yr	...	20.4
Shinano	period 1	1965	1988	Monotonic trend	295-207 (-4 / yr)	1.3 /yr	..	46
2589500								
Yodo	period 1	1965	1983		127	29	4	...
2588200	period 2	1984	1988	Step trend	86	20	5	27
Chikugo	period 1	1965	1974		36	10.4	3.5	
2590100	period 2	1975	1988	Step trend	45.3	6.5	1.7	8.2
	period 1-2	1965	1988	Monotonic trend	34.6-49.2(0.63/yr)	0.32/yr	...	8.2
Changjiang	period 1	1865	1904		6370	1570	252	...
2181800	period 2	1905	1985	Step trend	7230	1370	151	1440
	period 1-2	1865	1985	Monotonic trend	6390-7520(10 /yr)	4/yr	..	1460
Songhuajiang	period 1	1898	1946		108	53	3.3	
2106500	period 2	1947	1987	Step trend	302	112	7.5	85.5
	period 1-2	1898	1987	Monotonic trend	52.2-345 (3.1 / yr)	4 / yr	...	96
Yongding	period 1	1925	1942	No trend	9.5	6.4	1.1	6.4
2178300	period 2	1943	1970		15.4	7	1.1	..
	period 3	1971	1988	Step trend	9.3	3.2	0.4	5.1
	period 2-3	1943	1988	Monotonic trend	17.2-6.5(-0.23/yr)	0.02 /yr	..	5.1
Jinghe	period 1	1933	1986	No trend	17.2	4.6	0.38	4.6
2180500								
Huanghe(Yellow River)	period 1	1947	1955		576	60	14	...
2180800	period 2	1956	1988	Step trend	385	141	16.9	129
Beijang	period 1	1954	1969		201	33	5.5	..
2186900	period 2	1970	1969	Step trend	268	86	12.6	67
Dongjiang	period 1	1960	1973		208	68	10.5	..
2186950	period 2	1974	1987	Step trend	351	111	16	93
	period 1-2	1960	1987	Monotonic trend	171-398(8/yr)	2/yr	..	96
Yana	period 1	1938	1984	No trend	0.42	1.3	0.08	1.3
2998100								
Indigirka	period 1	1937	1984		7.1	2.4	0.35	..
	period 2	1985	1994	Step trend	10.2	3.8	1.1	2.7
Lena	period 1	1935	1978		1.1	0.25	0.015	..
2903420	period 2	1979	1994	Step trend	1.9	0.4	0.037	0.3
Shilka	period 1	1897	1985	No trend	3.63	3.1	0.2	3.1
2906200								
Kamchatka	period 1	1931	1984	Monotonic trend	323-438(2.1/yr)	0.21	..	24
2902800								
Amur (1)	period 1	1897	1946		486	146	8,6	
2906700	period 2	1947	1985	Step trend	765	165	10.7	155
	period 1-2	1897	1985	Monotonic trend	413-910(4.6/yr)	0.75/yr	...	173
Amur (2)	period 1	1933	1978		877	246	13	
2906900	period 2	1979	1990	Step trend	1660	444	45	302
	period 1-2	1933	1990	Monotonic trend	492-1610 (20/yr)	2.1/yr	...	301

Table 30 : Trends in mean yearly discharges (South East Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Bonga	period 1	1947	1959	No trend	26.3	8	1.4	8
5654100	period 2	1960	1976	Monotonic trend	42.8-4.2(-2.5/yr)	0.5/yr	..	8.2
Mekong (1)	period 1	1925	1966		8350	898	88	..
2969100	period 2	1967	1991	Step trend	7270	1110	138	989
	period 1-2	1925	1991	Monotonic trend	8820-7040(-27/yr)	6/yr	..	992
Mekong (2)	period 1	1961	1971		2950	400	126	..
2969010	period 2	1972	1991	Step trend	2600	334	73	356
	period 1-2	1961	1991	Monotonic trend	2950-2480(-15/yr)	7/yr	..	367

Table 31 : Trends in maximum monthly discharges (South East Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Bonga	period 1	1947	1958	No trend	98.6	37.6	10	37.6
5654100	period 2	1959	1976	Monotonic trend	163-358(8/yr)	2/yr	..	36
Mekong (1)	period 1	1925	1973		24400	3500	508	..
2969100	period 2	1974	1991	Step trend	20500	3670	841	3560
	period 1-2	1925	1991	Monotonic trend	25600-21000(-70/yr)	23/yr	..	3720
Mekong (2)	period 1	1961	1971		8080	1550	492	..
2969010	period 2	1972	1991	Step trend	6400	1380	300	1430
	period 1-2	1961	1991	Monotonic trend	8230-5650(-80/yr)	29/yr	..	1450
Mekong (3)	period 1	1962	1981		21400	3950	906	..
2969095	period 2	1982	1991	Step trend	17800	2920	924	3630
	period 1-2	1962	1991	Monotonic trend	22700-17700(-180/yr)	82/yr	..	3710

Table 32 : Trends in minimum monthly discharges (South East Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Bonga	period 1	1947	1966		1.9	1.1	0.26	..
5654100	period 2	1967	1976	Step trend	0.9	0.8	0.24	1.01
	period 1-2	1947	1976	Monotonic trend	2.3-0.74(-0.05/yr)	0.02	.	1.01
Kelantan	period 1	1950	1961		317	36	13.6	..
5223100	period 2	1962	1986	Step trend	231	101	18.5	93
Mekong (1)	period 1	1925	1950		1550	247	35.7	..
2969100	period 2	1951	1991	Step trend	1410	183	20.4	210
Nam Chi	period 1	1954	1966		5.83	2.51	0.35	..
2969150	period 2	1967	1991	Step trend	37.8	18.3	1.72	15.2
Nam Mun	period 1	1956	1966		18.4	14.4	2.3	..
2969200	period 2	1967	1991	Step trend	62	21	2.1	19.3
Nan	period 1	1956	1967		16.5	3.9	0.46	..
2964080	period 2	1968	1988	Step trend	27.8	8.9	1.1	6.8
	period 1-2	1956	1988	Monotonic trend	13-30.9(5.5/yr)	0.13/yr	..	7
Mekong (2)	period 1	1961	1971		764	79	26	..
2969010	period 2	1972	1991	Step trend	839	62	13	67
	period 1-2	1961	1991	Monotonic trend	756-878(4/yr)	1.2/yr	..	66
Mekong (3) 2969095	period 1	1962	1991	No trend	1440	224	20.8	224

Table 33 : Trends in mean yearly discharges (Indian Subcontinent area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Kali Gandaki (1)	period 1	1964	1976		284	42	12	..
2549300	period 2	1977	1993	Step trend	247	30	7	35
Kali Gandaki (2)	period 1	1964	1968		530	45	22	..
2549350	period 2	1969	1985	Step trend	457	74	17	70
	period 1-2	1964	1985	Monotonic trend	525-415(-5/yr)	2/yr	..	67
Sapt Kosi	period 1	1947	1967		1540	206	46	..
	period 2	1968	1978	Step trend	1770	202	58	204
	period 1-2	1947	1978	Monotonic trend	1480-1780(10/yr)	4/yr	..	216
Krishna	period 1	1901	1960		1780	454	37	..
2854300	period 2	1961	1979	Step trend	1250	522	74	472

Table 34 : Trends in maximum monthly discharges (Indian Subcontinent area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Ganges R. (1)	period 1	1934	1945		35200	5220	1580	..
2646200	period 2	1946	1989	Step trend	42500	7560	1130	7160
Sapt Kosi	period 1	1947	1969		4510	848	181	..
	period 2	1970	1978	Step trend	5440	814	257	837
	period 1-2	1947	1978	Monotonic trend	4180-5420(40/yr)	17/yr	..	866
Krishna	period 1	1901	1960	Monotonic trend	9590-3960(-245/yr)	100/yr	..	311
2854300								
Narmada	period 1	1949	1974	No trend	1730	1300	255	1300
2853500								

Table 35 : Trends in minimum monthly discharges (Indian Subcontinent area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Gin Ganga	period 1	1928	1957	No trend	19.5	5.7	1	5.7
2357750	period 2	1958	1989	Monotonic trend	26.3-11.3(- 0.5/yr)	0.2	..	7
Kali Gandaki (1)	period 1	1964	1993	Monotonic trend	31.2-55.7(0.9/yr)	0.13	..	7.4
2549350								
Ganges R. (1)	period 1	1934	1974		1950	353	25	..
2646200	period 2	1975	1989	Step trend	1130	442	50	380
Godavari	period 1	1902	1979	Monotonic trend	23.7-120(1.3/yr)	0.2/yr	..	42
2856900								
Krishna	period 1	1901	1979	No trend	21.7	32.1	1.4	32
2854300								

Table 36 : Trends in mean yearly discharges (Central Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Amu-Darya	period 1	1931	1957		1520	250	36	..
2917100	period 2	1958	1973	Step trend	1150	373	66	304
	period 1-2	1931	1973	Monotonic trend	1660-1090(- 13.3/yr)	4/yr	..	313
Biya	period 1	1895	1910		425	95	25	..
2910470	period 2	1911	1985	Step trend	489	96	11	96
Yenisei	period 1	1936	1972		17.7	1.2	0.2	..
2909150	period 2	1973	1995	Step trend	18.6	1.4	0.3	1.3
Syr-Darya	period 1	1930	1960		673	169	15	..
2916200	period 2	1961	1984	Step trend	384	214	21	190
	period 1-2	1930	1984	Monotonic trend	786-298(-8.4/yr)	1.5/yr	..	191
Naryn	period 1	1933	1970		393	84	9.5	..
2916850	period 2	1971	1990	Step trend	316	80	12	83

Table 37 : Trends in maximum monthly discharges (Central Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Amu-Darya	period 1	1931	1960		3540	889	165	..
2917100	period 2	1961	1973	Step trend	2730	1010	270	930
	period 1-2	1931	1973	Monotonic trend	3790-2760(-24/yr)	12/yr	..	957
Tom (2)	period 1	1965	1990	No trend	4620	1190	234	1190
2910300								
Syr-Darya	period 1	1930	1960		1310	418	46	..
2916200	period 2	1961	1984	Step trend	761	343	41	386
	period 1-2	1930	1984	Monotonic trend	1540-578(-18/yr)	3/yr	..	378
Naryn	period 1	1933	1973		1010	297	47	..
2916850	period 2	1974	1990	Step trend	703	223	52	276
	period 1-2	1933	1990	Monotonic trend	1070-766(-5/yr)	2/yr	..	299

Table 38 : Trends in minimum monthly discharges (Central Asia area).

River and GRDC #		Start Year	End Year	type of trend	level	sd	sd (mean)	RMSE
Amu-Darya	period 1	1931	1957		516	86	6	..
2917100	period 2	1958	1973	Step trend	180	153	13	119
	period 1-2	1931	1973	Monotonic trend	668-82(-14/yr)	1.2/yr	..	108
Biya	period 1	1895	1985	Monotonic trend	46-62(0.2/yr)	0.04	..	10.9
2910470								
Ob	period 1	1930	1994	Monotonic trend	2530-3970(2.2/yr)	3/yr	..	473
2912600								
Tom (1)	period 1	1894	1985	Monotonic trend	56.7-80.8(2.5/yr)	0.08/yr	..	19.2
2910490								
Tom (2)	period 1	1965	1979		112	30	4.7	..
2910300	period 2	1980	1990	Step trend	149	23	3.9	27
	period 1-2	1965	1990	Monotonic trend	102-155(2/yr)	0.75/yr	..	28.6
Tura	period 1	1896	1985	No trend	24.1	8.7	0.52	8.7
2912400								
Yenisei	period 1	1936	1969		3.92	0.44	0.02	..
2909150	period 2	1970	1995	Step trend	6.6	0.95	0.05	0.71
	period 1-2	1936	1995	Monotonic trend	2.9-7.3(0.075/yr)	0.006	..	0.79
Syr-Darya	period 1	1930	1964		334	101	9	..
2916200	period 2	1965	1984	Step trend	133	105	12	102
	period 1-2	1930	1984	Monotonic trend	411-104(-5.7/yr)	1/yr	..	109
Ural	period 1	1915	1953		38	19	1.5	..
2919200	period 2	1954	1981	Step trend	57.4	22.5	2	20
Naryn	period 1	1933	1990	No trend	136	43	2.5	43
2916850								

Table 39: Detailed results, for each area, of the trend analysis applied to the 3 types of series investigated (mean yearly, monthly maximum and minimum discharge series).

Region	Type of series	No trend detected	Upwards stepwise trend	Downwards stepwise trend	Monotonic upwards trend	Monotonic downwards trend
Oceania	mean	15	1	3	0	2
Pacific area	maximum	16	1	3	0	2
(19 rivers)	minimum	15	2	2	0	0
Far East	mean	15	3	4	2	6
Asia area	maximum	18	3	2	2	4
(25 rivers)	minimum	12	10	3	5	3
South-East	mean	6	0	2	0	3
Asia area	maximum	5	0	3	0	3
(9 rivers)	minimum	2	4	3	0	3
Indian Subcontinent	mean	8	3	1	1	1
area	maximum	9	2	0	1	1
(12 rivers)	minimum	8	0	1	2	1
Central Asia	mean	8	2	3	0	2
area	maximum	10	0	3	0	3
(13 rivers)	minimum	5	2	4	4	2

Table 40: Counts per decade of the occurrence of upwards and downwards trends in each of the 5 areas.

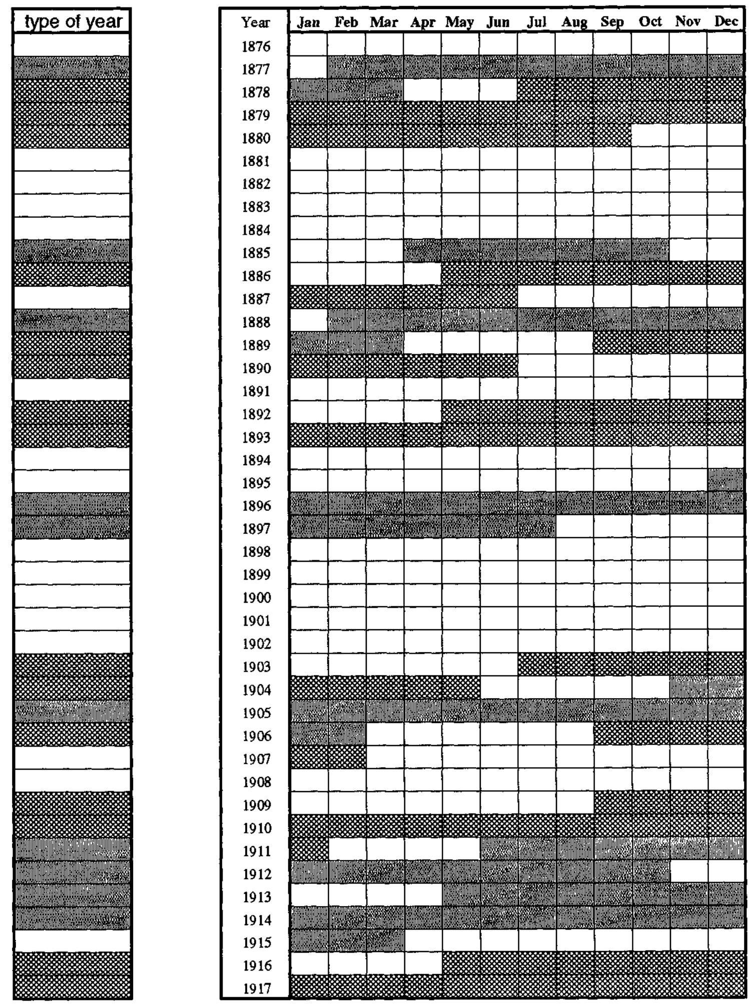
region	decade	'00	'10	'20	'30	'40	'50	'60	'70	'80	'90
Oceania	downs	2						4	3		
Pacific	ups								1	3	
Far East	downs						4	6	3	1	
Asia	ups	1		1	1	2	1	2	6	2	
South East	downs						2	4	3	1	
Asia	ups							3	1		
Indian	downs	1				1	1	2	2		
Subcontinent	ups	1						2	1	1	
Central	downs						2	4	2		
Asia	ups	2	1		1		1		2	1	

Table 41: Regional synthesis of the trend analysis.

Region	no trend	upwards trend	downwards trend
Oceania-Pacific	15/19	1/19	3/19
Far East Asia	15/25	3/25	7/25
South East Asia	6/9	0/9	3/9
Indian Subcontinent	8/11	0/11	3/11
Central Asia	8/13	2/13	3/13
Total	**52/77**	**6/77**	**19/77**

Table 42a: **Southern Oscillation Indices (SOI) and Identification of El Nino and La Nina years and months.**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1876	11.3	11	0.2	9.4	6.8	17.2	-5.6	12.3	10.5	-8	-2.7	-3
1877	-9.7	-6.5	-4.7	-9.6	3.6	-16.8	-10.2	-8.2	-17.2	-16	-12.6	-12.6
1878	-8.7	-21.1	-15.5	-8.8	2.1	-3.1	15.9	13	17.7	10.9	15.1	17.9
1879	12.7	14.3	13.2	12.7	2.1	16.4	21.8	22.6	18.9	15.2	9.8	-5.5
1880	10.8	7.7	14.3	5.3	12.3	9.1	1.6	14.3	8.1	4.8	7.2	-1.9
1881	-7.3	-5.5	1.8	0.3	-4.3	-4.7	-5.6	-11.4	-13.6	-23.9	7.2	9.8
1882	-6.8	-1.3	5.1	1.2	6.8	-12	-21.3	-25.6	-14.8	-2.5	2.6	10.3
1883	6	9.1	-25.3	14.4	13.9	3.4	-10.2	1.4	-8.2	4.8	5.2	-15.2
1884	-12.5	-5	9.4	-15.4	1.3	9.1	-3	-5	-7	4.2	-1.4	-12.6
1885	-16.3	1.6	5.1	-0.5	-4.3	-14.4	-5	-9.5	-4	-17.8	-15.9	5.2
1886	-0.6	1.6	2.9	4.5	6	5	7.4	13.6	13.5	13.4	10.5	14.4
1887	12.2	11	10	9.4	-4.3	5	4.8	4.6	5.1	4.8	-5.3	5.2
1888	-3	-2.2	-11.7	-23.6	-9.8	-16	-16.7	-8.9	-9.4	-14.7	-12.6	-2.4
1889	-25.9	-1.7	-27.5	-0.5	-1.9	22	1.6	2.1	11.1	4.2	23	22
1890	20.8	11	14.3	6.9	3.6	5.8	-2.3	-3.1	9.3	3.6	2.6	0.6
1891	15.6	-3.6	-9.5	4.5	-0.3	-1.5	-6.3	-8.9	-10.6	0.6	-4.7	-4.5
1892	2.7	-10.2	11.1	6.9	10	19.6	7.4	5.9	6.3	8.5	-0.7	3.7
1893	11.3	7.7	-1.4	1.2	-3.5	10.7	14	7.8	5.7	7.9	2.6	1.6
1894	17.5	10	5.6	-3	-5.1	-1.5	-2.3	-5.7	-1.6	1.8	7.2	0.1
1895	5.6	3	-0.3	-7.1	-8.2	-4.7	-0.4	-6.3	-4	-5.6	-8.6	-3.5
1896	1.3	4.9	-6.3	-8.8	-42.2	-30.6	-20.6	-22.4	-19	-19	-11.9	-14.2
1897	-12.5	-7.4	-16.6	-17.8	-16.9	0.2	-2.3	0.8	0.2	1.8	-8	10.3
1898	7	6.3	19.2	11.1	-1.9	-2.3	6.1	2.1	3.2	-0.7	-2.7	-0.4
1899	13.2	9.1	13.8	4.5	-7.4	-10.4	-5.6	-10.1	-1.6	6.1	15.8	-3
1900	-7.3	-6.5	-25.3	-18.7	-7.4	26.1	10	7.8	-16.6	-17.2	-6	-5.5
1901	-0.1	3	9.4	4.5	-0.3	19.6	14.6	9.8	-16	-22.1	-8.6	-1.9
1902	17	-2.2	11.6	7.8	7.6	2.6	1.6	-8.9	-17.8	-7.4	-3.4	-3
1903	-9.2	-10.2	17.6	17.7	7.6	-0.6	6.1	0.1	8.7	4.2	1.3	15.9
1904	14.1	16.2	9.4	31.7	9.2	-7.1	-8.9	0.8	0.2	1.2	-17.2	2.6
1905	-9.2	-16.8	-30.2	-42.6	-37.4	-31.4	-21.3	-7.6	-7	-5.6	-17.9	-13.1
1906	-3.5	-7.4	-5.2	-8.8	1.3	-3.9	6.8	15.5	18.3	9.1	21.7	4.7
1907	5.1	1.6	-0.3	4.5	10	8.3	-4.3	-8.2	0.2	0.6	-2	8.8
1908	-10.6	7.7	0.2	16.8	-1.1	-2.3	2.2	5.3	17.7	7.9	2.6	-5.5
1909	-2.5	-3.2	-0.3	-14.5	2.1	22.8	10.7	9.8	0.8	4.2	9.2	4.7
1910	5.6	15.2	12.7	5.3	0.5	22	20.5	9.8	15.3	10.3	19.7	15.9
1911	3.2	1.6	3.5	2	-8.2	-12	-12.8	-12.1	-8.8	-11.7	-7.3	-1.4
1912	-9.7	-17.3	-9	-21.1	-13	-6.3	-0.4	-7.6	-4	-8	2.6	-8
1913	-3.5	-5	1.3	-6.3	-8.2	-3.9	-1.7	-7.6	-9.4	-9.2	-11.9	-7
1914	-5.4	2	9.4	-14.5	-0.3	-16.8	-18	-17.2	-12.4	-8.6	-11.9	-1.4
1915	-21.6	-2.2	-20.4	-17.8	-12.2	6.6	14	7.2	7.5	2.4	-14.6	9.8
1916	5.6	-3.6	-6.3	-0.5	6.8	9.1	25.7	16.2	4.5	6.1	9.8	15.4
1917	5.1	10	18.1	21.8	21.8	21.2	28.3	34.8	29.7	15.2	21	22.5



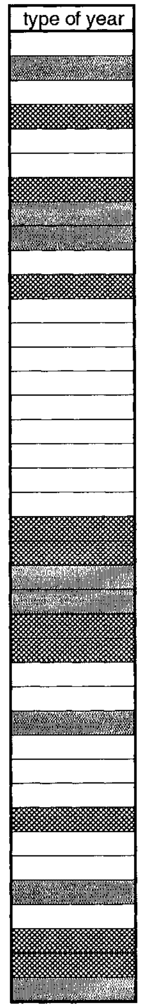
hot, low SOI El Nino event

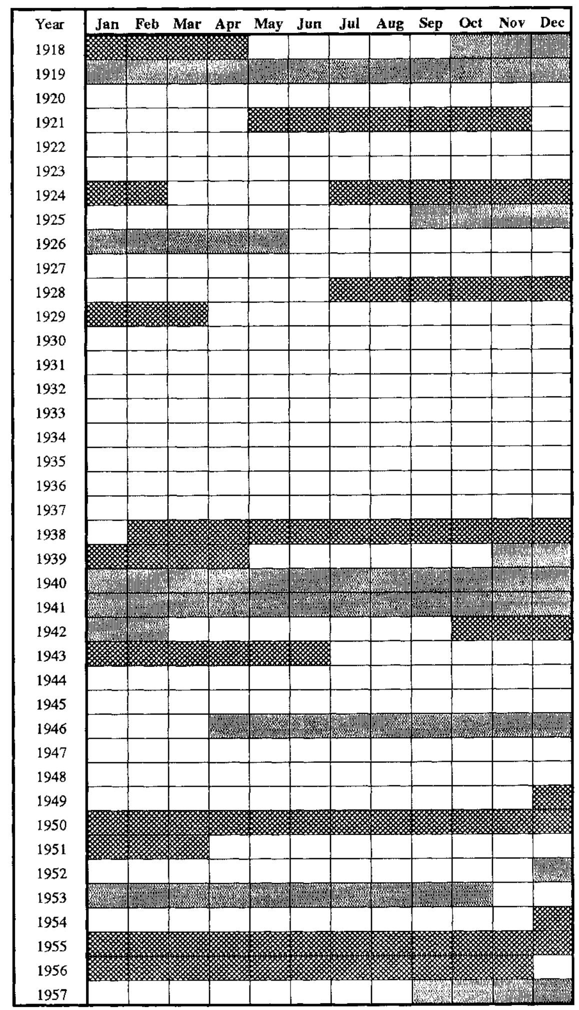
normal, neutral SOI year, month

cold, high SOI La Nina event

Table 42b: **Southern Oscillation Indices (SOI) and Identification of El Nino and La Nina years and months.**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1918	14.6	16.6	-2	16.8	10	-4.7	-14.1	-4.4	-8.2	-5	1.3	-8
1919	-14.9	-11.2	-12.8	-3	-7.4	-10.4	-8.9	-6.9	-5.8	-10.5	-11.3	-9.1
1920	1.8	-1.7	-4.1	0.3	-2.7	6.6	9.4	5.3	5.1	-4.3	-0.1	9.8
1921	10.8	6.7	8.9	-7.1	2.1	22	2.9	-6.9	5.1	9.7	8.5	8.2
1922	8	9.1	5.6	-5.5	-5.1	5.8	2.2	-1.2	5.1	6.1	8.5	11.8
1923	5.6	4.4	8.9	8.6	2.1	1	-11.5	-18.5	-14.8	-6.2	-12.6	2.1
1924	-5.4	1.1	2.4	-15.4	11.5	8.3	7.4	10.4	8.1	7.9	11.8	5.2
1925	5.6	13.8	14.9	14.4	-1.1	-4.7	-13.4	-10.8	-6.4	-12.9	-9.3	-7
1926	-5.4	-14.5	-13.3	-7.1	-2.7	-7.1	-1	-7.6	1.4	4.2	1.3	6.2
1927	5.1	1.1	18.1	6.9	6	8.3	6.1	-5	-0.4	-4.3	-8	7.7
1928	-10.1	10.5	13.8	11.9	-2.7	-7.9	-0.4	9.8	8.1	9.1	2.6	11.8
1929	16	18	5.1	4.5	-12.2	1	1.6	0.1	-0.4	7.9	11.1	5.7
1930	12.7	7.7	1.8	-3.8	2.1	-5.5	-4.3	-1.8	-7	3.6	1.9	-1.4
1931	7	-14.9	5.6	8.6	13.1	18.8	9.4	0.1	5.1	-12.9	-4.7	4.7
1932	1.8	-3.6	-2.5	-2.1	2.8	-4.7	-5	-6.9	-8.8	-4.3	-4.7	3.2
1933	-11.1	4.9	-2	3.6	6	-3.9	3.5	-0.5	2	3.6	7.2	8.2
1934	6.5	0.1	0.2	6.1	-7.4	10.7	2.9	-22.4	-6.4	4.2	13.1	-2.4
1935	6.5	-4.6	12.2	2.8	-6.6	-2.3	-0.4	2.1	6.3	7.3	3.9	-4
1936	-2	0.6	1.8	22.6	4.4	-1.5	4.2	-8.9	2.6	-0.1	-13.9	0.6
1937	9.4	-5	6.2	2	-0.3	3.4	-5.6	3.3	0.8	-2.5	-2	6.7
1938	7.5	3.4	-3.6	3.6	13.1	18	18.5	13	7.5	12.8	1.9	13.8
1939	17	7.7	11.6	9.4	-1.1	-1.5	8.1	-0.5	-9.4	-14.7	-8	-8.6
1940	-0.1	-4.1	-10.6	-9.6	-14.5	-19.3	-15.4	-18.5	-19.6	-18.4	-6.7	-29.4
1941	-9.7	-15.4	-10.6	-11.2	-6.6	-14.4	-20.6	-19.1	-8.2	-20.2	-9.3	-8.6
1942	-13	-3.6	-5.8	-5.5	5.2	8.3	-1	4	8.7	8.5	-4	13.8
1943	9.4	10.5	4	13.5	2.8	-7.9	2.9	7.8	5.7	9.1	3.9	-8.6
1944	-8.2	3.9	5.6	-5.5	-1.1	-3.9	-8.9	3.3	2.6	-8.6	-6.7	4.2
1945	5.1	6.3	13.2	-7.1	-0.3	8.3	3.5	11.7	8.7	2.4	-3.4	6.7
1946	-2.5	4.4	-2	-9.6	-11.4	-9.6	-10.2	-4.4	-16	-12.3	-1.4	-5.5
1947	-4.9	-4.1	11.6	-4.6	-13.7	2.6	9.4	7.2	11.7	-1.9	9.2	5.2
1948	-3	-2.7	-4.1	2.8	3.6	-4.7	0.9	-4.4	-7.6	6.1	4.6	-5.5
1949	-7.3	2	5.6	1.2	-5.8	-12	-1.7	-4.4	2	5.4	-6	7.7
1950	5.1	17.6	17.6	16.8	7.6	26.9	21.1	12.3	6.9	17.1	12.5	23
1951	16.5	9.6	-1.4	-1.3	-6.6	5	-8.2	-0.5	-7	-8	-3.4	-3
1952	-9.2	-7.9	0.2	-8.8	6	7.4	3.5	-3.7	-3.4	1.8	-0.7	-12.6
1953	2.2	-6	-5.8	-0.5	-31.9	-2.3	-1	-17.2	-13	-0.1	-2	-4
1954	6	-3.6	-0.9	6.9	4.4	-1.5	4.2	10.4	4.5	1.8	3.9	12.8
1955	-5.4	15.2	2.9	-3	13.1	16.4	19.2	14.9	14.1	15.2	15.1	9.3
1956	11.3	12.4	9.4	11.1	17.9	12.3	12.6	11	0.2	18.3	1.9	10.3
1957	5.6	-2.2	-0.9	1.2	-12.2	-2.3	0.9	-9.5	-10.6	-1.3	-11.9	-3.5





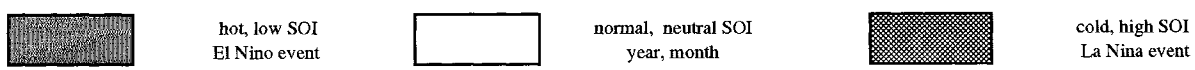
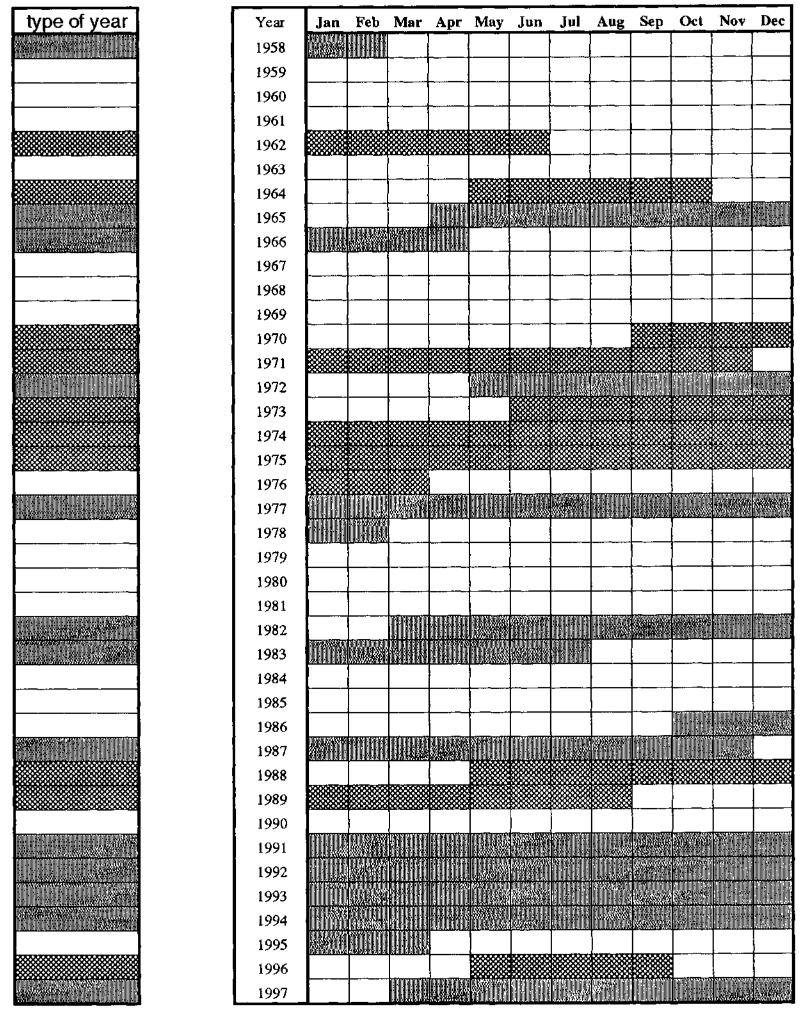


Table 42c: **Southern Oscillation Indices (SOI) and Identification of El Nino and La Nina years and months.**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1958	-16.8	-6.9	-1.4	1.2	-8.2	0.2	2.2	7.8	-3.4	-1.9	-4.7	-6.5
1959	-8.7	-14	8.4	3.6	2.8	-6.3	-5	-5	0.2	4.2	11.1	8.2
1960	0.3	-2.2	5.6	7.8	5.2	-2.3	4.8	6.6	6.9	-0.7	7.2	6.7
1961	-2.5	6.3	-20.9	9.4	1.3	-3.1	2.2	0.1	0.8	-5	7.2	13.8
1962	17	5.3	-1.4	1.2	12.3	5	-0.4	4.6	5.1	10.3	5.2	0.6
1963	9.4	3	7.3	6.1	2.8	-9.6	-1	-2.4	-5.2	-12.9	-9.3	-11.6
1964	-4	-0.3	8.4	13.5	2.8	7.4	6.8	14.3	14.1	12.8	2.6	-3
1965	-4	1.6	2.9	-12.9	-0.3	-12.8	-22.6	-11.4	-14.2	-11.1	-17.9	1.6
1966	-12	-4.1	-13.9	-7.1	-9	1	-1	4	-2.2	-2.5	-0.1	-4
1967	14.6	12.9	7.8	-3	-3.5	6.6	1.6	5.9	5.1	-0.1	-4	-5.5
1968	4.1	9.6	-3	-3	14.7	12.3	7.4	0.1	-2.8	-1.9	-3.4	2.1
1969	-13.5	-6.9	1.8	-8.8	-6.6	-0.6	-6.9	-4.4	-10.6	-11.7	-0.1	3.7
1970	-10.1	-10.7	1.8	-4.6	2.1	9.9	-5.6	4	12.9	10.3	19.7	17.4
1971	2.7	15.7	19.2	22.6	9.2	2.6	1.6	14.9	15.9	17.7	7.2	2.1
1972	3.7	8.2	2.4	-5.5	-16.1	-12	-18.6	-8.9	-14.8	-11.1	-3.4	-12.1
1973	-3	-13.5	0.8	-2.1	2.8	12.3	6.1	12.3	13.5	9 7	31.6	16.9
1974	20.8	16.2	20.3	11.1	10.7	2.6	12	6.6	12.3	8.5	-1.4	-0.9
1975	-4.9	5.3	11.6	14.4	6	15.5	21.1	20.7	22.5	17.7	13.8	19.5
1976	11.8	12.9	13.2	1.2	2.1	0.2	-12.8	-12.1	-13	3	9.8	-3
1977	-4	7.7	-9.5	-9.6	-11.4	-17.7	-14.7	-12.1	-9.4	-12.9	-14.6	-10.6
1978	-3	-24.4	-5.8	-7.9	16.3	5.8	6.1	1.4	0.8	-6.2	-2	-0.9
1979	-4	6.7	-3	-5.5	3.6	5.8	-8.2	-5	1.4	-2.5	-4.7	-7.5
1980	3.2	1.1	-8.5	-12.9	-3.5	-4.7	-1.7	1.4	-5.2	-1.9	-3.4	-0.9
1981	2.7	-3.2	-16.6	-5.5	7.6	11.5	9.4	5.9	7.5	-5	2.6	4.7
1982	9.4	0.6	2.4	-3.8	-8.2	-20.1	-19.3	-23.6	-21.4	-20.2	-31.1	-21.3
1983	-30.6	-33.3	-28	-17	6	-3.1	-7.6	0.1	9.9	4.2	-0.7	0.1
1984	1.3	5.8	-5.8	2	-0.3	-8.7	2.2	2.7	2	-5	3.9	-1.4
1985	-3.5	6.7	-2	14.4	2.8	-9.6	-2.3	8.5	0.2	-5.6	-1.4	2.1
1986	8	-10.7	0.8	1.2	-6.6	10.7	2.2	-7.6	-5.2	6.1	-13.9	-13.6
1987	-6.3	-12.6	-16.6	-24.4	-21.6	-20.1	-18.6	-14	-11.2	-5.6	-1.4	-4.5
1988	-1.1	-5	2.4	-1.3	10	-3.9	11.3	14.9	20.1	14.6	21	10.8
1989	13.2	9.1	6.7	21	14.7	7.4	9.4	-6.3	5.7	7.3	-2	-5
1990	-1.1	-17.3	-8.5	-0.5	13.1	1	5.5	-5	-7.6	1.8	-5.3	-2.4
1991	5.1	0.6	-10.6	-12.9	-19.3	-5.5	-1.7	-7.6	-16.6	-12.9	-7.3	-16.7
1992	-25.4	-9.3	-24.2	-18.7	0.5	-12.8	-6.9	1.4	0.8	-17.2	-7.3	-5.5
1993	-8.2	-7.9	-8.5	-21.1	-8.2	-16	-10.8	-14	-7.6	-13.5	0.6	1.6
1994	-1.6	0.6	-10.6	-22.8	-13	-10.4	-18	-17.2	-17.2	-14.1	-7.3	-11.6
1995	-4	-2.7	3.5	-16.2	-9	-1.5	4.2	0.8	3.2	-1.3	1.3	-5.5
1996	8.4	1.1	6.2	7.8	1.3	13.9	6.8	4.6	6.9	4.2	-0.1	7.2
1997	4.1	13.3	-8.5	-16.2	-22.4	-24.1	-9.5	-19.8	-14.8	-17.8	-15.2	-9.1



hot, low SOI
El Nino event

normal, neutral SOI
year, month

cold, high SOI
La Nina event

Table 43: Distribution, by type of years, of runoffs of rivers in the Oceania Pacific area.

River name	Year type	Percentiles 10%	30%	50%	70%	90%
Darling River 5204255	La Nina	1211	3957	7845	14606	51451
	Neutral	413	1316	3038	7090	19440
	El Nino	133	522	1203	4079	14044
Fitzroy 5101301	La Nina	1,6	6,7	19,4	110,7	823,2
	Neutral	0,4	2,9	15,1	52,0	220,8
	El Nino	0,3	1,4	8,8	26,2	149,6
Daly 5708145	La Nina	10,9	18,4	33,3	86,4	519,5
	Neutral	16,7	22,6	32,2	70,2	618,9
	El Nino	16,0	19,7	25,7	75,2	712,8
Herbert River 5101161	La Nina	6,3	15,7	30,9	97,2	331,2
	Neutral	4,3	12,5	24,3	62,8	330,6
	El Nino	3,3	8,2	19,3	57,4	325,5
Mary River (1) 5708185	La Nina	0,0	0,1	2,3	23,1	111,2
	Neutral	0,0	0,1	1,9	14,9	167,8
	El Nino	0,0	0,0	0,5	15,1	130,9
Mary River (2) 5101381	La Nina	2,2	5,8	12,6	30,9	119,3
	Neutral	1,2	3,4	7,3	17,2	89,5
	El Nino	0,9	2,9	5,9	16,1	70,0
Mitchell River 5302242	La Nina	3,0	13,0	25,5	50,0	89,0
	Neutral	2,0	6,0	15,0	33,0	70,0
	El Nino	2,0	5,0	11,0	22,0	52,0
Avoca River 5304080	La Nina	0,0	0,0	3,0	17,0	107,0
	Neutral	0,0	0,0	0,0	3,0	22,0
	El Nino	0,0	0,0	1,0	3,0	25,0
Huon River 5803600	La Nina	18,0	42,0	68,5	111,0	171,0
	Neutral	24,0	49,0	75,0	98,5	152,5
	El Nino	24,0	50,0	76,5	100,0	153,0
Murrumbidge 5204105	La Nina	74,0	108,0	489,5	1226,0	2818,0
	Neutral	57,0	167,0	378,0	829,0	2095,0
	El Nino	43,0	125,0	245,5	474,0	1656,0
Nymboida R 5202040	La Nina	374,0	696,0	1234,5	2701,0	6707,0
	Neutral	348,0	676,0	1164,0	2052,0	5751,0
	El Nino	282,0	492,0	836,5	1618,0	3706,0
Serpentine R. 5606145	La Nina	0,0	0,0	1,0	4,0	16,0
	Neutral	0,0	0,0	1,0	4,0	16,0
	El Nino	0,0	0,0	0,0	1,0	13,0
Tipindje 5762050	La Nina	1,0	1,0	4,0	11,0	37,0
	Neutral	0,0	1,0	2,0	7,0	19,0
	El Nino	0,0	1,0	1,0	4,0	30,0
Riviere Des Lacs 5762700	La Nina	0,0	2,0	3,0	5,0	11,0
	Neutral	0,0	2,0	3,0	7,0	14,0
	El Nino	0,0	2,0	3,0	5,0	10,0
Mataura 5868300	La Nina	19,3	37,7	52,9	67,6	86,3
	Neutral	27,1	42,2	56,2	73,5	108,0
	El Nino	35,2	53,8	69,2	92,1	134,0
Motu 5864150	La Nina	38,0	55,0	94,5	132,0	202,0
	Neutral	30,0	53,0	77,5	104,0	148,0
	El Nino	23,0	40,0	74,5	106,0	161,0
Ongarue 5865550	La Nina	8,5	18,1	30,4	45,4	75,9
	Neutral	11,7	19,6	27,7	38,2	59,0
	El Nino	12,4	19,1	26,4	38,8	59,2
Hurunui 5867500	La Nina	22,0	33,0	42,5	65,0	86,0
	Neutral	25,0	36,0	42,0	56,0	78,0
	El Nino	27,0	39,0	44,0	56,0	88,0
Ahuriri 5868200	La Nina	10,8	14,2	18,5	24,3	36,3
	Neutral	11,9	16,6	22,6	30,3	29,5
	El Nino	11,2	15,5	20,7	26,6	40.6

Table 44: Distribution, by type of years, of runoffs of rivers in the Far East Asia area.

River name	Year type	Percentiles				
		10%	30%	50%	70%	90%
Tone	La Nina	95,0	134,0	188,0	270,0	437,0
2588550	Neutral	93,0	146,0	200,5	277,0	432,0
	El Nino	102,0	128,0	174,5	279,0	551,0
Ishikari	La Nina	209,0	317,0	403,5	549,0	1133,0
2587100	Neutral	179,0	255,5	311,5	428,5	880,5
	El Nino	226,0	285,0	357,0	444,0	1128,0
Shinano	La Nina	269,0	345,0	411,0	560,0	868,0
2589500	Neutral	256,0	334,0	411,0	562,0	876,0
	El Nino	257,0	336,0	468,0	616,0	1130,0
Yodo	La Nina	112,0	163,0	207,5	310,0	516,0
2588200	Neutral	96,0	155,0	195,5	284,0	423,0
	El Nino	130,0	165,0	207,0	311,0	703,0
Chikugo	La Nina	37,0	50,0	77,0	112,0	216,0
2590100	Neutral	43,0	53,0	72,0	103,0	254,0
	El Nino	50,0	63,0	96,5	139,0	339,0
Changjia	La Nina	7740	12500	22300	32900	42000
2181800	Neutral	7310	12700	21303	32000	42150
	El Nino	7670	13550	21300	30000	41000
Songhua	La Nina	140,0	481,0	913,0	1500,0	2590,0
2106500	Neutral	158,0	453,0	932,0	1430,0	2630,0
	El Nino	158,0	479,0	881,0	1450,0	2470,0
Yongdin	La Nina	9,0	17,0	28,5	51,0	82,0
2178300	Neutral	10,0	15,0	24,5	41,0	77,0
	El Nino	11,0	17,0	28,0	38,5	77,0
Jinghe	La Nina	18,0	28,0	38,0	59,0	120,0
2180500	Neutral	19,0	28,0	38,0	56,0	124,0
	El Nino	19,0	28,0	36,0	56,0	145,0
Wujiang	La Nina	313,0	424,0	890,0	1500,0	2260,0
2181400	Neutral	300,5	422,5	804,0	1375,0	2623,5
	El Nino	282,0	454,0	860,5	1440,0	2030,0
Huanghe	La Nina	498,0	774,0	1075,0	1767,0	3150,0
2180800	Neutral	420,0	740,0	1035,0	1680,0	3440,0
	El Nino	513,5	685,0	929,5	1361,0	2870,0
Beijiang	La Nina	275,0	483,0	764,5	1420,0	2620,0
2186900	Neutral	251,0	389,0	721,0	1140,0	2330,0
	El Nino	239,0	415,0	765,0	1240,0	2180,0
Dongjial	La Nina	296,0	371,0	619,5	922,0	1550,0
2186950	Neutral	253,0	374,0	588,5	867,0	1370,0
	El Nino	296,0	456,0	603,5	847,0	1480,0
Yana	La Nina	0,0	2,0	44,5	960,0	2830,0
2998100	Neutral	0,0	2,0	56,0	1180,0	3300,0
	El Nino	0,0	6,0	81,0	1290,0	3050,0
Penzhina	La Nina	23,0	44,0	149,0	603,0	1650,0
2901300	Neutral	20,0	35,0	119,5	745,0	2150,0
	El Nino	21,0	32,0	123,0	741,0	1960,0
Indigirka	La Nina	10,0	28,0	144,0	2270,0	5340,0
2998400	Neutral	10,5	31,0	126,0	2035,0	6192,0
	El Nino	9,0	29,0	132,0	1980,0	5228,0
Lena	La Nina	1230,0	2270,0	3495,0	21900,0	47958,0
2903420	Neutral	1410,0	2540,0	3894,0	21500,0	48400,0
	El Nino	1360,0	2411,0	3975,5	19600,0	47100,0
Shilka	La Nina	4,0	33,0	260,5	549,0	1160,0
2906200	Neutral	4,0	35,0	268,5	575,0	1060,0
	El Nino	5,0	38,0	198,5	518,0	1100,0
Kamchatka	La Nina	388,0	446,0	571,5	851,0	1730,0
2902800	Neutral	370,0	427,0	578,0	868,0	1610,0
	El Nino	378,0	445,0	575,0	910,0	1550,0
Amur(1)	La Nina	637,0	1900,0	6115,0	13900,0	19400,0
2906700	Neutral	707,0	1770,0	6475,0	12800,0	19100,0
	El Nino	632,0	1820,0	6570,0	12700,0	18700,0
Amur(2)	La Nina	1200	2540	9105	16200	22000
2906900	Neutral	1120	2480	8040	14029	21200
	El Nino	1140	2370	9315	16000	21900
Li-Wu	La Nina	1219,0	1685,0	2361,0	3252,0	9001,0
2385760	Neutral	1116,5	1538,5	2261,5	3688,5	7064,5
	El Nino	923,0	1281,5	1756,5	2625,5	6733,0
Yufeng	La Nina	499,0	760,0	1097,0	1607,0	3195,0
2385500	Neutral	438,0	783,0	1153,5	2037,0	4346,0
	El Nino	396,0	580,0	870,0	1490,0	4459,0
Sandimen	La Nina	55,0	116,0	560,0	4130,0	9726,0
2385400	Neutral	66,0	94,0	755,5	3477,0	9878,0
	El Nino	77,0	118,0	340,0	2704,0	14464,0
Xinfadaqiao	La Nina	1270,0	1891,0	3510,0	7194,0	14981,0
2385200	Neutral	1045,0	1554,0	2819,5	7581,0	15682,0
	El Nino	1008,0	1770,0	3506,0	6980,0	24866,0

Table 45: Distribution, by type of years, of runoffs of rivers in the South East Asia area.

River name	Year type	Percentiles 10%	30%	50%	70%	90%
Pampanga 5654500	La Nina	23,0	47,0	103,0	264,0	590,0
	Neutral	23,0	44,0	105,5	266,0	631,0
	El Nino	25,0	68,0	132,0	294,0	559,0
Bonga 5654100	La Nina	1,0	2,0	5,5	23,0	53,5
	Neutral	2,0	3,0	9,0	27,0	93,0
	El Nino	1,0	3,0	6,5	31,0	76,0
Kelanatan 5223100	La Nina	324,0	387,5	459,0	624,0	1102,0
	Neutral	199,0	300,0	405,5	585,0	966,0
	El Nino	206,0	341,0	447,0	618,0	908,0
Mekong(3) 2969100	La Nina	1620,0	2320,0	4447,0	9850,0	20630,0
	Neutral	1450,0	2130,0	4311,5	10890	20781
	El Nino	1580,0	2000,0	4340,5	9760,0	18970,0
Nam Chi 2969150	La Nina	13,0	54,0	114,0	298,0	656,0
	Neutral	16,0	58,0	112,5	334,0	715,0
	El Nino	11,0	56,5	94,5	224,0	667,0
Nam Mun 2969200	La Nina	47,5	87,0	238,0	619,5	1621,0
	Neutral	48,0	94,0	206,0	846,0	1910,0
	El Nino	26,5	85,0	154,0	543,0	2178,0
Nan 2964080	La Nina	24,0	39,0	75,0	230,0	546,0
	Neutral	19,0	43,0	81,5	182,0	567,0
	El Nino	20,0	34,0	60,0	140,0	368,0
Mekong(1) 2969010	La Nina	839,0	1150,0	1966,0	3370,0	6540,0
	Neutral	845,0	1120,0	1830,0	3731,0	5750,0
	El Nino	861,0	1100,0	1905,0	3480,0	5601,0
Mekong(2) 2969095	La Nina	1460,0	2160,0	4450,0	9650,0	19290,0
	Neutral	1450,0	2210,0	4030,0	9673,0	16690,0
	El Nino	1550,0	2140,0	3850,0	8840,0	15750,0

Table 46: Distribution, by type of years, of runoffs of rivers in the Indian Subcontinent area.

River name	Year type	Percentiles 10%	30%	50%	70%	90%
Mahaweli Ganga 2357500	La Nina	16,5	32,5	56,0	94,5	143,0
	Neutral	15,0	35,0	58,0	82,0	130,0
	El Nino	11,0	26,0	47,5	78,0	125,0
Gin Ganga 2357750	La Nina	23,0	40,0	56,0	81,0	114,0
	Neutral	23,0	39,0	54,0	73,0	112,0
	El Nino	17,0	29,0	44,0	76,0	119,0
Karnali River 2548400	La Nina	355,0	450,0	617,0	1470,0	4150,0
	Neutral	326,0	405,0	632,5	1470,0	3750,0
	El Nino	329,0	436,5	621,5	1225,0	3150,0
Kali Gandaki (1) 2549300	La Nina	112,0	159,0	343,0	848,0	1610,0
	Neutral	119,0	152,0	313,0	941,0	1290,0
	El Nino	104,0	142,0	249,0	540,0	1260,0
Kali Gandaki (2) 2549350	La Nina	105,0	187,0	408,5	735,0	932,0
	Neutral	104,0	187,5	328,0	614,5	824,5
	El Nino	112,0	166,0	269,0	581,0	846,0
Tamur River 2550500	La Nina	109,0	187,0	564,0	719,0	1060,0
	Neutral	115,0	195,0	391,0	743,0	938,0
	El Nino	102,0	162,0	357,0	626,0	909,0
Ganges R. (1) 2646200	La Nina	2012,0	2640,0	4051,0	14610	36450,0
	Neutral	1578,0	2396,0	3806,5	13670	36984,0
	El Nino	1424,0	2316,0	3592,0	10310	31874,0
Ganges R. (2) 2646800	La Nina	1888,0	2615,0	4605,0	17110	44698,5
	Neutral	1716,0	2556,0	3938,5	15971	40266,0
	El Nino	1852,0	2337,0	3670,5	10700	36966,0
Sapt Kosi	La Nina	344,0	435,0	759,5	2074,5	4422,5
	Neutral	356,5	464,0	794,0	2109,0	4297,5
	El Nino	365,0	446,0	696,5	1612,0	3869,0
Godavari 2856900	La Nina	67,0	190,0	405,5	2849,0	10397,0
	Neutral	92,0	211,0	388,5	2797,0	10949,0
	El Nino	72,0	165,0	299,0	2073,0	9699,0
Krishna 2854300	La Nina	9,0	44,0	255,5	2343,0	5910,0
	Neutral	15,5	82,5	250,5	1792,5	5556,5
	El Nino	5,0	34,0	218,0	1451,0	5310,0
Narmada 2853500	La Nina	3,0	12,0	31,0	153,0	1333,0
	Neutral	2,0	10,0	26,0	107,0	1138,0
	El Nino	2,0	8,0	17,0	85,0	699,0

Table 47: Distribution, by type of years, of runoffs of rivers in the Central Asia area.

River name	Year type	Percentiles 10%	30%	50%	70%	90%
Amu-Darya 2917100	La Nina	366,0	622,0	935,0	1620,0	2630,0
	Neutral	498,0	752,0	1015,0	1860,0	3220,0
	El Nino	324,0	637,0	839,0	1470,0	2620,0
Zaravchan 2917450	La Nina	35,0	45,0	70,0	196,0	407,0
	Neutral	35,0	45,0	74,0	176,0	411,0
	El Nino	35,0	48,0	77,5	196,0	381,0
Gunt 2917700	La Nina	25,0	31,0	42,5	115,0	264,0
	Neutral	27,0	31,0	47,0	118,0	299,0
	El Nino	25,0	30,0	45,0	121,0	260,0
Vakhsh 2917900	La Nina	180,0	239,0	346,0	831,0	1430,0
	Neutral	177,0	223,0	352,5	838,0	1500,0
	El Nino	180,0	228,0	365,0	831,0	1370,0
Biya 2910470	La Nina	59,0	96,0	282,5	606,0	1160,0
	Neutral	57,0	103,5	326,5	631,0	1115,0
	El Nino	53,0	104,0	412,5	655,0	1100,0
Ob 2912600	La Nina	3470,0	4430,0	7904,5	16391,0	31500,0
	Neutral	3230,0	4370,0	7720,0	14670,0	31800,0
	El Nino	3250,0	4615,0	8129,0	13400,0	31800,0
Tom (1) 2910490	La Nina	69,0	118,0	241,0	633,0	1900,0
	Neutral	69,0	124,0	276,0	600,0	1810,0
	El Nino	71,0	146,0	307,5	631,0	2060,0
Tom (2) 2910300	La Nina	148,0	231,0	427,5	835,0	3350,0
	Neutral	139,0	239,0	507,5	887,0	2820,0
	El Nino	146,0	229,0	490,5	1050,0	3020,0
Tura 2912400	La Nina	23,0	35,0	72,0	160,0	546,0
	Neutral	21,0	36,0	64,0	170,0	507,0
	El Nino	21,0	34,0	53,5	147,0	487,0
Yenisei 2909150	La Nina	4350.0	6390.0	10030.0	17473.0	33200.0
	Neutral	4420.0	6440.0	10900.0	18400.0	41900.0
	El Nino	4550.0	7020.0	10365.0	16900.0	35300.0
Syr-Darya 2916200	La Nina	139,0	335,0	454,0	603,0	878,0
	Neutral	137,0	382,0	517,0	661,0	1150,0
	El Nino	85,0	251,0	387,0	556,0	890,0
Ural 2919200	La Nina	36,0	62,0	101,5	171,0	652,0
	Neutral	37,0	66,0	96,0	174,0	663,0
	El Nino	46,0	73,0	112,5	235,0	874,0
Naryn 2916850	La Nina	145,0	179,0	232,0	404,0	790,0
	Neutral	141,0	189,0	247,5	433,0	781,0
	El Nino	129,0	178,0	229,5	387,0	731,0

Table 48: Duncan test, Parametric and Non-Parametric ANOVA results for the discrimination of El Nino, La Nina and Neutral years (Oceania Pacific Area).

River	Mean Yearly flows			p-value	p-value	Monthly Maximum			p-value	p-value	Monthly Minimum			p-value	p-value
	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El El Nino	ANOVA	Kruskall-Wallis
Darling River	22224(A)	8616(B)	5383(B)	0.0048	0.0017	80146(A)	37850(AB)	21478(B)	0.0431	0.0116	1852.1(A)	794.4(B)	256.6(B)	0.0006	0.0006
Fitzroy	**254.2(A)**	**129.0(A)**	**152.4(A)**	0.30	0.0529	1771.3(A)	796.5(A)	1218.1(A)	0.34	0.0804	2.16(A)	1.98(A)	1.35(A)	0.82	0.0749
Daly	212.9(A)	215.7(A)	204.1(A)	0.99	0.81	1259.4(A)	1405.8(A)	1344.9(A)	0.97	0.68	16.2(A)	18.3(A)	15.8(A)	0.66	0.21
Herbert River	118.3(A)	103.0(A)	98.6(A)	0.59	0.51	551.6(A)	541.8(A)	506.5(A)	0.91	0.69	8.11(A)	5.13(B)	3.12(B)	0.0023	0.0022
Mary River (1)	47.4(A)	53.5(A)	44.5(A)	0.72	0.61	322.6(A)	370.7(A)	336.3(A)	0.88	0.86	0.04(A)	0.01(B)	0.00(B)	0.30	0.18
Mary River (2)	**54.5(A)**	**33.3(B)**	**30.9(B)**	0.0254	0.15	**327.6(A)**	**181.7(B)**	**169.9(B)**	0.0314	0.49	3.24(A)	1.89(B)	1.12(B)	0.0046	0.0146
Mitchell River	38.5(A)	27.4(B)	19.2(B)	0.0031	0.0016	97.7(A)	88.3(AB)	58.1(B)	0.0488	0.0381	3.00(A)	2.04(A)	1.77(A)	0.21	0.72
Avoca River	92.9(A)	16.2(B)	51.3(AB)	0.0479	0.0002	**396.0(A)**	**88.5(A)**	**287.2(A)**	0.11	0.0024	0.59(A)	0.43(A)	0.77(A)	0.79	0.41
Huon River	85.7(A)	82.6(A)	84.7(A)	0.89	0.70	214.3(A)	185.4(A)	184.6(A)	0.36	0.25	14.6(A)	19.7(A)	19.5(A)	0.25	0.19
Murrumbidgee River	1078.8(A)	801.7(AB)	579.2(B)	0.0927	0.14	**3291.3(A)**	**2608.3(AB)**	**1798.3(B)**	0.12	0.0770	91.5(A)	87.2(A)	72.9(A)	0.69	0.69
Nymboida River	2730.2(A)	2148.7(AB)	1549.1(B)	0.0066	0.0210	9969(A)	7535(AB)	5424(B)	0.0074	0.0229	**497.5(A)**	**431.9(AB)**	**305.3(B)**	0.0803	0.0747
Serpentine River	5.42(A)	4.81(A)	3.52(A)	0.33	0.36	22.0(A)	18.7(A)	15.6(A)	0.53	0.49	0.00(A)	0.05(A)	0.09(A)	0.39	0.39
Tipindje	10.51(A)	9.76(A)	8.27(A)	0.81	0.72	40.3(A)	43.1(A)	46.8(A)	0.92	0.86	0.75(A)	0.46(AB)	0.00(B)	0.12	0.0384
Riviere Des Lacs	4.37(A)	5.54(A)	4.12(A)	0.13	0.10	13.1(A)	17.4(A)	13.0(A)	0.13	0.18	0.00(A)	0.31(A)	0.29(A)	0.22	0.36
Mataura	54.4(B)	63.4(AB)	76.9(A)	0.0169	0.0211	**110.0(B)**	**121.4(AB)**	**157.3(A)**	0.0639	0.0799	19.5(B)	27.5(AB)	33.4(A)	0.0256	0.0324
Motu	105.1(A)	85.1(B)	83.9(B)	0.0249	0.0621	214.0(A)	177.6(A)	187.3(A)	0.15	0.14	**30.4(A)**	**25.8(AB)**	**18.1(A)**	0.0580	0.16
Ongarue	35.6(A)	31.9(A)	32.9(A)	0.42	0.54	**85.9(A)**	**64.8(B)**	**75.7(AB)**	0.0720	0.0281	8.6(A)	11.4(A)	12.3(A)	0.13	0.15
Hurunui	51.3(A)	49.4(A)	52.6(A)	0.78	0.78	109.8(A)	98.8(A)	109.8(A)	0.65	0.39	20.7(A)	23.9(A)	25.1(A)	0.40	0.64
Ahuriri	21.6(A)	24.5(A)	23.5(A)	0.37	0.35	45.7(A)	47.0(A)	47.6(A)	0.95	0.95	10.7(A)	11.6(A)	11.1(A)	0.79	0.44

Numbers associated with the same letters are not discriminated by the Duncan test on the equality of several mean values.

very significant

significant

differences in the mean values as demonstrated by the ANOVA tests.

Table 49: **Duncan test, Parametric and Non-Parametric ANOVA results for the discrimination of El Nino, La Nina and Neutral years (Far East Asia area).**

River	Mean Yearly flows			p-value	p-value	Monthly Maximum			p-value	p-value	Monthly Minimum			p-value	p-value
	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El El Nino	ANOVA	Kruskall-Wallis
Tone	247.7(A)	246.5(A)	266.9(A)	0.70	0.49	596.8(A)	592.0(A)	773.3(A)	0.12	0.14	96.0(A)	104.1(A)	95.2(A)	0.58	0.98
Ishikari	329.6(A)	423.2(B)	479.3(AB)	0.0253	0.0103	1441.2(A)	1121.7(A)	1316.8(A)	0.0890	0.0587	187.4(A)	181.9(A)	212.3(A)	0.34	0.41
Shinano	496.6(A)	507.5(A)	592.9(A)	0.41	0.96	1079.3(A)	1129.6(A)	1241.3(A)	0.70	0.77	248.0(A)	247.8(A)	259.7(A)	0.90	1.00
Yodo	270.6(A)	248.3(A)	309 1(A)	0.44	0.61	659.8(A)	620.3(A)	802.1(A)	0.53	0.86	109.8(A)	108.9(A)	133.6(A)	0.27	0.24
Chikugo	101.6(A)	109.7(A)	148.8(A)	0.11	0.0780	261.7(B)	343.4(AB)	488.7(A)	0.0209	0.0108	**36.2(B)**	**41.3(AB)**	**47.7(A)**	0.0844	0.13
Changjiang	23556(A)	23369(A)	22808(A)	0.66	0.52	43626(A)	44528(A)	41996(A)	0 24	0.41	7272.6(A)	6786.5(A)	6984.8(A)	0.33	0.28
Songhuajiang	1161.7(A)	1228.0(A)	1204.0(A)	0.85	0.95	2959.8(A)	3282 9(A)	3229.5(A)	0.75	0.89	205.4(A)	187.9(A)	214.0(A)	0.72	0.94
Yongding	42.3(A)	35.8(A)	36.0(A)	0.51	0.67	124.0(A)	91.9(A)	82.1(A)	0.29	0.65	**9.6(B)**	**10.3(B)**	**14.7(A)**	0.0372	0.14
Jinghe	60.7(A)	60.0(A)	64.0(A)	0.88	0.89	172.4(A)	194.1(A)	190.9(A)	0.84	0.74	16.5(A)	17.8(A)	16.8(A)	0.65	0.81
Wujiang	1127.2(A)	1185.9(A)	1081.5(A)	0.41	0.47	3121 8(A)	3382.2(A)	2677.3(A)	0.11	0.0892	293.3(A)	279.8(A)	259.2(A)	0.51	0.54
Huanghe(Yel Riv.)	1458.9(A)	1468.5(A)	1312.7(A)	0.65	0.60	3438.6(A)	3758.5(A)	3286.0(A)	0.59	0.70	420.5(A)	405.4(A)	458.8(A)	0.68	0.66
Beijiang	1224.3(A)	1023.0(A)	1039.0(A)	0.24	0.33	3645.6(A)	2946.1(A)	3145.6(A)	0.36	0 51	300.1(A)	224.8(B)	200.3(B)	0.0083	0.0394
Dongjiang	790.7(A)	718 6(A)	790.9(A)	0.61	0.85	1945 7(A)	1712.9(A)	1977.1(A)	0.65	0.68	295.6(A)	266.2(A)	310.3(A)	0.72	0.92
Yana	**843.6(B)**	**985.3(A)**	**886.0(AB)**	0.0559	0.18	3774.3(AB)	4454.3(A)	3609.2(B)	0.0311	0.0320	0.43(A)	0.10(A)	1.00(A)	0.16	0.36
Penzhina	662.2(A)	710 6(A)	700.0(A)	0.82	0.83	4161.4(A)	3898.0(A)	4318.8(A)	0.79	0.66	22.6(A)	20.9(A)	19.4(A)	0.59	0.58
Indigirka	**1518.7(AB)**	**1701.8(A)**	**1483.4(B)**	0.0560	0.11	5934.4(B)	6877.8(A)	5813.0(B)	0.0209	0 0400	7.63(A)	7.64(A)	7.94(A)	0.94	0.96
Lena	16854(A)	16664(A)	16325(A)	0.75	0.78	75147(A)	73813(A)	72925(A)	0.84	0 68	1207.4(A)	1351.9(A)	1459.8(A)	0.32	0.19
Shilka	403.7(A)	415.9(A)	396.7(A)	0.89	0.79	1279.9(A)	1304.0(A)	1237.6(A)	0.91	0.67	3.42(A)	3 70(A)	3.71(A)	0.93	0.74
Kamchatka	779.5(A)	775.5(A)	786.4(A)	0.94	0.91	1853.6(A)	1920 7(A)	1814.2(A)	0 55	0.60	393.5(A)	370.6(A)	387.5(A)	0.21	0.34
Amur (1)	8539.7(A)	8389.1(A)	8368.2(A)	0.94	0.92	20283(A)	20950(A)	21167(A)	0.86	0.94	605.3(A)	612 1(A)	617.3(A)	0.98	0.98
Amur (2)	10146(A)	9574(A)	10208(A)	0.51	0.68	22162(A)	22793(A)	24242(A)	0.54	0.58	1085.1(A)	1042.3(A)	1039.2(A)	0.95	0.77
Li-Wu	3573 9(A)	3335.4(A)	2940 1(A)	0.37	0.40	11105(A)	9342(A)	10195(A)	0.60	0.59	1218.0(A)	1036.5(A)	1006.5(A)	0.23	0.29
Yufeng	1575.6(A)	1836.8(A)	1637.8(A)	0.45	0 35	5297(A)	6157(A)	5794(A)	0.73	0.72	456.4(A)	444 6(A)	373.6(A)	0.47	0.43
Sandimen	3083.7(A)	3154.3(A)	3804.2(A)	0.43	0.48	12633(A)	14627(A)	16919(A)	0.34	0.41	58.3(A)	62 0(A)	73.6(A)	0.37	0.23
Xinfadaqiao	6426(A)	6566(A)	8341(A)	0.19	0.34	21937(A)	25725(A)	32962(A)	0 20	0.28	1338.5(A)	1016.9(A)	1123.9(A)	0.16	0.12

Numbers associated with the same letters are not discriminated by the Duncan test on the equality of several mean values.

very significant

significant

differences in the mean values as demonstrated by the ANOVA tests.

Table 50: Duncan test, Parametric and Non-Parametric ANOVA results for the discrimination of El Nino, La Nina and Neutral years (South East Asia area).

River	Mean Yearly flows			p-value	p-value	Monthly Maximum			p-value	p-value	Monthly Minimum			p-value	p-value
	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El El Nino	ANOVA	Kruskall-Wallis
Pampanga	215.6(A)	224.7(A)	251 5(A)	0.56	0.75	707.6(A)	730.2(A)	854.6(A)	0.52	0 92	25.2(A)	22.6(A)	24.9(A)	0.85	0.98
Bonga	21.4(A)	28.5(A)	25.6(A)	0.38	0.27	83.6(A)	109 6(A)	110.2(A)	0.38	0 35	1.30(A)	1.85(A)	1.50(A)	0.52	0.66
Kelantan	629.7(A)	507.0(A)	566.1(A)	0.0447	0.0384	1669.3(A)	1230.6(A)	1584.7(A)	0.21	0 42	304.4(A)	228.0(A)	225.2(A)	0.11	0.0510
Mekong (1)	8065.1(A)	8043.0(A)	7557.5(A)	0.32	0.37	23383(A)	23778(A)	22099(A)	0.38	0.33	1549.8(A)	1410.7(A)	1491.8(A)	0 0916	0.18
Nam Chi	239 2(A)	256.5(A)	228.9(A)	0.66	0.89	796.8(A)	826.2(A)	860.1(A)	0.88	0.77	23.0(A)	30.8(A)	27.6(A)	0.66	0.66
Nam Mun	556.9(A)	666.2(A)	620.0(A)	0 40	0.57	2018.5(A)	2543.1(A)	2514.9(A)	0.32	0.21	44.3(A)	55 4(A)	51.3(A)	0.69	0 66
Nan	192.0(A)	186.8(A)	138.0(B)	0.0395	0.0375	728.6(A)	752.9(A)	545.3(A)	0.20	0.14	20.9(A)	23.7(A)	20.1(A)	0.61	0.92
Mekong (2)	2761.4(A)	2681.0(A)	2722 5(A)	0.90	0.85	7350.1(A)	6801.2(A)	6723.4(A)	0.69	0 54	807.9(A)	809.7(A)	839 1(A)	0.65	0.74
Mekong (3)	7413.6(A)	7096.7(A)	6671 8(A)	0.40	0.35	21311(A)	20254(A)	18988(A)	0.54	0.62	1381.8(A)	1391.5(A)	1562.9(A)	0.18	0 38

Numbers associated with the same letters are not discriminated by the Duncan test on the equality of several mean values.

very significant

significant

differences in the mean values as demonstrated by the ANOVA tests.

Table 51: Duncan test, Parametric and Non-Parametric ANOVA results for the discrimination of El Nino, La Nina and Neutral years (Indian Subcontinent area).

River	Mean Yearly flows			p-value	p-value	Monthly Maximum			p-value	p-value	Monthly Minimum			p-value	p-value
	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El El Nino	ANOVA	Kruskall-Wallis
Mahaweli Ganga	69.7(A)	66.3(A)	60.2(A)	0.39	0.29	171.1(A)	158.6(A)	149.2(A)	0.64	0.56	15.8(A)	14.5(A)	11.1(A)	0.48	0.26
Gin Ganga	64.3(A)	61.8(A)	57.8(A)	0.30	0.19	134.4(A)	135.4(A)	134.5(A)	0.99	0.96	20.1(A)	20.1(A)	15.5(A)	0.13	0.19
Karnali River	1420.5(A)	1380.3(A)	1273.6(A)	0.47	0.28	4336.9(A)	4445.3(A)	4052.3(A)	0.65	0.62	323.4(A)	307 4(A)	324.2(A)	0.76	0.51
Kalı Gandakı (1)	**643.9(A)**	**570.6(AB)**	**439.9(B)**	0.0410	0.10	1646.7(A)	1434.0(A)	1354.8(A)	0.42	0.40	99.7(A)	104.6(A)	97.5(A)	0 82	0.84
Kali Gandaki (2)	491.5(A)	418.1(B)	392.0(B)	0.0162	0.0478	974.5(A)	832.7(B)	841.2(B)	0.0341	0.0513	99.9(A)	83 4(A)	105.2(A)	0.32	0.39
Tamur River	533.5(A)	493.8(AB)	419.5(B)	0.0268	0.0239	1067.2(A)	990.2(A)	954.2(A)	0.40	0.35	92 8(A)	105.8(A)	86.5(A)	0.66	0.80
Ganges R. (1)	11565(A)	11476(A)	10360(A)	0.33	0.18	39183(A)	41743(A)	39095(A)	0.59	0.85	1893.6(A)	1668 7(A)	1666.8(A)	0.38	0.21
Ganges R (2)	14051(A)	12479(AB)	10855(B)	0.0102	0.0189	50408(A)	45465(AB)	41615(B)	0.11	0.17	1804.0(A)	1719.6(A)	1675.3(A)	0.67	0.81
Sapt Kosi	1688.1(A)	1661.0(A)	1472.3(A)	0.14	0.0868	5112.3(A)	4683.5(A)	4603.4(A)	0.47	0.43	328.2(A)	352.3(A)	341.3(A)	0.25	0.28
Godavari	3028.5(A)	3186.1(A)	2828.1(A)	0.48	0.52	12428(A)	14018(A)	14201(A)	0.48	0.53	59 8(A)	81.7(A)	64.4(A)	0.27	0.18
Krishna	1818.3(A)	1607.5(A)	1502.3(A)	0.17	0.49	7186.1(A)	6965.3(A)	6947.1(A)	0.94	0.97	18.3(A)	23.3(A)	19.0(A)	0.84	0.0229
Narmada	323.3(A)	296.4(A)	280.3(A)	0.87	0.34	1727.0(A)	1541.4(A)	2094.2(A)	0.73	0 25	2.22(A)	1.82(A)	1.50(A)	0.55	0.67

Numbers associated with the same letters are not discriminated by the Duncan test on the equality of several mean values.

very significant

significant

differences in the mean values as demonstrated by the ANOVA tests.

Table 52: Duncan test, Parametric and Non-Parametric ANOVA results for the discrimination of El Nino, La Nina and Neutral years (Central Asia area).

River	Mean Yearly flows			p-value	p-value	Monthly Maximum			p-value	p-value	Monthly Minimum			p-value	p-value
	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El Nino	ANOVA	Kruskall-Wallis	La Nina	Neutral	El El Nino	ANOVA	Kruskall-Wallis
Amu-Darya	1261.1(A)	1494.4(A)	1240.7(A)	0.0828	0.13	2962.5(A)	3514.1(A)	3110.0(A)	0.28	0.37	313.8(A)	431.9(A)	318.7(A)	0.19	0 15
Zaravchan	156 4(A)	154.1(A)	154.8(A)	0.94	0.96	473.9(A)	474.3(A)	445.8(A)	0.50	0.62	34.8(A)	34.3(A)	36.4(A)	0.39	0.73
Gunt	101.6(A)	107.1(A)	100.1(A)	0.51	0.53	325.2(A)	355.6(A)	335.4(A)	0.63	0.53	26.0(A)	26.1(A)	25.0(A)	0.23	0.27
Vakhsh	631 8(A)	652 4(A)	622.4(A)	0.64	0.78	1648.9(A)	1715.0(A)	1590.0(A)	0.57	0.53	180.8(A)	170.0(A)	172.9(A)	0.29	0.29
Biya	465.4(A)	474.6(A)	500.0(A)	0.47	0.36	1400.8(A)	1399.8(A)	1417.7(A)	0.99	0.89	58.3(A)	52.6(A)	52.9(A)	0.15	0.27
Ob	12776(A)	12414(A)	12527(A)	0.83	0.72	34177(A)	32973(A)	33629(A)	0.57	0.59	3303.6(A)	3186.4(A)	3315.4(A)	0.74	0.92
Tom (1)	659.3(A)	630.1(A)	685.0(A)	0.19	0.30	3124 6(A)	2817.4(A)	3003.6(A)	0.27	0.0822	68.7(A)	67.6(A)	71.4(A)	0.78	0.78
Tom (2)	1057.7(A)	1008 9(A)	1101.7(A)	0.55	0.73	4219.7(A)	4602.3(A)	5060.6(A)	0.45	0.48	124.6(A)	125.9(A)	138 0(A)	0.71	0 78
Tura	181.7(A)	186 6(A)	205.6(A)	0.72	0.98	755.2(A)	777.0(A)	1093.6(A)	0.24	0.71	25.0(A)	24.2(A)	23.1(A)	0.78	0.89
Yenisei	17821(A)	18255(A)	17940(A)	0 59	0.45	76500(A)	77989(A)	79740(A)	0.76	0.80	5133.3(A)	4914 3(A)	5437.5(A)	0.55	0.44
Syr-Darya	500.9(A)	595.2(A)	460.9(A)	0.21	0 21	954.9(A)	1154.7(A)	945.4(A)	0.29	0.31	245 1(AB)	292.6(A)	187.1(B)	0.0902	0.0950
Ural	280.3(A)	278.8(A)	362.6(A)	0.36	0.37	1504.6(A)	1461.9(A)	1746.6(A)	0.77	0.49	45.6(A)	44.7(A)	52.1(A)	0.59	0.48
Naryn	363.2(A)	375.5(A)	344.7(A)	0.61	0.72	921.8(A)	922.7(A)	893.6(A)	0.96	0.81	146.1(A)	134.7(A)	126.2(A)	0.47	0.42

Numbers associated with the same letters
are not discriminated by the Duncan test
on the equality of several mean values.

very significant

significant

differences in the mean values as demonstrated by the ANOVA tests.

Table 53a: Monthly runoff distributions according to SOI classification (Oceania-Pacific area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Darling	La Nina	N obs	9	10	9	9	8	10	10	10	10	11	10	11	117
		Mean	25375	35581	81326	35227	21560	16001	23457	43730	23049	12140	18528	20529	29168
		sd	35553 0	43892.6	114371.2	38985 3	22209 0	23140.7	34692.9	76636.0	37422.4	8604.6	30247.0	44743.0	50286.4
	Neutral	N obs	33	31	31	31	30	30	30	29	29	27	31	30	362
		Mean	3866	4873	9068	6225	8854	7452	8530	10940	12425	6844	5366	4810	7378
		sd	4751 7	5277.7	12409.4	9044.0	22493 5	20251.4	14923.7	11452.3	17595.4	9227.8	6583.8	6796 6	13012.5
	El Nino	N obs	8	9	10	10	12	10	10	11	11	12	9	9	121
		Mean	3241	3621	8764	8449	2477	6440	4971	1859	1575	1624	2687	4854	4129
		sd	4559.4	3523.7	12365.1	13169.9	3670.1	14847.6	8244 2	2144.8	1483 6	1949.1	5368.4	7142.3	7855.3
Mean Darling (n=50)			7637	10789	22014	11890	9356	8959	10804	15500	12163	6756	7516	8276	10972
P-Value Darling			0.0016	0.0003	0.0009	0.0006	0.11	0.46	0.0741	0.0176	0.0797	0.0109	0.0304	0 11	0.0001
Fitzroy	La Nina	N obs	4	5	5	5	4	6	6	6	6	6	5	5	63
		Mean	1462	1307	583	286	184	60	23	16	7	21	28	698	347
		sd	1503.4	1102.5	291.1	429.3	327.4	121.2	24.7	27.4	9.9	44.0	19.9	767.0	692.3
	Neutral	N obs	20	17	17	16	15	15	16	15	15	14	17	17	194
		Mean	459	407	235	81	59	112	33	23	16	8	40	77	140
		sd	1339.7	608.8	493.7	231.5	132 3	252.8	72.1	49 7	34.4	9.2	48.1	97 3	513.4
	El Nino	N obs	7	9	9	10	12	10	9	10	10	11	9	9	115
		Mean	66	398	276	22	402	12	3	2	1	11	13	67	110
		sd	45.8	1021.2	468.4	26.0	1150.1	32.0	6.0	3.7	1.9	32.2	16.4	112.7	491.5
Mean Fitzroy (n=31)			500	550	303	95	208	70	23	15	10	12	30	174	166
P-Value Fitzroy			0.20	0.10	0.34	0.13	0.49	0.43	0.42	0 39	0.35	0 62	0.24	0.0011	0.0134
Daly	La Nina	N obs	4	5	5	5	4	6	6	6	6	6	5	5	63
		Mean	377	771	2151	547	62	30	23	18	17	19	26	131	326
		sd	308.5	582 2	1892.1	369.9	27 9	17.7	13.8	12.4	10.9	11.8	3.6	103.7	784.5
	Neutral	N obs	16	14	14	13	13	12	13	12	12	11	14	14	158
		Mean	268	725	672	169	37	26	22	21	19	18	26	78	185
		sd	220 1	709.3	696.6	258.3	18.0	10.4	7.4	4.7	3.6	2.6	8 9	67.0	394.0
	El Nino	N obs	6	7	7	8	9	8	7	8	8	9	7	7	91
		Mean	155	721	933	233	38	25	22	19	17	16	20	59	176
		sd	95.7	684.6	913.0	467.4	27.9	9.9	6 7	5.2	4.5	3.9	5.2	51 4	434.0
Mean Daly (n=26)			258	733	1027	261	41	26	22	19	18	18	25	83	211
P-Value Daly			0.29	0 99	0.04	0.15	0.17	0 76	0.98	0.76	0.86	0.51	0.22	0.23	0.13
Herbert	La Nina	N obs	15	16	15	15	13	14	15	15	15	16	16	17	182
		Mean	279	509	540	205	84	46	33	21	18	13	23	103	157
		sd	275.3	296 7	358 0	130.0	52 6	31.6	22.5	13.6	12.7	10.3	35.6	144.9	346.3
	Neutral	N obs	53	50	51	51	51	52	51	50	50	47	49	48	603
		Mean	183	370	330	102	62	42	26	18	14	10	10	27	101
		sd	252.5	353.2	318.3	87.4	53.7	33.3	21.3	11.0	12.5	9.8	14.6	52 6	200.6
	El Nino	N obs	13	15	15	15	17	15	15	16	16	18	16	16	187
		Mean	35	241	279	149	82	43	31	15	9	5	4	8	73
		sd	33.4	269.6	467.2	176 7	71.4	32.3	17.9	7.1	3.9	2.3	2 2	9.5	182.2
Mean Herbert (n=81)			177	374	359	130	70	43	28	18	14	9	12	39	106
P-Value Herbert			0.0285	0.0831	0 0896	0.0114	0.30	0.92	0.49	0.39	0.10	0.0610	0.0248	0.0008	0.0003
Mary (1)	La Nina	N obs	6	7	7	6	5	7	7	7	7	8	7	7	81
		Mean	88	228	411	46	5	1	0	0	0	0	5	27	68
		sd	53.7	149.6	401.7	40.0	3.5	0.6	0 3	0 2	0.3	0.7	3 1	29.9	171.9
	Neutral	N obs	25	22	22	23	22	22	22	21	21	19	22	22	263
		Mean	79	225	169	47	3	1	0	0	0	0	2	24	47
		sd	83.8	224.8	165 0	90.3	4.0	0 9	0.3	0 2	0.1	0.5	4 0	46.5	114.0
	El Nino	N obs	8	10	10	10	12	10	10	11	11	12	10	10	124
		Mean	59	227	191	13	1	0	0	0	0	1	1	12	40
		sd	67.0	199.2	216 9	11 5	1.9	0.3	0 4	0.1	0.0	1 4	1 4	10.6	112 3
Mean Mary (1) (n=39)			76	226	218	38	3	0	0	0	0	0	2	21	49
P-Value Mary (1)			0.75	0 99	0.0656	0.44	0.11	0.54	0.91	0.92	0 18	0 38	0.0445	0.69	0.28

= Monthly event runoff significantly different from the global monthly average

Table 53b: Monthly runoff distributions according to SOI classification (Oceania-Pacific area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Mary (2)	La Nina	N obs	17	18	16	15	13	14	15	15	16	17	17	18	191
		Mean	**159**	**158**	**162**	**100**	**71**	**36**	**71**	**14**	**7**	**10**	**15**	**45**	**72**
		sd	255.4	196.9	204.9	228.0	100.2	36.0	131.3	18.5	4.7	10.0	17.8	49.0	148.1
	Neutral	N obs	54	51	53	54	52	54	53	53	52	49	51	50	626
		Mean	**52**	**88**	**79**	**50**	**21**	**36**	**19**	**8**	**5**	**9**	**14**	**25**	**34**
		sd	125.2	141.0	141.6	73.3	40.5	76.0	45.1	11.9	5.6	19.9	27.7	45.2	82.5
	El Nino	N obs	15	17	17	17	21	18	18	18	18	20	18	18	215
		Mean	**8**	**75**	**54**	**18**	**26**	**17**	**9**	**4**	**4**	**6**	**10**	**10**	**20**
		sd	8.6	153.2	85.2	26.7	51.9	27.8	13.9	4.6	5.3	9.5	28.6	17.7	56.7
Mean Mary (2) (n=86)			**65**	**100**	**90**	**52**	**30**	**32**	**26**	**8**	**5**	**9**	**14**	**26**	**38**
P-Value Mary (2)			0.0130	0.21	0.0818	0.12	0.0180	0.51	0.0129	0.11	0.26	0.70	0.81	0.0455	0.0001
Mitchell	La Nina	N obs	10	11	10	10	9	9	9	10	10	11	11	12	122
		Mean	**18**	**12**	**14**	**32**	**41**	**44**	**62**	**73**	**69**	**68**	**41**	**18**	**40**
		sd	20.5	19.8	20.1	49.1	48.1	37.2	49.2	43.8	25.1	31.3	31.5	8.4	39.0
	Neutral	N obs	31	29	31	31	30	32	31	30	30	27	29	28	359
		Mean	**8**	**4**	**6**	**8**	**19**	**39**	**40**	**53**	**55**	**46**	**34**	**25**	**28**
		sd	5.6	4.8	6.2	11.2	19.6	52.2	30.0	29.1	24.2	24.3	27.1	31.8	31.4
	El Nino	N obs	9	10	9	9	11	9	10	10	10	12	10	10	119
		Mean	**7**	**5**	**3**	**5**	**8**	**18**	**26**	**30**	**32**	**38**	**19**	**10**	**17**
		sd	11.6	6.9	3.5	3.8	5.6	20.6	16.4	14.8	16.3	30.2	16.2	9.8	19.0
Mean Mitchell (n=50)			**10**	**6**	**7**	**12**	**21**	**36**	**41**	**52**	**53**	**49**	**33**	**20**	**28**
P-Value Mitchell			0.0426	0.0716	0.0558	0.0152	0.0188	0.40	0.0559	0.0129	0.0029	0.0269	0.15	0.27	0.0001
Avoca	La Nina	N obs	21	21	19	18	16	18	19	19	20	21	21	22	235
		Mean	**4**	**4**	**7**	**75**	**158**	**377**	**201**	**76**	**238**	**61**	**38**	**5**	**99**
		sd	8.7	7.5	13.3	214.6	413.7	789.8	367.6	132.8	802.5	145.8	141.2	11.8	373.7
	Neutral	N obs	65	64	66	67	65	66	66	66	65	62	64	62	778
		Mean	**3**	**2**	**1**	**1**	**33**	**24**	**49**	**72**	**54**	**44**	**11**	**7**	**25**
		sd	8.7	4.5	3.3	2.8	168.8	119.9	181.6	232.0	212.8	195.3	39.7	24.8	135.2
	El Nino	N obs	18	19	19	19	23	20	19	19	19	21	19	20	235
		Mean	**26**	**9**	**2**	**2**	**12**	**26**	**32**	**94**	**317**	**169**	**20**	**67**	**64**
		sd	97.3	25.8	3.8	3.4	46.4	75.3	99.9	225.7	797.8	641.9	82.6	294.0	325.1
Mean Avoca (n=104)			**7**	**4**	**2**	**14**	**47**	**85**	**74**	**77**	**137**	**73**	**18**	**18**	**46**
P-Value Avoca			0.0932	0.0778	0.0019	0.0074	0.0700	0.0006	0.0202	0.93	0.0945	0.33	0.39	0.17	0.0001
Huon	La Nina	N obs	9	10	9	9	8	10	10	10	10	11	10	11	117
		Mean	**34**	**19**	**33**	**54**	**89**	**95**	**126**	**143**	**112**	**121**	**89**	**54**	**82**
		sd	20.0	12.2	16.4	22.3	56.3	49.3	59.9	55.0	37.1	78.0	48.9	38.6	59.2
	Neutral	N obs	29	26	26	26	25	25	25	24	24	22	26	25	303
		Mean	**42**	**31**	**38**	**84**	**113**	**116**	**137**	**123**	**103**	**86**	**82**	**70**	**84**
		sd	31.8	22.1	19.1	40.4	63.1	86.0	53.9	52.8	50.1	41.8	47.0	42.5	58.5
	El Nino	N obs	8	10	11	11	13	11	11	12	12	13	10	10	132
		Mean	**53**	**29**	**44**	**77**	**106**	**103**	**120**	**116**	**122**	**86**	**70**	**70**	**85**
		sd	38.3	18.0	25.2	43.3	56.8	41.1	55.2	53.5	47.2	26.4	26.5	36.8	49.5
Mean Huon (n=46)			**43**	**28**	**39**	**77**	**107**	**108**	**130**	**125**	**110**	**94**	**81**	**66**	**84**
P-Value Huon			0.47	0.22	0.48	0.14	0.63	0.69	0.67	0.47	0.52	0.14	0.63	0.54	0.88
Murrumbidge	La Nina	N obs	12	13	12	11	10	11	11	11	12	13	13	14	143
		Mean	**242**	**429**	**1023**	**1477**	**1139**	**1629**	**1714**	**1977**	**1520**	**1739**	**1024**	**527**	**1178**
		sd	138.5	716.1	2138.2	2344.8	1791.1	2649.6	1647.4	1850.4	1047.7	1493.9	811.1	379.8	1601.0
	Neutral	N obs	44	42	43	44	43	44	44	43	42	39	42	41	511
		Mean	**303**	**159**	**191**	**299**	**440**	**946**	**1262**	**1846**	**1715**	**1383**	**828**	**458**	**815**
		sd	581.6	164.0	223.9	509.8	507.0	1732.7	1199.1	1659.6	1092.9	1084.6	644.1	476.1	1117.8
	El Nino	N obs	11	12	12	12	14	12	12	13	13	15	12	12	150
		Mean	**314**	**219**	**156**	**144**	**235**	**407**	**782**	**786**	**997**	**873**	**523**	**318**	**491**
		sd	430.7	319.7	105.2	142.7	313.0	388.5	969.7	840.1	792.7	801.6	468.9	515.2	634.6
Mean Murrumbidgee (n=67)			**294**	**222**	**334**	**465**	**501**	**961**	**1250**	**1662**	**1540**	**1338**	**811**	**447**	**819**
P-Value Murrumbidgee			0.93	0.0704	0.0187	0.0025	0.0215	0.26	0.21	0.0876	0.10	0.12	0.16	0.51	0.0001

= Monthly event runoff significantly different from the global monthly average

Table 53c: Monthly runoff distributions according to SOI classification (Oceania-Pacific area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Nymboida	La Nina	N obs	17	18	16	15	13	15	16	16	17	18	18	19	198
		Mean	4987	5199	5571	5259	3077	3334	2534	1177	808	812	1756	2227	3020
		sd	4426.1	5286.8	3441.3	5346.4	2286 9	5535.7	4461.2	1951.2	801.1	1108.4	2357.9	1506.0	3875.8
	Neutral	N obs	54	51	53	54	52	53	52	52	51	48	50	49	619
		Mean	2303	3202	3431	3125	2458	2728	1964	1343	984	1088	1194	1248	2110
		sd	2920.8	3554.5	3072.8	3152.0	3383.5	3714.2	2316.1	1471.1	966.1	1282.6	1552.4	1296.2	2721.4
	El Nino	N obs	15	17	17	17	21	18	18	18	18	20	18	18	215
		Mean	1543	1641	2794	1444	1507	1313	1065	978	595	1402	1128	1270	1382
		sd	1019 4	1259.5	2073.1	1190.6	1789.2	1138.2	1045.6	817.4	362.8	2269.3	1484 1	1164.5	1467.9
Mean Nymboida (n=86)			2701	3312	3703	3165	2319	2537	1882	1236	868	1103	1298	1469	2133
P-Value Nymboida			0.0030	0.0214	0.0191	0.0083	0.28	0.26	0.27	0.65	0.24	0 50	0.45	0.0217	0.0001
Serpentine	La Nina	N obs	16	17	15	14	12	13	14	14	15	16	16	17	179
		Mean	0	0	0	0	1	5	14	19	12	9	3	1	5
		sd	0.4	0.2	0.0	0 3	2.0	7 9	21.1	22.3	11 9	10.5	2.7	1.3	11.5
	Neutral	N obs	52	50	52	53	51	53	52	52	51	48	49	48	611
		Mean	0	0	0	0	1	8	17	16	11	6	2	1	5
		sd	0.8	0.5	0.4	0.4	1.6	9.5	16.6	13.7	9.1	4.4	2 1	0.9	9.6
	El Nino	N obs	14	15	15	15	19	16	16	16	16	18	17	17	194
		Mean	0	0	0	0	1	4	7	6	4	3	1	1	2
		sd	0.4	0 6	0.6	0.4	1.6	6.2	6 9	7.0	5 1	5.2	2.1	1.3	4.6
Mean Serpentine (n=82)			0	0	0	0	1	7	14	14	10	6	2	1	5
P-Value Serpentine			0.72	0.64	0.41	0.72	0.68	0.14	0.13	0 0483	0.0285	0 0218	0.16	0.34	0.0010
Tipindje	La Nina	N obs	6	7	7	6	5	6	6	7	7	8	7	7	79
		Mean	42	21	34	22	10	22	4	4	5	2	1	9	14
		sd	37.3	14.5	28.0	13.8	14.1	19.8	3.1	3.6	10.2	1.7	1 0	11 5	20.0
	Neutral	N obs	18	16	17	18	17	18	17	16	16	15	16	16	200
		Mean	16	29	21	11	7	4	6	3	3	2	2	8	10
		sd	22.1	32.5	23 1	14.8	9.4	4.5	9.0	2.8	8.3	2 9	4.6	25.9	18.0
	El Nino	N obs	5	6	5	5	7	5	6	6	6	6	6	6	69
		Mean	7	10	20	8	2	3	1	1	1	0	1	2	4
		sd	6.7	11 5	18.4	12.4	1.0	2.3	0.8	0.4	0.6	0.0	0.9	2.0	8.5
Mean Tipindje (n=29)			20	23	24	13	6	8	5	3	3	1	2	7	10
P-Value Tipindje			0.0484	0.31	0.47	0.19	0.28	0.0017	0 28	0.29	0 55	0.30	0.78	0.79	0.0023
Des Lacs	La Nina	N obs	5	6	6	5	4	5	5	6	6	7	6	6	67
		Mean	9	9	12	11	5	4	4	2	1	1	4	3	5
		sd	2.6	2.8	6.4	7.7	3 0	1.9	4.5	2.1	1.2	1 1	3.9	2 1	5.1
	Neutral	N obs	17	15	16	17	16	17	17	16	16	15	16	16	194
		Mean	7	11	7	8	5	5	3	3	1	2	3	4	5
		sd	6.3	6 1	4.4	6.6	3.2	5 2	1.6	2.5	1.9	4.8	5.8	6 6	5.5
	El Nino	N obs	5	6	5	5	7	5	5	5	5	5	5	5	63
		Mean	5	7	9	4	3	5	3	3	3	1	2	3	4
		sd	4.2	5 8	6 2	3.4	1.5	5.1	1.8	2.6	1 8	0.8	2.7	2.9	4.0
Mean Des Lacs (n=27)			7	10	8	8	5	5	3	3	2	2	3	4	5
P-Value Des Lacs			0.61	0 39	0.16	0.23	0.11	0.83	0.51	0.54	0.33	0.63	0.77	0.89	0.27
Mataura	La Nina	N obs	6	7	7	6	5	7	7	7	7	8	7	7	81
		Mean	33	27	44	45	59	73	53	64	80	69	62	42	55
		sd	15 7	8.9	19.8	21.2	21.9	40.0	23 9	39.5	29.9	17 2	13.9	15.4	27.6
	Neutral	N obs	20	18	18	18	17	17	18	17	17	15	18	18	211
		Mean	53	43	50	57	75	73	75	72	69	89	56	58	64
		sd	38.1	20.3	32.6	36 8	37.1	32.3	28.4	41.7	29.8	42.9	20 2	28.6	34.5
	El Nino	N obs	7	8	8	9	11	9	8	9	9	10	8	8	104
		Mean	59	48	69	63	91	89	63	73	99	90	86	69	76
		sd	43 7	28 9	66 5	17.2	49.5	39 1	15.0	36.4	54.9	29.3	39.6	32.8	41.0
Mean Mataura (n=33)			51	41	53	56	78	77	67	71	79	85	65	57	65
P-Value Mataura			0 42	0.13	0.47	0 54	0.32	0.53	0 15	0.89	0.18	0.33	0.0285	0.19	0 0002

= Monthly event runoff significantly different from the global monthly average

Table 53d: Monthly runoff distributions according to SOI classification (Oceania-Pacific area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Motu	La Nina	N obs	6	7	7	6	5	7	7	7	7	8	7	7	81
		Mean	**75**	**49**	**51**	**68**	**101**	**138**	**129**	**159**	**151**	**138**	**82**	**74**	**102**
		sd	43.3	21.6	43 0	47.9	57.6	45.3	74.7	39.8	71.9	47.7	31.5	61.9	61.3
	Neutral	N obs	21	19	20	21	20	20	20	20	20	18	20	20	239
		Mean	**56**	**58**	**74**	**59**	**95**	**130**	**135**	**125**	**109**	**87**	**83**	**89**	**91**
		sd	29.4	46.0	55.5	36.2	40.2	58.6	47.6	50.4	40.1	62.9	50.7	41.6	53.6
	El Nino	N obs	6	7	6	6	8	6	6	6	6	7	6	6	76
		Mean	**37**	**60**	**43**	**83**	**79**	**100**	**87**	**114**	**90**	**65**	**69**	**60**	**74**
		sd	30.7	78.3	30.7	38.4	26.3	61.3	37.8	97.9	26.6	18.6	81.8	40.8	53.4
Mean Motu (n=33)			**56**	**56**	**63**	**65**	**92**	**126**	**125**	**130**	**114**	**94**	**80**	**81**	**90**
P-Value Motu			0.15	0.91	0.33	0.43	0.58	0.44	0.16	0.33	0.0572	0.0304	0 86	0.38	0.0049
Ongarue	La Nina	N obs	5	6	6	6	5	7	7	7	7	7	5	5	73
		Mean	**24**	**18**	**10**	**10**	**26**	**52**	**62**	**57**	**68**	**61**	**32**	**23**	**39**
		sd	11.7	11.8	2.5	4.1	14.1	20.3	32.3	16.3	19.1	22.5	6.2	7.6	26.4
	Neutral	N obs	20	17	17	16	15	15	16	15	15	14	18	18	196
		Mean	**22**	**19**	**20**	**17**	**30**	**39**	**54**	**47**	**43**	**36**	**30**	**29**	**32**
		sd	14.3	12 2	11.9	9 7	15.7	16.3	18.3	18.4	13.7	19.0	11.9	13.0	18.1
	El Nino	N obs	7	9	9	10	12	10	9	10	10	11	9	9	115
		Mean	**21**	**14**	**13**	**18**	**34**	**44**	**49**	**56**	**40**	**34**	**32**	**20**	**32**
		sd	7.6	7 2	5.2	6.7	11.6	23.8	25.4	34.0	13.3	10.8	25.0	7.3	21.5
Mean Ongarue (n=32)			**22**	**17**	**16**	**16**	**31**	**43**	**54**	**52**	**48**	**41**	**31**	**26**	**33**
P-Value Ongarue			0.91	0.38	0.0412	0.19	0.54	0.38	0.55	0.57	0.0014	0.0064	0.95	0.12	0.0261
Hurunui	La Nina	N obs	6	7	7	6	5	7	7	7	7	8	7	7	81
		Mean	**34**	**28**	**29**	**48**	**52**	**56**	**60**	**61**	**89**	**85**	**71**	**37**	**55**
		sd	15.3	12.0	17.0	40.0	41.3	20.6	35.5	20.1	44 9	33.7	16.2	8.9	32.8
	Neutral	N obs	22	20	21	22	21	21	20	20	20	18	20	20	245
		Mean	**44**	**33**	**33**	**37**	**55**	**46**	**48**	**52**	**58**	**68**	**64**	**57**	**49**
		sd	22.5	10.3	14.1	13.2	30.2	14.8	14.5	16 5	22.5	34.1	32.7	18.4	23.8
	El Nino	N obs	6	7	6	6	8	6	7	7	7	8	7	7	82
		Mean	**52**	**31**	**37**	**38**	**54**	**47**	**42**	**37**	**50**	**75**	**73**	**66**	**51**
		sd	21.8	14.5	13.4	17 5	26.0	21.9	9.5	10.0	19.8	34.1	36.8	46.8	27.9
Mean Hurunui (n=34)			**43**	**31**	**33**	**39**	**55**	**48**	**49**	**51**	**63**	**74**	**67**	**55**	**51**
P-Value Hurunui			0.37	0.61	0 67	0.52	0.97	0.42	0.23	0.0274	0 0250	0.48	0 79	0.0879	0.26
Ahuriri	La Nina	N obs	4	5	5	6	5	7	7	7	7	7	5	5	70
		Mean	**16**	**18**	**22**	**20**	**21**	**18**	**14**	**17**	**27**	**35**	**38**	**26**	**23**
		sd	3.0	6.5	9.3	13.7	10.8	5.0	3.9	8.8	19.6	13.7	5 8	7.1	12.1
	Neutral	N obs	20	17	17	15	14	14	15	14	14	13	17	17	187
		Mean	**30**	**20**	**23**	**21**	**23**	**18**	**15**	**20**	**19**	**31**	**30**	**36**	**24**
		sd	13 7	6.1	9.2	9 0	9.6	6.4	3.4	8.1	8.4	14.3	9.4	15.5	11 7
	El Nino	N obs	7	9	9	10	12	10	9	10	10	11	9	9	115
		Mean	**29**	**18**	**19**	**19**	**20**	**19**	**13**	**16**	**24**	**28**	**38**	**30**	**23**
		sd	11.5	5.8	10.1	7.0	7.5	11.9	4.9	8.2	15.3	8.2	15.9	8.7	11.6
Mean Ahuriri (n=31)			**28**	**19**	**22**	**20**	**21**	**18**	**14**	**18**	**23**	**31**	**33**	**33**	**23**
P-Value Ahuriri			0.16	0.78	0.67	0.93	0.65	0.98	0.60	0.59	0.42	0.49	0.18	0.25	0.47

= Monthly event runoff significantly different from the global monthly average

Table 54a: Monthly runoff distributions according to SOI classification (Far East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Tone	La Nina	N obs	10	11	10	10	9	9	9	10	10	11	11	12	122
		Mean	**106**	**106**	**137**	**298**	**274**	**313**	**416**	**358**	**469**	**314**	**214**	**144**	**257**
		sd	26.9	30.3	46.2	85.9	91.6	214.3	211.6	296.1	266.0	182.2	81.8	57.2	191.0
	Neutral	N obs	30	28	30	30	29	31	30	29	29	26	27	26	345
		Mean	**110**	**111**	**143**	**270**	**271**	**277**	**335**	**354**	**418**	**367**	**191**	**147**	**250**
		sd	31.4	31.9	57.1	177.2	155.9	153.9	132.3	240.6	284.3	193.8	54.8	50.9	183.0
	El Nino	N obs	8	9	8	8	10	8	9	9	9	11	10	10	109
		Mean	**100**	**102**	**143**	**224**	**203**	**268**	**458**	**465**	**552**	**249**	**144**	**121**	**252**
		sd	13.6	21.3	38.1	46.8	95.5	171.9	361.6	263.8	208.5	96.2	34.4	32.6	210.6
Mean Tone (n=48)			**108**	**108**	**142**	**268**	**257**	**282**	**373**	**376**	**454**	**328**	**187**	**141**	**252**
P-Value Tone			0.63	0.71	0.94	0.57	0.37	0.83	0.24	0.52	0.43	0.17	0.0270	0.36	0.93
Ishikari	La Nina	N obs	6	7	7	7	6	7	7	8	8	9	8	8	88
		Mean	**234**	**233**	**278**	**1253**	**805**	**433**	**364**	**608**	**454**	**491**	**498**	**350**	**498**
		sd	102.6	70.0	84.7	198.9	231.0	73.3	141.6	221.1	132.0	154.3	136.4	52.0	300.1
	Neutral	N obs	21	19	20	20	19	20	19	18	18	16	17	17	224
		Mean	**218**	**200**	**288**	**1207**	**831**	**326**	**296**	**540**	**385**	**372**	**418**	**338**	**454**
		sd	55.1	42.9	99.1	449.5	331.4	75.1	143.7	479.7	167.7	133.9	122.9	84.7	366.6
	El Nino	N obs	5	6	5	5	7	5	6	6	6	7	7	7	72
		Mean	**253**	**208**	**363**	**1032**	**895**	**419**	**276**	**386**	**546**	**424**	**424**	**400**	**470**
		sd	30.1	69.9	119.5	537.3	410.2	78.3	63.5	112.8	230.8	166.3	73.7	60.7	308.8
Mean Ishikari (n=32)			**227**	**209**	**297**	**1190**	**840**	**364**	**307**	**528**	**432**	**417**	**439**	**355**	**467**
P-Value Ishikari			0.53	0.41	0.28	0.65	0.88	0.00	0.43	0.56	0.15	0.17	0.2900	0.19	0.59
Shinano	La Nina	N obs	3	4	4	4	3	5	5	6	6	6	5	5	56
		Mean	**272**	**320**	**482**	**1107**	**809**	**543**	**590**	**323**	**526**	**375**	**414**	**368**	**496**
		sd	61.5	65.8	100.0	220.4	107.2	99.5	202.2	93.9	216.8	75.4	65.9	71.6	244.0
	Neutral	N obs	16	14	15	14	13	13	13	12	12	11	13	13	159
		Mean	**308**	**298**	**458**	**1050**	**805**	**665**	**690**	**442**	**565**	**432**	**404**	**359**	**538**
		sd	84.0	101.5	106.4	188.4	253.3	520.7	348.9	215.6	458.3	133.3	117.1	65.5	331.0
	El Nino	N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
		Mean	**364**	**405**	**930**	**1066**	**695**	**444**	**558**	**467**	**514**	**271**	**365**	**405**	**538**
		sd	42.1	196.0	846.4	249.0	278.7	228.1	338.1	248.1	255.5	69.4	145.4	90.4	360.0
Mean Shinano (n=24)			**315**	**328**	**560**	**1064**	**769**	**584**	**636**	**418**	**542**	**371**	**396**	**372**	**530**
P-Value Shinano			0.23	0.25	0.07	0.89	0.60	0.55	0.67	0.42	0.96	0.02	0.7500	0.46	0.69
Yodo	La Nina	N obs	3	4	4	4	3	5	5	6	6	6	5	5	56
		Mean	**154**	**194**	**281**	**369**	**242**	**378**	**556**	**275**	**331**	**190**	**139**	**136**	**275**
		sd	37.9	21.0	21.3	107.8	64.8	218.3	252.7	94.3	225.1	50.1	33.5	43.2	171.9
	Neutral	N obs	16	14	15	14	13	13	13	12	12	11	13	13	159
		Mean	**157**	**169**	**222**	**323**	**308**	**396**	**583**	**236**	**350**	**212**	**142**	**147**	**268**
		sd	61.7	60.0	56.7	114.8	86.0	208.1	434.7	131.1	307.8	87.2	33.2	54.5	210.5
	El Nino	N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
		Mean	**194**	**235**	**417**	**317**	**298**	**300**	**532**	**312**	**356**	**142**	**124**	**126**	**277**
		sd	113.9	157.9	391.0	104.6	181.8	146.4	310.9	319.6	265.1	42.2	34.4	40.8	222.2
Mean Yodo (n=24)			**165**	**190**	**272**	**329**	**296**	**368**	**565**	**265**	**347**	**186**	**137**	**140**	**272**
P-Value Yodo			0.61	0.35	0.13	0.74	0.71	0.62	0.96	0.72	0.99	0.13	0.5400	0.66	0.94
Chikugo	La Nina	N obs	3	4	4	4	3	5	5	6	6	6	5	5	56
		Mean	**39**	**56**	**77**	**94**	**85**	**217**	**243**	**122**	**124**	**69**	**47**	**39**	**105**
		sd	6.0	23.0	25.2	39.7	26.6	100.6	63.2	83.2	32.1	11.3	8.6	6.9	79.0
	Neutral	N obs	16	14	15	14	13	13	13	12	12	11	13	13	159
		Mean	**48**	**57**	**78**	**98**	**102**	**238**	**299**	**127**	**161**	**92**	**68**	**54**	**116**
		sd	10.4	17.2	27.8	37.8	46.6	142.3	195.5	146.9	163.1	37.0	44.8	13.1	118.6
	El Nino	N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
		Mean	**65**	**74**	**174**	**116**	**125**	**199**	**447**	**155**	**109**	**71**	**57**	**49**	**136**
		sd	17.4	16.4	170.8	30.1	51.5	100.3	174.1	104.1	49.7	19.6	14.8	12.1	128.8
Mean Chikugo (n=24)			**50**	**61**	**98**	**102**	**108**	**224**	**324**	**133**	**139**	**80**	**61**	**50**	**119**
P-Value Chikugo			0.01	0.13	0.07	0.55	0.39	0.82	0.14	0.88	0.66	0.19	0.5000	0.08	0.29

[ ] = Monthly event runoff significantly different from the global monthly average

Table 54b: Monthly runoff distributions according to SOI classification (Far East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Changjiang	La Nina	N obs	23	23	21	20	18	19	22	23	24	25	24	25	267
		Mean	7424	7735	10591	15923	25178	31974	42282	40848	37375	32732	21621	11198	23723
		sd	1819.8	2210.9	3270.7	3499.7	5876.8	5028.6	5388.1	6558.1	6579.5	7505.8	6967.2	3152.7	13701.8
	Neutral	N obs	68	66	69	71	70	71	68	68	67	64	65	63	810
		Mean	7574	8052	10791	15519	24856	30483	41128	39782	37009	31026	20891	11564	23272
		sd	1631.8	2051.2	2717.5	3977.0	5331.3	5887.2	6934.5	7813 6	7892.4	7602.2	6452.7	3462.0	13228.1
	El Nino	N obs	18	20	19	18	21	19	19	18	18	20	20	21	231
		Mean	8621	8135	11282	17017	23838	29058	36905	36800	34444	28765	20615	12233	22162
		sd	2743.1	1980.5	4070.5	3953.7	4944.4	7574.0	8276.4	6917.8	7638.2	7114.8	6068.5	3724.2	11773.6
Mean Changjiang (n=109)			7715	8000	10838	15840	24713	30494	40625	39515	36666	31002	21001	11609	23168
P-Value Changjiang			0 09	0.78	0 76	0.35	0.69	0.34	0.03	0.20	0.39	0.22	0.8600	0.59	0.39
Songhuajiang	La Nina	N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
		Mean	267	216	239	955	1295	1514	1889	2931	2294	1680	1138	474	1211
		sd	175.5	148.2	163.4	296.0	446.5	541.5	686.8	1746.8	1171 3	983.0	630.9	244 2	1119.6
	Neutral	N obs	57	56	60	61	59	61	59	59	58	54	55	53	692
		Mean	267	217	247	940	1189	1231	1734	2581	2524	1798	987	461	1187
		sd	146.7	136.3	160 4	361.8	427.0	560.8	1030.3	1623 4	1368.1	984 5	535.4	260.2	1126 3
	El Nino	N obs	15	16	14	14	18	15	16	15	15	17	16	17	188
		Mean	262	222	248	924	1347	1324	1739	2801	3157	1918	806	402	1263
		sd	201.4	186 9	166.8	356.3	634.5	629.2	824.3	1416.8	2019.0	1100.2	465.0	225.2	1264.5
Mean Songhuajiang (n=90)			266	217	245	940	1236	1290	1761	2680	2586	1795	987	453	1205
P-Value Songhuajiang			0.99	0.99	0.98	0.97	0.42	0.24	0.85	0.71	0.22	0.78	0.2100	0 64	0.72
Yongding	La Nina	N obs	12	13	12	11	9	10	10	11	12	13	13	14	140
		Mean	18	20	43	48	41	50	68	52	35	28	24	21	36
		sd	8.7	11.9	30.2	23.3	21.5	35.1	71.3	61.6	29 0	20.1	14.9	11.5	34 5
	Neutral	N obs	42	40	42	43	43	44	43	42	41	38	40	39	497
		Mean	19	19	44	37	33	46	84	56	46	29	26	20	39
		sd	11.5	10.8	27.0	22.2	29.3	35.0	92.3	44 8	40.2	20.0	13 0	12.1	41.2
	El Nino	N obs	10	11	10	10	12	10	11	11	11	13	11	11	131
		Mean	18	14	40	30	31	39	61	61	40	28	27	20	34
		sd	13.3	9.6	33.0	13 6	20.5	24.2	45 6	62.2	29.2	20.5	19.0	13.9	31 7
Mean Yongding (n=64)			19	19	43	38	34	45	77	56	43	29	25	20	37
P-Value Yongding			0.88	0 33	0.93	0.15	0 67	0.75	0.68	0.92	0.62	0.97	0.8500	0.97	0.40
Jinghe	La Nina	N obs	10	11	10	10	9	9	9	10	10	11	11	12	122
		Mean	22	32	42	39	38	50	127	168	120	103	52	30	68
		sd	7.8	8 2	6.7	14.5	31 6	45 7	63.9	106.0	77.2	63.3	29.7	13.6	65.5
	Neutral	N obs	36	34	36	36	35	37	36	35	35	32	33	32	417
		Mean	20	29	42	34	39	40	106	155	124	71	47	27	61
		sd	5.9	6.9	12 6	13 9	25.9	20.5	65.8	119.8	91.7	44 0	19.0	9.7	65.6
	El Nino	N obs	8	9	8	8	10	8	9	9	9	11	10	10	109
		Mean	16	27	42	35	39	28	147	107	85	46	35	21	52
		sd	4.5	8 0	10 1	10.7	21 5	9.0	119.4	89.5	83.6	40.2	25.1	9.5	62 4
Mean Jinghe (n=54)			20	29	42	35	39	40	117	149	117	73	46	27	61
P-Value Jinghe			0.16	0.29	0 99	0.61	0.99	0.22	0.33	0.45	0.50	0 03	0 2100	0.14	0.21
Wujiang	La Nina	N obs	10	11	10	9	8	8	8	9	9	10	10	11	113
		Mean	297	315	368	870	2002	2888	1636	1472	1441	986	740	394	1044
		sd	60.6	66 1	77.0	370.3	347.3	1137.7	417.2	540.8	347 9	337.1	332.6	122.2	845.8
	Neutral	N obs	27	25	27	28	27	28	27	26	26	24	25	24	314
		Mean	328	351	411	807	1679	2604	2427	1725	1309	1122	661	376	1167
		sd	77.0	126.0	157 6	281.8	537 3	996.6	1027.1	883.9	793.0	620.0	286.4	109 5	985.5
	El Nino	N obs	7	8	7	7	9	8	9	9	9	10	9	9	101
		Mean	343	290	492	804	1656	2445	1958	1711	1446	1198	875	519	1176
		sd	110 8	52 5	238.8	637.2	457 7	1186.3	997.8	808 4	628.0	402.1	240 3	176.9	875.8
Mean Wujiang (n=44)			323	331	414	819	1733	2627	2187	1671	1364	1108	723	410	1142
P-Value Wujiang			0.47	0.31	0.29	0.90	0 25	0.69	0.09	0.71	0 82	0.66	0.1700	0.02	0.45

= Monthly event runoff significantly different from the global monthly average

Table 54c: Monthly runoff distributions according to SOI classification (Far East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Huanghe		N obs	8	9	8	8	7	9	9	10	10	11	10	11	110
	La Nina	Mean	581	605	1089	1178	1151	1100	2084	2710	2597	2615	1751	809	1574
		sd	154.6	237.7	431 3	302.2	650.5	652.9	920.8	1379.5	1387.9	1395.9	843.1	398.7	1150.8
		N obs	26	24	25	25	24	24	23	22	22	20	23	22	280
	Neutral	Mean	574	537	973	995	976	863	2130	3121	3332	2762	1359	773	1484
		sd	183.2	198.1	314.8	285.8	416.9	489.8	963.7	1255.8	1357 4	1109.6	610 0	293.4	1197.5
		N obs	6	7	7	7	9	7	8	8	8	9	7	7	90
	El Nino	Mean	458	414	901	946	931	754	1791	2161	1459	1207	831	560	1068
		sd	81.2	135.2	292.4	345.7	311 4	246.1	850.7	1139.2	475.4	686.2	262.2	93.3	720.5
Mean Huanghe (n=40)			558	531	984	1023	996	897	2052	2826	2774	2372	1364	746	1427
P-Value Huanghe			0.29	0.17	0.54	0.26	0.58	0 35	0.67	0.19	0.00	0.00	0.0210	0.21	0.00
Beijiang		N obs	6	7	7	7	6	7	7	8	8	9	8	8	88
	La Nina	Mean	344	544	694	1333	2462	3143	1672	1265	897	679	500	419	1128
		sd	101.9	381.8	590.8	796.0	1336 5	912.2	803.5	504 5	492.9	385.8	195.2	189.7	1007.1
		N obs	22	20	21	21	20	21	20	19	19	17	19	19	238
	Neutral	Mean	290	415	776	1842	2368	2674	1287	1018	904	500	387	271	1077
		sd	151.4	197.5	395 9	666.0	1077.6	1382.1	629.0	403.6	729.6	234.1	145 7	57 7	1020.7
		N obs	6	7	6	6	8	6	7	7	7	8	7	7	82
	El Nino	Mean	652	684	1285	1430	2439	1797	968	1100	605	549	538	426	1038
		sd	527.4	600.5	1611.6	457.9	918.0	525.2	333.6	257.0	304.2	236.4	249.0	266.1	842 9
Mean Beijiang (n=34)			363	497	849	1664	2401	2616	1300	1093	841	559	445	338	1080
P-Value Beijiang			0.01	0 22	0.31	0.15	0.98	0.14	0.12	0.36	0.53	0.32	0.1200	0.03	0.83
Dongjiang		N obs	5	6	6	5	4	5	5	6	6	7	6	6	67
	La Nina	Mean	325	379	343	533	1154	1794	1120	1021	1081	825	449	395	765
		sd	122.7	139.5	152.6	179 4	919.3	435.3	410.1	302.9	552.5	400.8	129.3	108.6	545.3
		N obs	18	16	17	17	16	17	17	16	16	14	16	16	196
	Neutral	Mean	361	321	356	686	999	1616	1102	1081	1022	555	475	414	751
		sd	141.4	137 4	135 4	342.6	372.0	904.5	378.6	350.5	617.7	235.9	152.1	143.2	554.2
		N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
	El Nino	Mean	360	472	920	867	1183	1241	903	1123	657	481	395	329	755
		sd	145.0	399.5	984.2	597.6	386 7	323.0	232.4	245.6	150.6	101.4	104.1	77.8	481.4
Mean Dongjiang (n=28)			354	366	454	697	1074	1567	1062	1077	956	604	452	392	755
P-Value Dongjiang			0.87	0.36	0.03	0.38	0.63	0 45	0.48	0.86	0.32	0.05	0.4900	0.38	0.98
Yana		N obs	10	11	10	10	9	9	9	10	10	11	11	12	122
	La Nina	Mean	1	1	0	1	468	3471	2344	1953	959	151	38	10	721
		sd	1 8	0.5	0.5	0.7	454.8	928.3	1018.2	478 7	465.0	68.8	24 9	11.8	1167.9
		N obs	29	27	29	29	28	30	29	28	28	26	27	26	336
	Neutral	Mean	1	1	0	0	644	3831	3212	2492	1265	190	38	8	1005
		sd	1.3	0.9	0.9	0.8	643.7	1272.2	914.7	1172.6	549.2	118.2	17.5	5.5	1505.0
		N obs	8	9	8	8	10	8	9	9	9	10	9	9	106
	El Nino	Mean	4	3	2	3	768	3091	2832	2116	1447	170	35	8	869
		sd	3.3	3.7	4.5	4.4	444.7	677.4	1089.5	580.5	625 4	46.1	9.0	1.8	1211.8
Mean Yana (n=47)			2	1	1	1	637	3636	2973	2305	1235	177	37	9	918
P-Value Yana			0.01	0.00	0.05	0.03	0.53	0.25	0.07	0.27	0.15	0.53	0.9300	0.66	0.14
Penzhina		N obs	5	6	6	5	4	5	5	6	6	7	6	6	67
	La Nina	Mean	42	31	25	23	478	4232	904	626	916	443	113	62	622
		sd	13.9	9 2	5.1	7.5	185.3	684.6	309.5	181.9	712 6	274.7	27.6	19.2	1121.7
		N obs	18	16	17	18	17	18	17	16	16	15	16	16	200
	Neutral	Mean	30	23	21	24	655	4104	1229	1066	798	362	95	50	726
		sd	10.0	8.1	5 5	8 6	461 8	1574.2	698.1	372 7	435 7	211.4	34 8	19.5	1268 7
		N obs	5	6	5	5	7	5	6	6	6	6	6	6	69
	El Nino	Mean	36	26	20	25	403	3864	1377	810	1297	369	112	60	679
		sd	10.8	6 1	7 0	8.8	289.2	1182.9	343.7	292.8	818.1	213.3	34.9	11.9	1091 5
Mean Penzhina (n=28)			33	25	22	24	567	4084	1203	917	930	384	102	55	695
P-Value Penzhina			0.08	0.11	0.21	0 91	0 35	0.91	0 42	0.02	0.23	0.73	0 4000	0.28	0.82

= Monthly event runoff significantly different from the global monthly average

Table 54d: Monthly runoff distributions according to SOI classification (Far East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Indigirka	La Nina	N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
		Mean	39	19	11	8	215	5416	4394	4099	2630	543	135	69	1426
		sd	11.5	5.2	3.7	2.1	255.4	1207.9	1257.4	1148.5	1175.9	314.5	28 8	27.9	2077.6
	Neutral	N obs	36	33	34	34	33	34	34	33	33	30	33	32	399
		Mean	37	20	12	8	383	5769	5892	4585	2583	561	136	75	1684
		sd	9.8	5.2	3.7	2.6	542.2	1710.0	1415.1	1687.8	1055 6	212.9	38.6	19 1	2460.4
	El Nino	N obs	11	13	13	13	15	13	13	14	14	16	13	13	161
		Mean	31	16	12	8	163	5490	5033	3870	2484	452	122	69	1483
		sd	5.9	3 2	4.0	4.4	140.5	1667.8	1203.3	1231.1	761.3	110.5	28.1	15.6	2158.6
Mean Indigirka (n=58)			36	19	12	8	298	5640	5415	4320	2568	527	133	72	1587
P-Value Indigirka			0.08	0.07	0.67	0.68	0.22	0.77	0.01	0.29	0.93	0 27	0.4700	0.54	0.43
Lena	La Nina	N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
		Mean	2599	1906	1493	1194	6270	78332	40796	29646	25265	11709	3097	2758	16704
		sd	611.3	576.6	465 5	396.2	6883.4	11436.4	9586.7	8598 5	5592.8	3919.1	686.1	532.6	22909.0
	Neutral	N obs	38	35	36	36	35	36	36	35	35	32	35	34	423
		Mean	2875	2226	1637	1322	7198	73465	40086	27050	25018	15070	3599	2954	16937
		sd	665.4	591.1	539.4	392.0	8296 4	11571.8	8875.3	6219.1	7012.3	3950.3	725.9	604.3	21885.1
	El Nino	N obs	11	13	13	13	15	13	13	14	14	16	13	13	161
		Mean	2650	2109	1826	1560	3968	71433	37627	26252	21002	12724	3615	3028	15710
		sd	613.1	662.0	708.5	683.8	2655 7	6998.8	5956.2	4725.3	5516.2	3330.5	1907.6	1229.4	20340.6
Mean Lena (n=60)			2783	2137	1652	1350	6236	73917	39683	27340	24126	13772	3502	2928	16619
P-Value Lena			0.35	0.29	0.36	0.15	0 34	0.28	0 60	0.39	0.13	0.02	0.3600	0.64	0 83
Shilka	La Nina	N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
		Mean	12	5	5	144	757	767	1027	894	915	499	101	41	403
		sd	7.2	5 1	6.9	115 0	390.1	341.2	453.9	461.2	418.8	305 2	45.7	21.1	477.8
	Neutral	N obs	56	55	59	60	58	60	59	59	58	55	55	53	687
		Mean	10	4	4	137	688	720	828	986	915	474	88	37	415
		sd	5.4	2.7	2.4	125.8	324.0	345.5	481.6	662.3	532.2	206.5	36.2	15 6	500.4
	El Nino	N obs	15	16	14	14	18	15	15	14	14	15	15	16	181
		Mean	12	5	4	77	611	655	867	984	905	412	93	38	386
		sd	4.5	2.6	2.3	55.1	316.3	438.3	386.4	481.8	519.5	171 0	40.9	15.9	464.1
Mean Shilka (n=89)			11	5	4	129	682	717	868	969	913	469	92	38	408
P-Value Shilka			0.48	0.67	0 38	0.19	0.47	0.70	0.34	0.86	0.99	0.52	0.4500	0 65	0.76
Kamchatka	La Nina	N obs	10	11	10	10	9	9	9	10	10	11	11	12	122
		Mean	433	420	412	450	843	1803	1759	992	808	695	449	430	762
		sd	40.9	33 4	27.2	63.4	78.1	85.0	314 1	108.1	88.4	78 5	25 5	47.9	477.3
	Neutral	N obs	36	34	36	36	35	37	36	35	35	33	34	33	420
		Mean	408	391	392	445	857	1620	1656	1019	779	696	474	417	770
		sd	55.8	53.5	43.3	56.5	155.2	282 8	430.1	188.9	119.1	124.5	81.9	47.7	479.5
	El Nino	N obs	8	9	8	8	10	8	9	9	9	10	9	9	106
		Mean	440	409	396	456	931	1603	1879	1203	941	773	470	445	833
		sd	41.2	42.4	30.9	42.2	156.9	236.4	483.3	310 1	222.9	152 7	57.0	68.2	517.1
Mean Kamchatka (54)			417	400	396	448	869	1648	1710	1045	811	710	468	425	779
P-Value Kamchatka			0.17	0.19	0.40	0.88	0.33	0.15	0.35	0.04	0.01	0 21	0 5900	0.35	0.45
Amur(1)	La Nina	N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
		Mean	1122	687	610	3693	13008	15885	16496	19725	17165	11826	4124	1764	8412
		sd	379.9	242.0	201.1	1271.1	3336.2	4911.2	5160 7	5238.0	5211.9	4163.6	1501.3	483.9	7839.6
	Neutral	N obs	56	55	59	60	58	60	59	59	58	55	55	53	687
		Mean	1149	715	616	3247	12479	14205	13961	17518	18144	12352	4251	1784	8484
		sd	396.8	249 5	214 5	1222 8	3335 2	4549.0	4547.7	5629.0	6629 7	4200.6	1706.8	557.5	7572.1
	El Nino	N obs	15	16	14	14	18	15	15	14	14	15	15	16	181
		Mean	1220	753	603	3046	12536	14305	13482	17980	18171	11439	3847	1741	8216
		sd	516.2	331.3	217.2	1274 4	4059.5	4066 9	3847.8	6938.8	5143.5	3788.6	1433.3	415.1	7417 1
Mean Amur(1) (n=89)			1156	716	613	3290	12568	14486	14307	17987	17962	12086	4155	1771	8425
P-Value Amur(1)			0 78	0.77	0.98	0.34	0.88	0.46	0.12	0.40	0.84	0.72	0.6900	0.96	0.91

= Monthly event runoff significantly different from the global monthly average

Table 54e: Monthly runoff distributions according to SOI classification (Far East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Amur(2)		N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
	La Nina	Mean	1889	1288	1086	3486	13569	16772	16997	20368	20361	16382	6224	2281	9872
		sd	469.6	362.9	367.7	1057.9	2097.0	4108.9	4093.4	5229.3	5618.0	6517.9	2410.0	697.3	8370.8
		N obs	38	36	38	38	37	38	37	37	37	34	36	35	441
	Neutral	Mean	2001	1342	1068	3109	14254	15661	15341	18706	20801	16741	6319	2520	9795
		sd	679.5	533.2	497.7	1355.8	4252 5	4198.5	4609.1	5370.4	6353.7	5711.8	2949.0	649.5	8265 7
		N obs	9	10	9	9	11	9	10	10	10	12	10	10	119
	El Nino	Mean	2016	1299	982	3434	14032	16156	14747	20270	21356	16403	5524	2371	10169
		sd	632.2	412.8	399.6	1035.6	3899.2	3950.8	4026.2	5099.0	4823.3	6347 6	2297.5	483.2	8328.3
Mean Amur(2) (n=58)			1982	1324	1058	3231	14094	15948	15553	19291	20813	16597	6162	2441	9874
P-Value Amur(2)			0.86	0.93	0.86	0.60	0.89	0.73	0 46	0.54	0.93	0.98	0.7200	0.48	0.91
Li-Wu		N obs	6	7	7	6	5	7	7	7	7	8	7	7	81
	La Nina	Mean	1403	1622	1981	2084	2516	3447	2846	5186	5742	9372	2733	1938	3542
		sd	482 6	557 8	559.6	916.7	1372.1	1195.9	2369 5	4067.3	4754.1	3573.4	899.3	583.0	3219.3
		N obs	21	19	19	19	18	18	19	18	18	16	19	19	223
	Neutral	Mean	1521	2038	2314	2386	2608	5265	3098	4087	6865	3670	2766	1460	3124
		sd	637 3	1547.4	1221 0	1588.9	1308.2	3693.7	2090.6	3055 9	5094.1	2466.5	2951.5	705.2	2875.1
		N obs	7	8	8	9	11	9	8	9	9	10	8	8	104
	El Nino	Mean	1480	2912	2866	2183	1835	3006	6358	5608	6885	4182	1926	1442	3419
		sd	383.4	3115.0	2653 3	1331.6	498 4	953.4	4947.3	4077.6	6131.4	3448.1	807.2	632.9	3428.1
Mean Li-Wu (n=34)			1491	2158	2375	2279	2344	4293	3813	4716	6639	5162	2562	1554	3282
P-Value Li-Wu			0.91	0.40	0.55	0.88	0.20	0.12	0.04	0.54	0.88	0.00	0.6800	0.25	0.51
Yufeng		N obs	4	5	5	6	5	7	7	7	7	7	5	5	70
	La Nina	Mean	564	566	721	1037	1664	2418	1312	1613	3608	3258	1089	773	1686
		sd	179 6	197 2	347.6	673.9	1053.2	1533.7	546.6	1320.6	3082.5	1421.3	214.0	227 9	1595.9
		N obs	17	15	16	14	13	13	13	13	13	12	15	15	169
	Neutral	Mean	609	1033	1211	1169	1451	2897	1676	3446	3386	1815	1099	589	1632
		sd	300 6	1183.9	829 2	720.8	717.7	1981.4	1316 0	2995.0	2276.1	960 3	787.2	214.1	1646 6
		N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
	El Nino	Mean	627	1448	2174	911	864	1737	3153	4513	3443	2436	810	567	1883
		sd	245.4	2395.6	2933.1	666.5	325.2	538.6	1380.5	2721.9	3051.2	2465.5	261.3	144.0	2063.4
Mean Yufeng (n=26)			605	1039	1302	1079	1311	2500	1919	3199	3459	2371	1030	619	1703
P-Value Yufeng			0.94	0.61	0.26	0.74	0.10	0.37	0 02	0.14	0.98	0.19	0.6300	0.19	0.59
Sandimen		N obs	4	5	5	6	5	7	7	7	7	7	5	5	70
	La Nina	Mean	90	82	69	117	583	6525	5837	9436	6878	6762	589	132	3663
		sd	24 3	41.2	32.4	110.9	368.3	4852.0	5451.8	4916.0	3056.4	4237.2	272 1	21.9	4670 0
		N obs	17	15	16	14	13	13	13	13	13	12	15	15	169
	Neutral	Mean	103	81	227	299	3550	7935	5802	8306	6849	2050	802	134	2788
		sd	62 8	26.0	462 4	289.4	2678.4	5785.5	4692.5	6679 3	6221 7	2734.4	1746 4	114 9	4601.5
		N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
	El Nino	Mean	101	118	172	81	2100	13329	11673	12788	5957	2892	274	109	4170
		sd	34.4	100.9	217.4	41.8	1369.5	8919.9	4131.2	7221 3	5501 1	2877.9	188.9	45 2	6304.4
Mean Sandimen (n=26)			101	90	186	207	2533	8800	7167	9645	6651	3545	639	128	3308
P-Value Sandimen			0 91	0.36	0.72	0.10	0.03	0.15	0.05	0.38	0 94	0.02	0.7600	0.86	0.12
Xinfadaqiao		N obs	4	5	5	6	5	7	7	7	7	7	5	5	70
	La Nina	Mean	1555	1482	1722	2089	3459	15928	10261	15356	11916	8954	3120	2018	7352
		sd	199.1	425.6	807 8	1282.3	2186 6	8993.4	7031.3	10228 8	5703 0	3903.1	531.2	211 2	7473.3
		N obs	17	15	16	14	13	13	13	13	13	12	15	15	169
	Neutral	Mean	1460	1377	1862	2451	7507	17370	11021	14879	11702	4573	2520	1462	6133
		sd	788 6	670 1	1153.4	1654.6	3898.9	12227.9	10181.0	11865.8	8911.1	3277.9	1638 9	385.0	8169.0
		N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
	El Nino	Mean	1336	2021	3185	2696	7082	27067	17836	22974	10116	5044	2171	1540	8672
		sd	366 1	1893.1	3961.0	2579.4	4989.1	17054 6	5473 1	11786.1	5114.8	2195.6	446.6	316.8	10602.0
Mean Xinfadaqiao (n=26)			1451	1546	2090	2424	6597	19220	12389	16876	11393	5879	2555	1587	7001
P-Value Xinfadaqiao			0 89	0.45	0 38	0.85	0.17	0.24	0.23	0.35	0.89	0 02	0.5000	0.02	0.11

= Monthly event runoff significantly different from the global monthly average

Table 55a: Monthly runoff distributions according to SOI classification (South East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Pampanga	La Nina	N obs	7	7	6	6	6	7	7	8	8	9	8	9	88
		Mean	**81**	**48**	**36**	**52**	**45**	**128**	**301**	**339**	**444**	**568**	**224**	**189**	**222**
		sd	45.9	14.0	10.6	60.6	27.4	150.4	232.6	176.2	268 1	292.1	134.7	158.4	236.0
	Neutral	N obs	19	18	19	20	18	18	17	16	16	15	17	16	209
		Mean	**100**	**56**	**36**	**26**	**29**	**146**	**315**	**542**	**663**	**390**	**290**	**196**	**219**
		sd	77.0	30.4	14.0	9.6	17.4	89.8	229.3	200.5	219.1	193.1	193.1	149.3	242.9
	El Nino	N obs	3	4	4	3	5	4	5	5	5	5	4	4	51
		Mean	**62**	**45**	**32**	**20**	**148**	**129**	**634**	**778**	**536**	**249**	**230**	**86**	**276**
		sd	13 9	26.0	25 1	15.0	230.9	66.7	607.3	413.3	75.4	68.0	159.4	5.0	342.4
Mean Pampanga (n=29)			**92**	**53**	**36**	**31**	**53**	**139**	**367**	**527**	**581**	**421**	**263**	**178**	**228**
P-Value Pampanga			0.59	0.66	0.86	0.13	0.0557	0.91	0.14	0.0124	0.0795	0.0354	0.63	0.39	0.37
Bonga	La Nina	N obs	7	8	7	7	7	8	8	9	9	10	9	10	99
		Mean	**6**	**4**	**2**	**1**	**5**	**14**	**32**	**56**	**55**	**36**	**14**	**9**	**21**
		sd	5.9	3.9	1.5	0.8	6 2	11.8	25.0	60.4	62.6	22.2	10.7	7 1	33.5
	Neutral	N obs	19	17	18	19	17	17	16	15	15	14	16	15	198
		Mean	**4**	**3**	**3**	**2**	**4**	**35**	**62**	**80**	**80**	**43**	**23**	**9**	**27**
		sd	2 5	1 4	2.0	1.8	4.9	35.6	54.2	36.5	43.5	47.7	21.0	8 7	39 7
	El Nino	N obs	3	4	4	3	5	4	5	5	5	5	4	4	51
		Mean	**4**	**3**	**2**	**1**	**6**	**46**	**79**	**48**	**64**	**29**	**13**	**6**	**28**
		sd	1.5	0.6	0.5	0.6	5 4	40.5	40.8	29.3	54.2	15.1	7.0	2.2	36.2
Mean Bonga (n=29)			**5**	**3**	**2**	**2**	**4**	**30**	**57**	**67**	**69**	**38**	**19**	**9**	**25**
P-Value Bonga			0 38	0.42	0 54	0.39	0.69	0.20	0.17	0.29	0.52	0.73	0.37	0.72	0.37
Kelantan	La Nina	N obs	8	9	8	8	7	8	8	9	9	10	9	9	102
		Mean	**1110**	**540**	**420**	**365**	**468**	**407**	**367**	**381**	**545**	**614**	**899**	**1605**	**652**
		sd	691.7	190.5	174.8	102.8	118.5	57.1	38.5	40 8	124.0	245.4	328.5	1115.7	538.5
	Neutral	N obs	24	22	23	23	22	23	22	21	21	19	21	21	262
		Mean	**833**	**479**	**371**	**318**	**411**	**346**	**308**	**317**	**413**	**565**	**814**	**1023**	**514**
		sd	424 6	268 6	258.5	144.4	176.0	147.8	105 4	123.3	76.6	129.8	374.6	496.8	347.3
	El Nino	N obs	5	6	6	6	8	6	7	7	7	8	7	7	80
		Mean	**871**	**423**	**338**	**240**	**334**	**331**	**330**	**344**	**487**	**630**	**829**	**1568**	**562**
		sd	307.9	210.6	168.5	123.4	149.1	123.3	106.8	146.1	234.0	132.1	112.3	525.9	421 9
Mean Kelantan (n=37)			**898**	**485**	**376**	**315**	**405**	**357**	**325**	**338**	**459**	**592**	**837**	**1268**	**555**
P-Value Kelantan			0.38	0.65	0.79	0.24	0.28	0 47	0.33	0.38	0.0421	0.59	0.81	0 0634	0 0170
Mekong(3)	La Nina	N obs	13	14	13	12	10	11	11	11	12	13	13	14	147
		Mean	**2441**	**1914**	**1575**	**1600**	**2437**	**7056**	**13290**	**22018**	**21499**	**11138**	**5808**	**3532**	**7594**
		sd	363 6	268.7	242 6	296.8	732.2	2046.7	4687.6	4101.0	2982.0	2769.1	864 6	559.1	7407.4
	Neutral	N obs	44	42	43	44	44	45	44	44	43	40	42	41	516
		Mean	**2364**	**1823**	**1542**	**1470**	**2374**	**7236**	**14171**	**22101**	**21608**	**12966**	**6346**	**3674**	**8144**
		sd	360.8	274.8	220.2	230.8	696.4	2217.0	3590.2	3972 6	4677.5	2740.6	1476.6	708.1	7775.7
	El Nino	N obs	10	11	11	11	13	11	12	12	12	14	12	12	141
		Mean	**2477**	**1897**	**1597**	**1571**	**2022**	**6690**	**13379**	**19481**	**18475**	**10779**	**5822**	**3489**	**7511**
		sd	308.7	189.5	224.5	249.0	697.1	3590.8	3675.7	5110.8	3518.9	2808.1	1525.7	690.0	6849.3
Mean Mekong(3) (n=67)			**2395**	**1854**	**1557**	**1510**	**2315**	**7116**	**13884**	**21618**	**21027**	**12154**	**6148**	**3611**	**7933**
P-Value Mekong(3)			0.58	0.45	0.73	0.19	0.24	0.80	0.69	0.16	0.0787	0.0169	0 33	0.63	0.57
Nam Chi	La Nina	N obs	7	8	8	8	7	9	9	9	9	10	9	9	102
		Mean	**41**	**41**	**43**	**56**	**81**	**214**	**313**	**383**	**619**	**705**	**346**	**82**	**261**
		sd	31.9	29.4	36.1	49 1	40.9	139.9	183.9	150.2	286 7	423.1	255.9	54.6	295.0
	Neutral	N obs	25	23	23	23	22	22	21	21	21	19	21	21	262
		Mean	**44**	**41**	**42**	**46**	**70**	**179**	**288**	**444**	**703**	**722**	**414**	**92**	**244**
		sd	30.4	30.1	37.1	48.9	55.7	123 7	214.6	223 0	262 5	335 3	256.1	62.2	293.7
	El Nino	N obs	6	7	7	7	9	7	8	8	8	9	8	8	92
		Mean	**27**	**29**	**49**	**70**	**96**	**141**	**204**	**265**	**662**	**649**	**294**	**56**	**225**
		sd	22 6	23.7	33.3	27.6	43.3	86.3	177.1	170.8	260.9	327.2	214 8	36.5	271.0
Mean Nam Chi (n=38)			**40**	**39**	**43**	**52**	**78**	**180**	**276**	**392**	**674**	**700**	**372**	**82**	**244**
P-Value Nam Chi			0 47	0 61	0.90	0 47	0.43	0 49	0.50	0.11	0.73	0.88	0.48	0.32	0.67

= Monthly event runoff significantly different from the global monthly averag

Table 55b: Monthly runoff distributions according to SOI classification (South East Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Nam mun	La Nina	N obs	7	8	8	7	6	8	8	8	8	9	8	8	93
		Mean	79	58	59	76	128	340	645	851	1389	1831	994	209	588
		sd	39.4	31.2	37.3	50.0	40.8	162.9	446.0	346.9	667 2	1057.6	614.9	111.0	731.6
	Neutral	N obs	23	21	21	22	21	21	20	20	20	18	20	20	247
		Mean	84	64	60	59	106	335	637	1172	1865	2305	1226	302	650
		sd	37.7	33 2	37.4	47.0	80.0	290.0	415.8	530.8	611.9	1171.6	812 3	228.8	868.9
	El Nino	N obs	6	7	7	7	9	7	8	8	8	9	8	8	92
		Mean	68	47	64	82	146	232	428	531	1808	2069	888	159	585
		sd	28.2	24.0	40.3	27.5	121.3	157.6	335.2	329.6	798.9	836.0	481.0	56.3	795.9
Mean Nam mun (n=36)			80	60	61	67	120	316	592	958	1746	2127	1099	250	623
P-Value Nam mun			0.64	0.44	0.96	0 42	0 50	0.61	0.44	0 0067	0.24	0.55	0.48	0.15	0.73
Nan	La Nina	N obs	6	7	7	6	5	7	7	8	8	9	8	8	86
		Mean	44	34	29	33	66	150	327	734	582	225	94	50	213
		sd	14.2	16.6	12.6	21.9	17.4	51.8	109.1	270.4	255.8	68.0	35.8	18.4	260.3
	Neutral	N obs	21	19	20	21	20	20	19	18	18	16	18	18	228
		Mean	38	28	26	29	69	121	308	521	628	233	100	52	172
		sd	13.7	11.3	10.7	14.0	42.9	58.7	210.9	159.8	335.6	104.8	36.0	15.9	230.4
	El Nino	N obs	6	7	6	6	8	6	7	7	7	8	7	7	82
		Mean	33	26	25	32	48	85	205	450	426	197	95	47	143
		sd	7.1	7.4	14.2	17.1	23 9	40.1	101.6	192.2	234.8	82.2	13.0	4.0	173.9
Mean Nan (n=33)			38	29	26	30	63	121	290	558	574	222	97	50	175
P-Value Nan			0.37	0.40	0.71	0.83	0 39	0.12	0.36	0.0188	0.33	0.65	0.91	0.74	0.14
Mekong(1)	La Nina	N obs	6	7	7	6	5	7	7	7	7	8	7	7	81
		Mean	1130	920	788	931	1235	2377	4993	7196	5847	3475	2339	1661	2829
		sd	174.1	131.8	82.7	69.0	172 8	398.4	1623.4	2353.6	946.6	524.4	392.9	452.9	2269.9
	Neutral	N obs	20	18	18	18	17	17	17	17	17	15	17	17	208
		Mean	1169	936	837	893	1354	2663	4786	6624	5643	4200	2675	1607	2718
		sd	145.4	112.0	82.8	95.8	307.4	676.9	1056.0	1624.6	1803.3	807.4	551.2	195.8	2117 8
	El Nino	N obs	5	6	6	7	9	7	7	7	7	8	7	7	83
		Mean	1213	926	844	925	1094	2180	3971	6332	4711	4023	2620	1657	2596
		sd	175.5	100.2	106.4	125.5	198.2	597.3	1180.1	1703.1	797.0	964 3	880.5	373 2	1896.3
Mean Mekong(1) (n=31)			1168	930	827	907	1260	2489	4649	6687	5478	3967	2586	1631	2715
P-Value Mekong(1)			0.68	0.95	0.41	0.63	0 0717	0.20	0.25	0.66	0.30	0.13	0.48	0.89	0.78
Mekong(2)	La Nina	N obs	6	7	7	6	5	6	6	6	6	7	5	5	72
		Mean	2282	1782	1440	1444	2135	6460	13021	20768	22047	10879	5100	3428	7613
		sd	431.1	340.7	207.5	239.3	427.0	853.9	4209.3	4329.0	2418.3	1922.5	556.6	794.2	7471.4
	Neutral	N obs	18	16	16	16	15	16	16	16	16	14	17	17	193
		Mean	2399	1858	1551	1414	2494	7047	13285	18793	17470	10527	5614	3364	7064
		sd	287.5	280.6	185.6	153 3	684 5	1935.9	3814.6	3997 7	4007.5	1228.2	1240.4	527.9	6430.3
	El Nino	N obs	5	6	6	7	9	7	7	7	7	8	7	7	83
		Mean	2544	1888	1604	1638	1873	5845	11161	18417	14865	8867	5639	3345	6601
		sd	339.8	265.7	328.0	408.9	385 9	3320.0	3656.3	3989.8	1168.9	2172.1	1559.9	664.4	5811.7
Mean Mekong(2) (n=29)			2400	1846	1535	1474	2240	6635	12717	19111	17788	10154	5531	3371	7067
P-Value Mekong(2)			0.43	0.79	0 40	0 16	0.0478	0.48	0.48	0 53	0.0002	0.0537	0.70	0.97	0.63

= Monthly event runoff significantly different from the global monthly average

Table 56a: Monthly runoff distributions according to SOI classification (Indian Subcontinent area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Mahaweli		N obs	8	9	8	8	7	8	8	9	9	10	9	9	102
	La Nina	Mean	34	17	16	30	62	122	102	117	112	91	91	61	72
		sd	13.6	5.6	4.2	16.7	35.9	80.4	46.2	32.2	54.9	37.5	62 0	24.9	54.4
		N obs	22	20	21	21	20	21	20	19	19	18	20	20	241
	Neutral	Mean	29	22	16	33	56	86	100	87	81	105	100	62	64
		sd	12 8	14.1	11.2	17.1	43.4	56.1	45.9	37.9	41.2	34.2	43.3	24.5	46.4
		N obs	5	6	6	6	8	6	7	7	7	7	6	6	77
	El Nino	Mean	30	15	15	26	69	96	96	67	52	91	92	99	64
		sd	11.0	7.7	10.7	14.8	53.7	64.6	40.3	19.1	17.1	34.9	26.2	84.7	48.6
Mean Mahaweli (n=35)			31	19	16	31	60	96	100	90	83	98	97	68	66
P-Value Mahaweli			0.64	0.40	0.91	0.62	0 78	0.39	0.96	0.0182	0.0256	0.50	0.87	0.14	0.30
Gin Ganga		N obs	12	13	12	11	10	11	11	11	12	13	13	14	143
	La Nina	Mean	38	23	31	61	98	89	68	52	68	85	95	61	64
		sd	17 0	10.3	13.6	23.7	54.2	41.8	36.0	21.4	37 7	42.6	45.0	22.1	39.7
		N obs	41	39	41	42	41	42	41	41	40	37	39	38	482
	Neutral	Mean	38	31	37	58	98	78	52	46	54	88	90	62	61
		sd	16.2	15.4	17.2	19.9	47.7	35.4	25.0	29.9	32.3	37.3	25.9	22.8	35.6
		N obs	9	10	9	9	11	9	10	10	10	12	10	10	119
	El Nino	Mean	31	30	38	49	104	80	38	46	42	110	104	74	64
		sd	16.3	16.2	23.3	24 3	65.0	29.4	27.5	29.6	29.8	31.8	28.6	33.9	43.2
Mean Gin Ganga (n=62)			37	29	36	57	99	80	53	47	55	92	93	64	62
P-Value Gin Ganga			0.53	0.25	0 61	0.41	0.92	0 70	0.0520	0.82	0.19	0.21	0.45	0.43	0.68
Karnali		N obs	6	7	7	6	5	7	7	7	7	8	6	6	79
	La Nina	Mean	411	364	384	463	659	1862	3272	4558	3045	1463	714	504	1544
		sd	50.4	59.3	56.2	78.3	178.7	877 2	1473.3	392.1	930.4	656.8	143.2	50.5	1504.5
		N obs	19	17	17	17	16	16	17	16	16	14	18	18	201
	Neutral	Mean	359	326	359	461	759	1477	3318	4478	2918	1278	594	413	1357
		sd	43.8	51.9	78 7	102.7	233.4	469.5	757.7	870.4	987 1	752 2	122.7	90.7	1415.3
		N obs	7	8	8	9	11	9	8	9	9	10	8	8	104
	El Nino	Mean	360	328	326	457	773	1357	2858	3861	2814	1025	598	435	1289
		sd	41.2	37.4	60.3	121.2	190.6	366 2	583.6	869 3	736.2	199.0	58.0	41.7	1228.1
Mean Karnali (n=32)			369	335	356	460	748	1528	3193	4322	2916	1245	618	436	1377
P-Value Karnali			0.05	0.25	0.29	0.99	0.59	0.19	0 5000	0.14	0.88	0.31	0.09	0.05	0.43
Kali Gand.(1)		N obs	3	4	4	5	4	5	5	6	6	6	4	4	56
	La Nina	Mean	120	112	75	122	149	437	1257	1597	1170	681	272	161	593
		sd	21.2	0.0	0.0	8.5	48.2	208.1	322.6	158.3	365.3	374.1	45.9	21 6	583 5
		N obs	15	13	14	12	11	12	12	11	11	11	13	13	148
	Neutral	Mean	131	112	90	109	148	419	1269	1365	1124	501	242	159	446
		sd	21.7	29.0	39.4	21.1	44 3	174.8	316 0	354.1	260.9	232.0	71.9	37.0	518.5
		N obs	4	5	4	5	7	5	5	5	5	5	5	5	60
	El Nino	Mean	147	117	91	103	137	330	1033	1458	1023	423	253	148	439
		sd	32 5	21.5	35.4	0.7	21.9	103.3	136 7	399.5	142.0	90 5	75.4	47 4	474.3
Mean Kali Gand.(1) (n=22)			132	113	87	111	144	403	1212	1449	1113	532	250	156	475
P-Value Kali Gand.(1)			0.96	0.94	0.56	0 84	0.61	0.39	0.3800	0.38	0 72	0.28	0.75	0 85	0.14
Kali Gand.(2)		N obs	4	5	5	6	5	7	7	7	7	7	5	5	70
	La Nina	Mean	0	0	29	0	126	311	809	946	674	355	139	80	336
		sd	0.0	0 0	0.0	0.0	0.0	154.3	190 9	114.0	143.9	196.7	28.7	0.0	332.1
		N obs	19	17	17	15	14	14	15	14	14	13	17	17	186
	Neutral	Mean	51	42	44	54	118	274	736	761	561	225	115	81	239
		sd	0 0	0.0	0.0	5.0	20.7	84.9	177.0	119.4	103.1	62.0	10 7	0.0	285.6
		N obs	7	8	8	9	11	9	8	9	9	10	8	8	104
	El Nino	Mean	0	46	0	0	104	220	626	851	557	195	114	0	231
		sd	0 0	4.2	0 0	0.0	11.8	52.1	103 4	140.8	165 4	33.2	3.5	0 0	291.2
Mean Kali Gand.(2) (n=30)			32	36	30	27	114	266	724	831	586	246	119	59	256
P-Value Kali Gand.(2)			N.A	0.58	N A.	N.A	0 40	0.19	0.1100	0 01	0.16	0.01	0.01	N.A	0.05

= Monthly event runoff significantly different from the global monthly average

Table 56b: Monthly runoff distributions according to SOI classification (Indian Subcontinent area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Tamur	La Nina	N obs	3	4	4	4	3	4	4	5	5	5	4	4	49
		Mean	**0**	38	44	108	168	**618**	949	957	754	430	158	109	394
		sd	0.0	0.0	0 0	0.0	49.9	69.0	288.2	183.7	200.0	116.9	26 5	0.0	361.8
	Neutral	N obs	15	13	14	13	12	13	13	12	12	11	12	12	152
		Mean	103	46	42	103	182	450	956	904	733	336	154	122	337
		sd	0.0	1.4	0.0	2.1	29.7	98.2	132.4	148 4	150.3	172.1	42.1	16.2	344.3
	El Nino	N obs	4	5	4	5	7	5	5	5	5	6	6	6	63
		Mean	66	0	39	105	180	455	807	817	584	264	143	0	285
		sd	0.0	0.0	0 0	3.5	54.7	140.8	96.4	212.1	117.3	71 5	29.5	0.0	292.3
Mean Tamur (n=22)			82	34	42	104	180	482	921	896	704	338	152	86	335
P-Value Tamur			N.A.	0.14	N.A.	0.35	0.87	0.03	0.2300	0.44	0.17	0 18	0.80	0.53	0.11
Ganges (1)	La Nina	N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
		Mean	3044	2556	2111	1840	2016	**5516**	**22858**	**44633**	39213	19698	**8156**	4484	12902
		sd	978.6	816.6	869.6	646.1	657.2	2363.5	4834.3	5757 1	5250.8	7741.5	3939 7	1477 5	14847 2
	Neutral	N obs	36	34	36	36	35	36	35	35	35	32	34	33	417
		Mean	2697	2315	2040	1860	2026	3947	18075	37868	36525	18271	6518	3645	11252
		sd	863.6	853 8	649.4	527.3	534.4	1401.8	4385.1	7342.0	8950.6	7383.6	1999.4	992.2	13608.4
	El Nino	N obs	9	10	9	9	11	9	10	10	10	12	10	10	119
		Mean	2558	2141	1627	1396	1759	3360	14661	34394	34791	**13149**	**5616**	3593	10164
		sd	644 0	574.6	566.8	380.2	400.9	980.4	4382.5	8978 7	10145.0	3422.3	966.9	712.1	12546 7
Mean Ganges (1) (n=56)			2743	2335	1988	1782	1972	4161	18405	38576	36743	17479	6708	3830	11394
P-Value Ganges (1)			0.40	0.47	0.23	0.07	0.34	0.01	0 0006	0.01	0.52	0.05	0.05	0.06	0.34
Ganges (2)	La Nina	N obs	8	9	8	8	7	8	8	9	9	10	9	10	103
		Mean	2976	2422	2031	1787	2175	6172	**26268**	47859	44372	21758	**8598**	**4686**	14784
		sd	428.2	551 4	542.5	215.8	392.9	3152.7	8113.8	10537.7	7099.7	6714.1	2373.3	780 6	17082.6
	Neutral	N obs	24	22	23	23	22	23	22	21	21	20	22	21	264
		Mean	2756	2390	2043	1846	2127	4574	20592	42760	39154	19479	6637	3874	11933
		sd	472 6	496.4	405.1	369 0	479.6	1801.9	5090.7	9424.6	10342.7	9182.9	2280.1	546.6	14918.3
	El Nino	N obs	5	6	6	6	8	6	7	7	7	7	6	6	77
		Mean	2527	2143	1662	1587	1957	4074	17516	38507	35768	13518	**5756**	3661	11412
		sd	289 7	280 1	222.0	416.5	466.7	1124.5	5271.5	11236.5	8173.2	4300.3	1032.6	399 5	13900.7
Mean Ganges (2) (n=37)			2772	2358	1979	1791	2099	4839	21237	43196	39783	18967	6971	4059	12504
P-Value Ganges (2)			0 22	0.50	0.14	0.29	0.61	0.12	0.0188	0.19	0 18	0.11	0.03	0 00	0.22
Sapt Kosi	La Nina	N obs	8	9	8	8	7	8	8	9	9	10	9	10	103
		Mean	403	349	342	389	668	2123	4006	4987	3599	1721	800	528	1678
		sd	35.7	42.1	50.0	36 8	175.0	785.7	989.4	1280.5	761 1	423.8	106.2	43 9	1690.3
	Neutral	N obs	20	18	19	20	19	19	18	17	17	16	18	17	218
		Mean	403	376	375	430	726	2013	4210	4774	3445	**1902**	900	540	1623
		sd	40.1	69 3	98.0	51 2	131.3	632.7	1143.2	889.6	571 1	514.8	217.7	54.6	1611.0
	El Nino	N obs	4	5	5	4	6	5	6	6	6	6	5	5	63
		Mean	385	350	348	416	741	1602	3659	4212	2913	**1339**	810	501	1562
		sd	16.5	36.8	39.3	55.5	117.2	175.1	638.0	646.0	347 3	304.8	100.8	40.8	1409.8
Mean Sapt Kosi (n=32)			400	364	362	418	716	1976	4056	4729	3389	1740	858	530	1628
P-Value Sapt Kosi			0.69	0.48	0 59	0.14	0.58	0.34	0.5300	0.33	0.10	0.05	0.33	0 32	0.90
Godavari	La Nina	N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
		Mean	289	229	173	138	75	1172	7692	10390	10587	**5781**	**1608**	455	3213
		sd	69.9	68.1	62.5	62.1	65.7	1019.3	4185 1	4078.8	4673 1	3476.9	1161.1	178 5	4659.4
	Neutral	N obs	47	46	50	52	50	51	49	49	48	45	45	43	575
		Mean	255	202	153	121	89	962	7945	11698	10317	3629	1024	444	3087
		sd	94.4	85.2	82.3	104.8	72 5	1521 3	4949.5	4746.8	4858 3	2687.2	734 7	284.2	4917.0
	El Nino	N obs	13	14	12	11	15	13	14	13	13	14	14	15	161
		Mean	213	178	139	106	90	899	6616	12278	9203	2684	632	346	2762
		sd	89.9	71.9	46.8	44.1	69 1	1222.8	3527 7	7015.5	4616.3	1649.3	288.6	211.6	4773.0
Mean Godavari (n=78)			256	204	155	122	87	989	7658	11526	10190	3984	1096	428	3058
P-Value Godavari			0.08	0.22	0.52	0 70	0 84	0.87	0.6400	0.60	0.71	0.01	0.00	0.38	0.66

= Monthly event runoff significantly different from the global monthly average

Table 56c: Monthly runoff distributions according to SOI classification (Indian Subcontinent area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Krishna		N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
	La Nina	Mean	**146**	**86**	**84**	**41**	**46**	**717**	**4825**	**6374**	**5005**	**3934**	**1513**	**287**	**1927**
		sd	128.6	93 6	175.7	46.0	76.6	662 9	2834.1	3846.3	1750.0	1769.1	2351.4	320.2	2826.6
		N obs	48	47	51	53	51	52	50	50	49	46	46	44	587
	Neutral	Mean	**110**	**63**	**44**	**37**	**118**	**476**	**4754**	**6343**	**4028**	**2349**	**871**	**243**	**1626**
		sd	116.5	53.8	52.0	48 6	200.7	369.0	2500 8	2139 5	1879.3	1115.6	717.9	226.1	2431.0
		N obs	13	14	12	11	15	13	14	13	13	14	14	15	161
	El Nino	Mean	**70**	**41**	**29**	**11**	**169**	**363**	**4442**	**5873**	**3197**	**1849**	**522**	**163**	**1397**
		sd	70.4	43.7	44.1	7.5	311.6	440.7	2429.0	3034.2	1490.5	1317.9	466.8	115.8	2292.4
Mean Krishna (n=79)			**112**	**64**	**50**	**34**	**116**	**500**	**4712**	**6272**	**4101**	**2642**	**964**	**239**	**1650**
P-Value Krishna			0.20	0.16	0.22	0 18	0.36	0.12	0.9100	0.84	0.03	0.00	0.08	0.32	0.12
Narmada		N obs	7	7	6	6	6	7	7	8	8	9	8	9	88
	La Nina	Mean	**22**	**13**	**11**	**5**	**2**	**114**	**993**	**1634**	**987**	**248**	**75**	**44**	**367**
		sd	6.8	6.9	7.0	3.7	1.9	174.8	563.4	490 3	680.7	173.1	33.0	33.6	608.3
		N obs	16	15	16	17	15	15	14	13	13	12	14	13	173
	Neutral	Mean	**22**	**14**	**9**	**6**	**2**	**41**	**751**	**1300**	**841**	**204**	**41**	**22**	**249**
		sd	18.2	8.0	6.3	5.4	1.1	38.6	606.1	496.7	513.0	140.2	20.1	12.5	482.6
		N obs	3	4	4	3	5	4	5	5	5	5	4	4	51
	El Nino	Mean	**11**	**14**	**5**	**1**	**1**	**13**	**412**	**1272**	**1956**	**89**	**31**	**18**	**373**
		sd	4.6	17.8	3.7	0.6	0.5	22.2	289.2	662.3	3213.9	28.2	11.7	9.4	1146.0
Mean Narmada (n=26)			**20**	**14**	**9**	**5**	**2**	**56**	**751**	**1398**	**1100**	**197**	**50**	**29**	**303**
P-Value Narmada			0.50	0.95	0.27	0.26	0.39	0.17	0.2700	0.33	0 34	0.15	0.00	0.06	0.29

= Monthly event runoff significantly different from the global monthly average

Table 57a: Monthly runoff distributions according to SOI classification (Central Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Amu-Darya	La Nina	N obs	8	8	7	7	7	7	7	8	8	9	10	11	97
		Mean	493	441	471	628	1524	2433	2700	2341	1676	918	664	583	1188
		sd	68.8	186.8	374.6	331.3	731.1	722.1	852.5	756.5	305.1	129.8	114.7	219.4	910.7
	Neutral	N obs	29	28	30	31	29	30	29	28	28	26	26	25	339
		Mean	597	586	455	801	1703	2502	3243	2828	1722	1073	858	691	1432
		sd	207.6	208.8	260.4	470.3	610.9	693.7	1053.0	738.6	367.3	157.2	124.5	153.5	1062.9
	El Nino	N obs	6	7	6	5	7	6	7	7	7	8	7	7	80
		Mean	495	367	503	1028	1820	2883	3181	2291	1397	965	785	615	1367
		sd	104.2	156.0	307.2	704.1	763.9	1311.1	1327.1	1213.8	533.7	239.3	236.2	159.2	1154.3
Mean Amu-Darya (n=43)			564	523	464	799	1693	2544	3145	2650	1661	1020	801	651	1376
P-Value Amu-Darya			0.22	0.0207	0.93	0.37	0.70	0.53	0.49	0.17	0.15	0.0458	0.0036	0.20	0.13
Zaravchan	La Nina	N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
		Mean	40	37	35	49	144	355	451	372	187	82	57	46	151
		sd	6.1	5.2	3.7	12.3	56.3	94.5	107.3	66.1	43.8	12.4	7.2	6.7	153.0
	Neutral	N obs	41	38	39	39	38	39	39	38	38	35	38	37	459
		Mean	40	35	35	53	143	342	472	355	186	87	60	47	155
		sd	5.9	3.7	4.1	15.8	47.2	74.3	79.9	45.1	31.4	10.5	7.5	7.2	151.6
	El Nino	N obs	11	13	13	13	15	13	13	14	14	16	13	13	161
		Mean	39	39	41	58	154	380	430	340	186	89	62	49	157
		sd	4.4	8.3	9.5	14.3	48.4	87.4	91.0	42.8	36.3	14.7	12.6	11.3	144.8
Mean Zaravchan (n=63)			40	36	36	54	146	352	460	355	186	87	60	47	155
P-Value Zaravchan			0.75	0.11	0.0033	0.36	0.77	0.34	0.30	0.28	0.99	0.26	0.38	0.46	0.94
Gunt	La Nina	N obs	9	10	9	8	7	8	8	9	9	10	10	11	108
		Mean	30	27	26	27	60	241	316	251	120	60	44	35	98
		sd	3.7	3.3	2.3	2.5	39.9	94.4	77.4	53.9	23.6	7.2	5.1	3.6	104.9
	Neutral	N obs	29	27	29	30	29	30	29	28	28	27	28	27	341
		Mean	29	27	26	30	62	234	340	254	126	64	44	35	107
		sd	2.7	2.1	1.9	4.1	27.8	85.7	100.3	41.4	24.2	8.7	4.8	3.8	112.9
	El Nino	N obs	8	9	8	8	10	8	9	9	9	9	8	8	103
		Mean	28	25	25	28	65	249	294	224	105	58	40	32	99
		sd	2.3	1.7	0.7	2.5	28.1	75.9	98.5	54.3	20.8	9.8	4.2	3.7	102.9
Mean Gunt (n=46)			29	27	26	29	62	238	327	248	121	62	43	35	104
P-Value Gunt			0.23	0.15	0.0952	0.0990	0.95	0.90	0.43	0.24	0.0692	0.0937	0.0929	0.0850	0.68
Vakhsh	La Nina	N obs	7	7	6	6	6	5	5	5	5	6	7	8	73
		Mean	190	181	229	428	872	1145	1542	1410	682	315	249	220	562
		sd	30.1	19.3	32.3	114.7	170.6	152.1	434.6	155.4	84.5	28.9	43.3	41.2	481.8
	Neutral	N obs	23	23	24	25	24	26	25	25	25	23	23	22	288
		Mean	180	177	225	476	829	1222	1688	1437	759	354	257	207	670
		sd	19.7	17.9	37.1	151.8	169.5	242.2	271.1	169.4	112.3	55.3	30.7	26.1	536.7
	El Nino	N obs	5	5	5	4	5	4	5	5	5	6	5	5	59
		Mean	178	181	238	429	894	1345	1492	1153	611	329	238	197	593
		sd	18.2	10.0	37.3	101.9	218.9	271.4	358.5	248.5	134.6	50.6	23.2	25.5	489.7
Mean Vakhsh (n=35)			182	178	227	463	846	1225	1639	1393	727	343	252	209	640
P-Value Vakhsh			0.53	0.77	0.75	0.67	0.70	0.45	0.34	0.0107	0.0259	0.21	0.49	0.39	0.22
Biya	La Nina	N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
		Mean	69	56	58	635	1273	1205	742	440	394	334	183	87	413
		sd	15.0	13.8	18.9	295.3	377.8	355.2	274.0	129.7	167.9	140.2	63.0	24.7	432.5
	Neutral	N obs	58	57	60	61	59	61	60	60	59	56	56	54	701
		Mean	70	56	58	677	1179	1221	803	591	437	357	220	101	490
		sd	16.2	12.7	12.9	273.4	379.0	428.1	328.3	230.9	168.5	128.6	88.7	30.0	464.7
	El Nino	N obs	15	16	15	15	19	16	16	15	15	16	16	17	191
		Mean	72	58	58	683	1319	1201	722	546	487	395	248	103	505
		sd	18.3	13.5	15.2	325.1	532.2	425.0	233.2	166.8	156.9	124.3	107.0	29.4	491.3
Mean Biya (n=91)			70	57	58	671	1222	1215	778	557	437	359	217	98	478
P-Value Biya			0.92	0.94	0.99	0.86	0.40	0.98	0.57	0.0404	0.29	0.39	0.0933	0.13	0.0811

= Monthly event runoff significantly different from the global monthly average

Table 57b: Monthly runoff distributions according to SOI classification (Central Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Ob		N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
	La Nina	Mean	5056	4044	3407	3262	14721	33313	29914	23694	14991	10756	6628	5819	12721
		sd	768.0	644.6	488.6	441.2	3502.0	3681.5	5648.6	8934.7	5153.6	3324.4	1506.5	996.4	10797.3
		N obs	43	40	41	41	40	41	41	40	40	37	40	39	483
	Neutral	Mean	4600	3837	3379	3426	14447	32999	29936	22178	13800	10170	5993	5084	12509
		sd	963.1	669.1	591.4	780.8	4853.7	3081.7	4855.7	8393.5	5360.1	1884.2	1852.0	1211.6	10845.2
		N obs	11	13	13	13	15	13	13	14	14	16	13	13	161
	El Nino	Mean	4691	3867	3531	3819	14919	31993	29404	20629	12801	10069	6316	5588	12443
		sd	1081.0	995.4	986.0	1059.1	5569.2	3332.2	6786.4	10081.1	6659.8	2682.8	1907.1	1104.2	10541.3
Mean Ob (n=65)			4693	3881	3414	3476	14598	32851	29825	22101	13786	10253	6175	5332	12532
P-Value Ob			0.37	0.70	0.78	0.20	0.95	0.55	0.95	0.69	0.63	0.72	0.54	0.10	0.97
Tom (1)		N obs	19	19	17	15	13	14	15	16	17	19	19	20	203
	La Nina	Mean	89	73	80	1077	3078	1298	467	313	395	487	204	128	557
		sd	28.4	18.7	23.7	581.4	714.2	418.6	252.9	179.1	255.3	303.8	108.2	45.9	808.4
		N obs	58	57	60	62	60	62	61	61	60	57	57	55	710
	Neutral	Mean	86	74	78	1140	2843	1359	529	382	437	476	247	130	661
		sd	29.9	22.2	28.2	585.4	725.6	655.1	290.4	197.7	259.4	245.9	146.3	56.5	856.2
		N obs	15	16	15	15	19	16	16	15	15	16	16	17	191
	El Nino	Mean	89	71	80	1083	3098	1418	470	339	451	545	252	133	711
		sd	25.3	22.5	30.3	645.1	990.8	730.5	274.7	136.2	195.1	217.8	120.7	33.6	985.8
Mean Tom (1) (n=92)			87	73	78	1120	2929	1360	509	363	432	490	239	130	651
P-Value Tom (1)			0.94	0.88	0.94	0.90	0.36	0.88	0.62	0.37	0.78	0.63	0.44	0.96	0.19
Tom (2)		N obs	4	5	5	5	4	6	6	6	6	6	5	5	63
	La Nina	Mean	169	122	122	2075	4074	2605	679	629	484	753	344	210	988
		sd	29.3	35.0	42.9	508.5	685.8	1196.9	213.3	427.5	158.4	312.2	102.1	28.0	1202.1
		N obs	17	15	16	15	14	14	14	14	14	13	15	15	176
	Neutral	Mean	176	135	145	1961	4400	2154	734	625	537	721	455	233	993
		sd	37.7	30.6	52.7	763.3	1104.4	1102.1	329.3	211.9	236.0	345.6	250.4	45.6	1296.1
		N obs	5	6	5	6	8	6	6	6	6	7	6	6	73
	El Nino	Mean	204	145	142	1635	5287	2047	612	439	752	999	548	266	1228
		sd	18.4	39.9	43.9	911.2	1425.5	1345.7	408.3	188.4	249.5	353.3	179.8	50.8	1669.8
Mean Tom (2) (n=26)			180	135	140	1908	4623	2233	693	583	574	803	455	237	1047
P-Value Tom (2)			0.23	0.54	0.68	0.59	0.16	0.67	0.75	0.35	0.10	0.22	0.32	0.13	0.44
Tura		N obs	18	18	16	15	13	14	15	16	17	19	19	20	200
	La Nina	Mean	30	29	30	243	652	316	180	158	153	114	91	46	154
		sd	11.3	9.2	8.2	125.2	326.1	206.9	166.8	193.9	176.1	144.2	63.0	25.2	210.6
		N obs	57	56	59	60	58	60	59	59	58	55	55	53	689
	Neutral	Mean	30	28	29	284	809	543	203	133	109	108	75	44	203
		sd	14.7	11.1	10.5	192.7	520.3	875.7	167.2	124.1	101.9	98.9	77.9	33.5	389.2
		N obs	15	16	15	15	19	16	16	15	15	16	16	17	191
	El Nino	Mean	26	23	23	270	727	446	177	111	66	71	58	38	180
		sd	12.5	8.4	7.9	214.7	344.4	357.9	132.1	126.5	43.3	43.5	36.2	20.8	274.9
Mean Tura (n=90)			30	27	28	275	769	490	194	134	110	103	75	43	190
P-Value Tura			0.57	0.13	0.11	0.75	0.50	0.57	0.79	0.65	0.10	0.40	0.36	0.69	0.18
Yenisei		N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
	La Nina	Mean	5517	5622	5884	5978	28701	79691	26144	17523	16940	13956	6510	5530	17694
		sd	1563.5	1878.1	2157.0	2429.9	9173.7	9592.8	2674.0	3083.7	2343.3	2272.3	1169.5	1214.1	20450.1
		N obs	38	35	36	36	35	36	36	35	35	32	35	34	423
	Neutral	Mean	6077	5904	5744	5624	28510	76803	27488	18090	17326	14210	6856	5839	18279
		sd	1402.9	1598.9	2005.5	2281.5	15026.2	16213.3	5340.9	3630.6	2989.4	2627.0	1710.2	1588.2	20787.6
		N obs	11	13	13	13	15	13	13	14	14	16	13	13	161
	El Nino	Mean	6426	6714	6734	7065	24477	77053	24466	15944	15787	13498	7176	6152	17750
		sd	1600.1	1897.9	2261.7	2441.0	10728.4	8998.7	4414.0	2613.3	2314.7	2489.5	1846.8	1344.8	19359.0
Mean Yenisei (n=60)			6039	6023	5984	6001	27534	77387	26587	17485	16896	13969	6856	5840	18050
P-Value Yenisei			0.34	0.24	0.34	0.17	0.59	0.83	0.15	0.13	0.22	0.66	0.60	0.56	0.94

= Monthly event runoff significantly different from the global monthly average

Table 57c: Monthly runoff distributions according to SOI classification (Central Asia area).

River	SOI	Month	J	F	M	A	MA	JN	JL	AU	S	O	N	D	Total
Syr-Darya	La Nina	N obs	10	11	10	10	9	9	9	10	10	11	11	12	122
		Mean	**373**	**416**	**410**	**562**	**823**	**766**	**549**	**403**	**290**	**307**	**345**	**362**	**457**
		sd	186.7	233.0	246.7	342.1	293.4	408.8	241.0	207.5	141.8	173.9	164.8	178.5	281.8
	Neutral	N obs	37	35	37	37	36	38	37	36	36	34	35	34	432
		Mean	**371**	**437**	**517**	**704**	**946**	**1016**	**885**	**530**	**342**	**370**	**434**	**406**	**584**
		sd	182 7	207 7	220.9	328.5	395.9	504.1	463.8	269.0	182.2	196.8	242.7	216.6	383.5
	El Nino	N obs	8	9	8	8	10	8	9	9	9	10	9	9	106
		Mean	**316**	**334**	**439**	**598**	**783**	**929**	**630**	**377**	**248**	**302**	**316**	**354**	**466**
		sd	171.3	193.8	298.1	438.1	444.0	569.5	354.3	264.9	181.9	242.5	192.3	174.5	364.3
Mean Syr-Darya (n=55)			**363**	**416**	**486**	**662**	**896**	**962**	**788**	**482**	**317**	**345**	**397**	**388**	**542**
P-Value Syr-Darya			0.73	0.43	0.38	0.45	0.43	0.40	0.0550	0.17	0.32	0.51	0.26	0.70	0.0002
Ural	La Nina	N obs	13	14	13	12	11	11	12	13	14	15	15	16	159
		Mean	**54**	**51**	**69**	**593**	**1022**	**313**	**160**	**117**	**102**	**97**	**91**	**67**	**207**
		sd	26.5	24.3	53 7	336.1	953.6	229.5	75.6	49.3	43.6	38.6	41.8	40 9	374.8
	Neutral	N obs	44	42	44	45	44	47	45	44	43	41	42	41	522
		Mean	**64**	**59**	**68**	**1019**	**1499**	**420**	**210**	**137**	**107**	**101**	**93**	**61**	**326**
		sd	36.7	33 1	58.5	1129 0	1213.8	232.3	88.9	62.0	46.6	42.9	46.3	30.5	658.6
	El Nino	N obs	10	11	10	10	12	9	10	10	10	11	10	10	123
		Mean	**57**	**51**	**81**	**731**	**1258**	**476**	**193**	**128**	**102**	**88**	**82**	**67**	**287**
		sd	19.0	17.6	101.2	461.7	986.5	422.3	101 2	68 7	54.4	40.4	26.3	26.0	508.3
Mean Ural (n=67)			**61**	**56**	**70**	**899**	**1377**	**410**	**199**	**132**	**105**	**98**	**91**	**63**	**297**
P-Value Ural			0.59	0.58	0.84	0.34	0.43	0.36	0.23	0.58	0.90	0.64	0.79	0.75	0.0813
Naryn	La Nina	N obs	11	12	11	11	10	11	11	11	11	12	12	13	136
		Mean	**163**	**160**	**182**	**283**	**597**	**823**	**755**	**500**	**277**	**206**	**192**	**167**	**350**
		sd	61.8	56.5	42.5	110.2	202.2	346.3	277.5	102.1	99.6	51.1	38.6	42.4	274.5
	Neutral	N obs	38	36	38	38	37	38	37	37	37	34	36	35	441
		Mean	**163**	**175**	**184**	**308**	**593**	**857**	**766**	**538**	**263**	**212**	**200**	**186**	**373**
		sd	43.5	43.4	34.6	94.3	198 4	333.5	233.7	141.3	93.1	73.4	74 0	47.8	282.6
	El Nino	N obs	9	10	9	9	11	9	10	10	10	12	10	10	119
		Mean	**135**	**137**	**179**	**307**	**654**	**878**	**733**	**466**	**218**	**191**	**190**	**156**	**353**
		sd	50.7	36.4	39.5	89.2	289.5	509.9	330.9	168.9	70.4	71.4	81.3	55.8	316 7
Mean Naryn (n=58)			**159**	**165**	**183**	**303**	**605**	**854**	**758**	**518**	**258**	**206**	**197**	**176**	**365**
P-Value Naryn			0 30	0.0695	0.92	0.76	0.71	0.94	0.94	0.33	0.29	0.65	0 90	0.18	0 63

= Monthly event runoff significantly different from the global monthly average

Table 58: Breakdown by area, of the number of stations teleconnected to the different phases of the El Niño phenomenon.

Region	Number of stations			
	influenced by El Niño	influenced by La Nina	influenced by both El Niño and La Nina	not influenced
Oceania-Pacific	10/19	15/19	9/19	3/19
Far East Asia	14/25	9/25	5/25	8/25
South East Asia	3/9	4/9	2/9	5/9
Indian Subcontinent	4/11	9/11	4/11	2/11
Central Asia	3/13	2/13	1/13	9/13