Synthesis of Simple Predictive Models For Tropical River Fisheries

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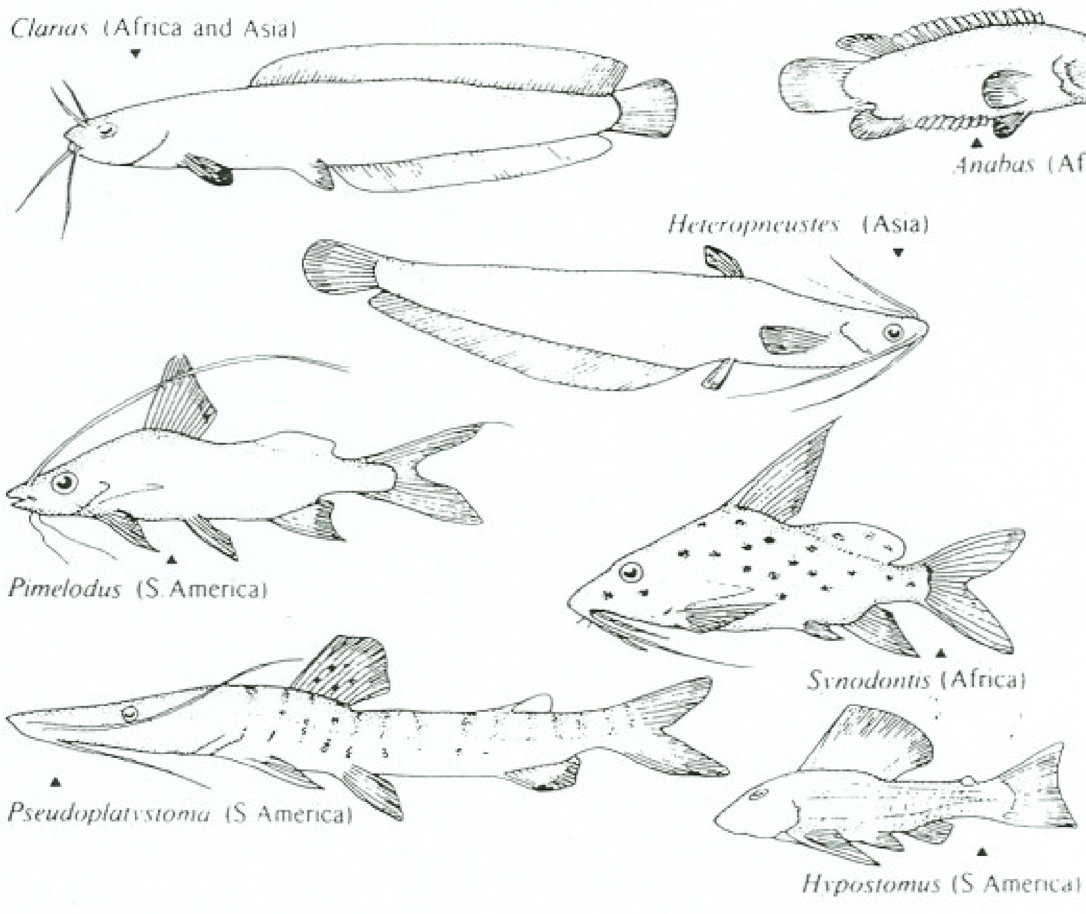

Fisheries Management Science Programme

Overseas Development Administration

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Contents

Introduction

1.1 Executive Summary

1 A primary database has been constructed on R:BASE, containing annotated statistics on physical, morphological, hydrological, edaphic, fisheries and demographic data for 45 rivers in South America and Asia, drawn from local, national and international sources.

2 This database has been summarised to one representative value for each variable, and as such, is comparable to the FAO database on African inland waters (Crul 1992), although covering more parameters.

3 This database is available on diskette to provide planning information for river basin development, including planned utilisation of water resources, other natural resources or engineering projects, in all major regions of the tropics. In addition they can also provide the basis of a GIS system for tropical rivers.

4 The summary database table was used to look for predictive relationships between fish catches and a range of parameters within the river systems. Significant positive relationships were found with the physical dimensions of drainage basin area, river length and floodplain area, amongst all the rivers involved and more specifically for South America. The relationships for Asia are more uncertain owing to the few data points available and questions over their representative nature.

5 The form of the relationship between catch (c) in tonnes/year and drainage basin area (dba) in km^2 for South American rivers:

$$c = 0{:}046(dba)^{0.901}$$

is very similar to that found for African rivers (Welcomme 1974):

$$c = 0.074(dba)^{0.89}$$

although showing a slightly lower level of catch.

6 The Mekong, and to some extent the Ganges, are shown to have exceptionally high fish yields, even though their flood plains have been highly modified for agriculture and other human activities compared to those of South American and African rivers.

7 The edaphic factors of conductivity and pH are shown to bear no relationship to fish catch. They are irrelevant to the riverine production system, unlike their role in lakes. This is emphasised by conformity of the "black water" Rio Negro within the main relationships of South American rivers notwithstanding the acid pH and demineralised composition of the water.

8 Most significantly, fish catch has been shown to be positively correlated with river discharge rate. This provides yet a further series of empirical relationships based on a different sort of information which is fairly widely available. It also, however, has considerable biological implications for interpreting the basis of production in rivers and opens up the way to providing a dynamic model for management of tropical river fisheries centred around the hydrological cycle.

9 Given information on drainage basin area, river length, flood plain area or mean discharge rate it is now possible to provide a first order planning estimate for fish production in South American, African or, in a more generalised fashion, Asian rivers. Multiple regressions amongst the three physical variables with respect to fish catch, have also been produced to try to increase the precision of the estimate.

10 The database highlights gaps in the knowledge of tropical rivers and in this way can assist in the orientation of research or development projects or even to assign priorities. Unquestionably the biggest gap lies in Asian rivers. The database is very flexible and can readily be extended as new information becomes available.

1.2 Project Objectives

1.21 Original Objectives

(1) To compile and review all catch data from tropical rivers. Particular emphasis should be placed on extending the database to Asia and South America as well as Africa.

(2) To assess the physical and chemical, and other hydrological and climatological factors which might significantly influence fish production and collect such data from sites where catch data are available.

(3) To compile demographic data on population numbers and fisherman numbers where possible at sites where catch data are available.

(4) To re-examine the previous databases (Welcomme 1974) and the relationships derived.

(5) To devise and test mathematically relationships between river fish catch and readily obtainable parameters of hydrology or climate.

(6) To test for significant differences amongst rivers in Africa, South America and Asia, and between forest and Savanna rivers.

(7) To examine differences in catch rates and yields at different order tributaries down major river systems.

(8) To consider methods of obtaining catch data from different order tributaries in a river basin with a view to filling gaps in the database in subsequent practical projects.

(9) To consider application and dissemination of deduced relationships.

1.22 Modifications of Objectives

In order to aid the compilation and retrieval of the data collected during the review stage of the project, it was decided to enter the data into a computerised database. During the compilation and entry of the data into the database it became apparent that the available information on river and floodplain systems was not of sufficient detail to meet some of the more specific analytical objectives originally proposed. It was not possible to test the effects of river classification i.e. Savanna and Forest (objective 6) or river order (objective 7) on catch rates. The construction of the database has specifically helped to identify areas where there are gaps in the information available. The lack of detailed data resulted in greater emphasis being placed on the database application, to provide a user friendly interface. The database will provide a tool for research workers to identify areas where data is unavailable and may aid in deciding future research priorities. Through the general dissemination of the database it is hoped that some of the gaps in the database may be filled in.

1.3 Introduction

Rivers have an intimate connection with rural economies in developing countries because they ramify so extensively amongst rural communities to the extent that so many villages rely upon them as both a major water supply and a major supply of animal protein in the form of fish. Planned economic development is a predominant feature of most international funding projects and of national development programmes, and this has been particularly evident in the number of integrated river basin development projects which are being planned and implemented. In such planning it is essential that each sectoral activity can be evaluated and its potential worth to the community factored into the plan. In the evaluation of resources of a river basin, the significance of fisheries needs to be taken into account.

River fisheries are notoriously difficult to assess owing to their diffuse nature. The fact that rivers and their tributaries can spread out over such vast areas means that, whilst so many people can benefit from their proximity, it is equally difficult to assess the scale of exploitation, since so many subsistence and part-time fishermen fish purely for their own consumption and the fish goes straight from the river to the household without ever touching a market or recognisable centre of trade. Lakes, by contrast, are more circumscribed and often require specialised equipment, such as a boat, for their proper exploitation, which themselves can be enumerated. The linear nature of rivers makes them susceptible to all manner of gears which are not dependent upon boats, particularly the smaller tributaries. It is this difficulty of assessment which makes river fisheries so difficult to include in the planning process.

Planning estimates often require only an indication of the order of magnitude of the contribution by sector. This can establish the scale of the contribution of the sector and to some extent its scope for development in future. In the case of tropical lakes the establishment of the most probable magnitude of fish production was greatly enhanced by the recognition that a relationship existed between a feature termed the morpho-edaphic index (MEI) and fish catch (Henderson and Welcomme 1974). The MEI is the ratio of what is effectively the inorganic nutrient concentration (as total dissolved solids or conductivity) to mean depth. The relationship suggests that the higher the nutrient concentration and the shallower the depth, the higher is the fish yield (Payne 1986). However, the basis of production in rivers is different to that in lakes, rendering this index rather less appropriate for catch assessment in rivers.

In an attempt to define a simple predictive relationship for rivers which might provide order of magnitude estimates of fish catches, Welcomme (1974) took the limited amount of data available from African rivers for analysis. He found that there was little relation between edaphic factors, such as conductivity or pH and catch, but did find highly significant positive relationships with physical features, such as river basin area and river length. This may well reflect the rather more important role that inputs from the terrestrial system play compared to autochthonous phytoplanktonic productivity of lakes in the productivity of rivers. The relationships obtained indicated the scale of catch to be expected in the basin area or total river length was known. It did concern Welcomme (1974), however that most of the data was obtained from the larger, higher order rivers and that predictions were rather underestimated since they did not take into account exploitation of the lower order streams at a subsistence level, which could account for 65% of the total catch.

The predictive relationships obtained by Welcomme (1974) have been used to give indications of the yield from river systems, not only in Africa but in other parts of the tropics such as South America (eg Bayley and Petrere 1981). More recently, the data on river catches and characteristics from all African inland waters, including rivers have been compiled into source books. (Van den Bosche and Bernacsek 1990a, 1990b and 1991) whilst information on socio-economic characteristics in Africa have been similarly compiled (Bonzon and Horemans 1988). Based upon these more extensive compilations Crul (1992a) reworked the analyses for both African lakes (cf Henderson and Welcomme 1974) and rivers (Welcomme 1974) and was able to refine the original findings. The type of relationships remain essentially unchanged, however.

One essential step forward however, has been the compilation of all physical and edaphic factors of African rivers into a single database (Crul 1992b). Whilst based upon the African source books this is a databank based on d BASE IV software, with information on morphometric characteristics, limnology and fisheries of more than 1000 African lakes, rivers, swamps and coastal lagoons. This is a planning tool in its own right. Over twenty years, therefore, the inland fisheries data of Africa has been collected, sifted and, to an extent, analysed.

This is not true for other parts of the tropics. In a review of fisheries over a wide range of tropical rivers (Payne and Temple 1992), the lack of systematic data compilation and planning estimates over other parts of the tropics was noted. The present project is concerned with summarising such data into a database which can then be used to develop simple predictive relationships comparable with those determined for African rivers. At present those relationships have been used for rivers on other continents, such as South America (Bayley and Petrere 1989) although there is no evidence that relationships found for African rivers are equally valid elsewhere.

The relationships themselves, whilst they can be treated as purely empirical, may nevertheless give some indication as to the underlying basis of productivity in tropical rivers, with the possibility that this might vary, at least by degree, from region to region.

Procedures

2.1 Sources of Information

In addition to the usual searches of the scientific literature, a wide variety of other sources have been used. Particularly productive sources of local and regional information proved to be the library of the Institute of Freshwater Ecology and the Fisheries Library of the FAO, Rome. Both possessed a wide range of regional journals as well as published and unpublished reports. We were also very generously provided with a complete copy of all personal notes on river literature collected by Dr Robin Welcomme of the FAO up to the present time and given open access to the document collection of Dr Tomi Petr, also of FAO. Many local South American reprints and reports were gleaned from the Fisheries Library of the Mision Britanica (ODA), to the Centro Desorollo Pesquero, La Paz, Bolivia and a large number were also provided directly by Dr Miguel Petrere of UNESP, Sao Paulo.

2.2 Structure of Database

The main aim in constructing the database was to facilitate the storage and retrieval of data to be used in the following analysis, and to provide a tool for use in any future assessments of river and floodplain systems. With this in mind the database is supplied with an application program which allows user to enter new data and references, edit data already stored, and output the information for use in analyses.

The database contains the full citation details of each reference examined, together with details of the data cited in each reference. One important feature of the database is that all the data stored in the data section is fully cross referenced to the source of the data in the citation section. In this way it is possible to view any aspect of the data on any river system and make comparisons between the figures derived from different sources. In the event of conflicting statistics discovered during analyses, it is possible to return to the precise source of the data to resolve questions about the provenance of the figures.

The fields included in the database were defined with regard to the most common data found in the literature search and cover morphometric, edaphic and biotic information. There are eight editable tables in the database. The citation table contains full details of the source of the data. The six data tables contain the statistics derived from each reference, together with a note field in which any information necessary for the interpretation of the statistics is held. The final table is the summary table. The summary table has been constructed with one row for each river system. The single most representative value for each of the fields in the data tables is entered into the summary table. It is the data from this table that has been used in the following analysis. The editable tables and their fields are listed below.

- **Citation**

  Contains the citation details of each reference located by the literature search. The table contains the following fields *citation reference number, year of publication, full author list,full title, full source citation,notes.*

- **River dimensions**

  Contains the dimensions of the river and floodplain if cited in the reference. The fields are *citation reference number, river basin, river/floodplain, country, year, length, drainage basin area, altitude,floodplain present,floodplain area, dimension notes.*

- **River hydrology**

  Hydrological details of the individual river systems. The fields are *citation reference number, river basin, river/floodplain, country, year, mean discharge rate,minimum seasonal discharge rate,maximum seasonal discharge rate,minimum annual water level. maximum annual water level, annual amplitude of changes in water level, start of flood season, end of flood season, duration of flood season, presence of flood regulators, hydrological notes.*

- **Water chemistry**

  Details of the river or floodplain water chemistry. The fields are *citation reference number, river basin, river/floodplain, country, year, conductivity, pH, sediment load, presence.absence of pollution, water chemistry notes.*

- **Climatic features**

  Details of river basin climate. The fields are *citation reference number, river basin, river/floodplain, country, year, start of rainy season, end of rainy season, duration of rainy season, annual rainfall, mean water temperature, mean air temperature, climatic notes.*

- **Demography**

  Demographic details of the river and floodplain basins. The fields are *citation reference number, river basin, river/floodplain, country, year, basin population, floodplain population, per capita fish consumption, number of fishermen, type of land use, percentage land use, demographic notes.*

- **Biotic features**

  Details of catch and effort statistics available in the literature. The fields are *citation reference number, river basin, river/floodplain, country, year, total annual catch, catch per unit area, effort type, biotic notes.*

- **Summary**

Summary statistics from each of the data tables. The fields are; *river basin, river/floodplain, country, year, length, drainage basin area, altitude, floodplain present, floodplain area, mean discharge rate, minimum seasonal discharge rate, maximum seasonal discharge rate, minimum annual water level, maximum annual water level, annual amplitude of changes in water level, start of flood season, end of flood season, duration of flood season, presence of flood regulators, conductivity, pH, sediment load, presence/absence of pollution, start of rainy season, end of rainy season, duration of rainy season, annual rainfall, mean water temperature, mean air temperature, basin population, floodplain population, per capita fish consumption, number of fishermen, type of land use, percentage land use, total annual catch, catch per unit area, effort type.*

The database has been constructed using a commercial database software package called R:BASE produced by Microrim.

Results

3.1 Outline of the Analysis

Since the initial database was compiled from very diverse sources containing information of varying precision, there was a preliminary need to condense and summarise the database in an attempt to obtain as homogeneous and comparable a data set as possible. The initial database remains the fullest account of the river basins and their ranges of specifications, but the summarising version was necessary to reduce each factor to a single average or representative value, in order that the rivers can be analysed numerically. (See Appendix 1.)

In order to produce simple predictive relationships, simple linear and multiple linear regressions have been used. An attempt was made to made a direct correlation of the arithmetic values but generally the numerical range of many of the factors was too great and gave an aggregation of points close to the origin. Consequently, a double logarithmic correlation of variables has been used from which the correlation coefficient and parameters of the regression line have been obtained. In a double logarithmic plot the regression equation has the following form:

$$\log y = \log a + b \log x$$

where *a* is the intercept on the *y* axis and *b* is the slope of the line. This can be transformed into the equation:

$$y = ax^b$$

This is the form of equation also used by Welcomme (1974) and Crul (1992). The results of the analyses are therefore summarised in terms of the correlation coefficient (r), the probability value (p) and the regression equation parameters *a* and *b* (Tables 3.1 and 3.2).

The analysis carried out included a limited examination of morphometric relationships of river basins but was mainly confined to deriving the relationships of total annual fish catch to physical, edaphic, hydrological and social indices.

An initial analysis on these factors was carried out on the summarised database to obtain an initial indication as to the possible significance of any relationships (Table 3.1). From the statistics produced, however, it became possible to identify outliers and extraneous points which were not homogeneous with the data sets. The fact that some points consistently lay outside the data sets was itself significant in some cases. Following this attempt, the summary database was refined and a more detailed analysis was performed on the potentially significant relationships to provide 95% confidence limits and other statistics (Table 3.2; Appendix 3). A distinction was also made between 'whole rivers', i.e. the catch from whole basins and records from any part of a river, which could include tributary or territorial records.

Finally, a multiple regression analysis incorporating those features which seemed most strongly related to fish catch was also carried out with a view to providing a relationship with a high reliability as a predictor of yields.

3.2 Morphometric Characteristics

Whilst hypothetically river basins could be any shape, from long and thin to short and wide, nevertheless they do tend to conform to certain morphometric laws. Symptomatic of this conformity is the very strong correlation between river length and basin area which appears amongst all the rivers considered here. The regression line is very similar to that obtained for African rivers by Welcomme (1974) and is close to the line derived from the equation $length = 1.4\ DBA^{0.6}$ obtained for world rivers by Leopold et al (1964) (Figure 3.11). It is possible that many of the physical geographical values used here come from the same sources as those used by Leopold et al, and may have been used in their analysis.

3.3 Catch and Physical Factors

Initially the association between annual catch and drainage basin area did not appear pronounced when all rivers were considered together (Fig. 3.2), but dissociating South American from Asian rivers showed a significant positive relationship in each case (Tables 3.1, 3.2; Fig. 3.3). However, one thing becomes immediately apparent and that is the low number of points for Asia. Of all the Asian river systems, catch records are only available for parts of the Mekong, the Ganges and the Sepik. No regression line with less than five points can be considered significant in this context.

The same pattern is apparent with regard to other physical features. There is a very significant positive correlation between catch and both river length and floodplain area for all rivers and for South American rivers in particular. Predictive equations are therefore available for catches in South American rivers once drainage basin area, river length or floodplain area is known (Table 3.2).

Definite predictive relationships can only be suggested for Asian rivers with regard to length (Table 3.2). Where sufficient data points are available equally positive relationships to those found for South American rivers emerge. The orientation of the regression line, however, is rather different. The slope (b) of the equation for catch against length for all parts of Asian rivers is 4.8 whilst the log intercept (a) is -12.01 compared to 0.7 and 1.4 respectively for South American rivers (Table 3.2). The line is much steeper in Asian rivers indicating a much greater rise in catch with increase in river length than for South American rivers. Although there are too few points to estimate significant regression lines in comparison with drainage basin area and floodplain size, a similar trend is apparent between the continents in these also. It can be seen, for example, in Fig 3.2 that the catch from the Mekong is extraordinarily large in relation to drainage basin area, compared to those from South American rivers.

3.4 Catch and Edaphic Factors

There appears to be no correlation at all between fish catch and the chemical factors of conductivity, a measure of the total dissolved salts in the water, or pH (Table 3.2). To some extent one of the difficulties of including these factors in the analysis is the variation within a river basin, which renders obtaining a representative value for the river something of a problem. Conductivity, for example, will always increase down a river system. However, the fact also remains that the range found in rivers is very limited. In the summary database the range for conductivity is from 9.4 μS in the Rio Negro to 471 μS in the Ganges. By comparison lakes span the whole range up to sea water (46000 μS) and even beyond, in the case of salt lakes. Similarly, the range for pH is from pH 4.8 in the Rio Negro to pH 8.8 in the Grand Lac floodplain of the Mekong, which again is rather more limited than the range found in lakes, where values in excess of pH 10 can be found in soda lakes.

3.5 Catch and Hydrological Features

The mean discharge rate of a river can be obtained when regular, often daily, measurements of discharge are taken in m^3sec^{-1}, which can then be averaged for a month and then eventually for the year. Sometimes this measure is multiplied up to indicate the total volume of water passing down a river in a year. It is therefore, an index of this.

A positive and highly significant relationship was shown for both South American rivers (Table 3.1, 3.2) and upon more detailed analysis, for Asian rivers. The relationship is less clear when the mean discharge for whole rivers is compared to catch rather than the estimates for individual parts of the river system, i.e. when tributaries are considered separately (Table 3.2). Presumably averaging discharge rates over the whole Amazon, for example, blurs the distinction between the tributaries, which can have very different origins in such a large basin.

TABLE 3.1 Preliminary Screening of Relationship Between Catches and Other Variables of the River Systems.

NOTES

Those with a probability of (P) of 0.05 or below were taken to be significant.
All regressions are based upon log_{10} transformed data except [1,2,3]
N - Number of observations in the sample R - Correlation coefficient
d - Deltaic floodplains excluded

KEY TO ABBREVIATIONS

dba	drainage basin area (km^2)	baspop	basin population (millions)
len	river length (km)	fmen	fishermen (numbers)
fpa	floodplain area (km^2)	sdrmax	maximum seasonal discharge rate (m^3s^{-1})
mdrate	mean discharge rate (m^3s^{-1})	CPUA	catch per unit area (kg ha^{-1})

DESCRIPTION	S.AM/ASIA/BOTH	N	R	P
catch v dba	BOTH	19	0.381	0.108
catch v dba	S.AM	14	0.776	0.001
catch v dba	ASIA	3	0.991	0.087
catch v len	BOTH	23	0.545	0.007
catch v len	S.AM	15	0.685	0.005
catch v len	ASIA	3	0.998	0.040
catch v fpa	BOTH	27	0.616	0.001
catch v fpa	S.AM	22	0.657	0.001
catch v fpa	ASIA	7	0.472	0.422
catch v mdrate	BOTH	18	0.662	0.003
catch v mdrate	S.AM	11	0.733	0.01
catch v mdrate	ASIA	7	0.634	0.119
catch v baspop	BOTH	6	0.790	0.062
CPUA v fmen	BOTH	6	0.716	0.109
CPUA v sdrmax	BOTH	5	0.816	0.092
fpa v len	BOTH	18	0.565	0.015
len v fpa/len	BOTH	18	0.133	0.598
len v dba	BOTH	29	0.697	0.000
len v dba	S.AM	21	0.682	0.001

len v dba	ASIA	8	0.758	0.029
len v dba [1]	BOTH	29	0.766	0.000
len v dba [2]	S.AM	21	0.828	0.000
len v dba [3]	ASIA	8	0.797	0.018
catch v dba v fpa	S.AM	10	0.815	0.42
catch v dba v fpa (d)	S.AM	7	0.84	0.059
catch v len v fpa	S.AM	12	0.85	0.017

TABLE 3.2 Detailed Analysis of Relationship Amongst Physical, Hydrological, Edaphic, Fisheries and Demographic Variables in South American and Asian Rivers.

NOTES

a - Any part of river (upper, middle, lower, mouth etc)
w - Whole river only (middle and upper and lower etc)
The constants of the exponential equation are given as α and β,
N - number of observations in the sample. R - Correlation coefficient
d - Deltaic flooodplains excluded
All plots are log,log

KEY TO ABBREVIATIONS

ph	pH	mdrate	mean discharge rate (m^3s^{-1})
cond	conductivity (k_{20} µmhos cm^{-1})	fmen	fishermen (numbers)
dba	drainage basin area (km^2)	baspop	basin population (millions)
len	river length (km)	sdrmax	maximum seasonal discharge rate (m^3s^{-1})
fpa	floodplain area (km^2)		

DESCRIPTION	S.AM/ASIA/BOTH	α	β	N	R	P
catch v ph	BOTH (a)	4.951	-1.258	22	0.068	0.765
catch v cond	BOTH(a)	0.398	0.276	17	0.171	0.510
catch v dba	BOTH(a)	0.204	0.688	24	0.430	0.036
catch v dba	BOTH(w)	-2.317	1.099	19	0.674	0.002
catch v dba	S.AM(w)	-1.338	0.901	15	0.761	0.001
catch v dba	S.AM(a)	-1.790	0.990	17	0.769	0.000
catch v dba	ASIA(w)	-6.777	2.075	3	0.991	0.087
catch v len	BOTH(a)	-0.416	1.265	27	0.512	0.006
catch v len	BOTH(w)	-0.898	1.416	23	0.565	0.005
catch v len	S.AM(a)	1.400	0.705	19	0.450	0.053
catch v len	S.AM(w)	0.403	0.983	17	0.551	0.022
catch v len	ASIA(a)	-12.07	4.803	8	0.893	0.003
catch v len	ASIA(w)	-10.94	4.523	4	0.962	0.038
catch v fpa	BOTH(a)	-0.127	0.977	27	0.572	0.002
catch v fpa	BOTH(w)	-1.004	1.191	18	0.665	0.003

catch v fpa	S.AM(a)	0.477	0.8077	21	0.572	0.007
catch v fpa	S.AM(w)	-0.683	1.053	13	0.657	0.015
catch v fpa	S.AM(w)(d)	0.033	0.929	10	0.648	0.043
catch v fpa	ASIA(a)	-7.295	2.596	4	0.770	0.230
catch v fpa	ASIA(w)	-6.092	2.440	3	0.990	0.089
catch v mdrate	BOTH(a)	-1.670	1.335	19	0.658	0.002
catch v mdrate	BOTH(w)	0.706	0.826	14	0.501	0.068
catch v mdrate	S.AM(a)	-0.730	1.103	11	0.734	0.010
catch v mdrate	S.AM(w)	1.284	0.649	9	0.571	0.108
catch v mdrate	ASIA(a)	-4.633	2.137	8	0.638	0.089
catch v mdrate	ASIA(w)	-5.171	2.451	5	0.773	0.126
cpua v fmen	BOTH(a)	-0.353	0.411	7	0.715	0.071
catch v baspop	BOTH(a)	5.589	-0.985	6	0.795	0.059
cpua v sdrmax	BOTH(a)	-0.003	0.367	5	0.816	0.092
fpa v len	BOTH(a)	1.598	0.836	18	0.565	0.015
fpa v len	BOTH(w)	-0.510	1.423	13	0.615	0.025
fpa v len	S.AM(w)	0.066	1.253	11	0.538	0.087
fpa v len	ASIA(w)	0.107	1.304	4	0.882	0.118
len v dba	BOTH(a)	0.370	0.508	29	0.697	0.000
len v dba	BOTH(w)	0.381	0.513	27	0.811	0.000
len v dba	S.AM(a)	0.391	0.499	23	0.680	0.000
len v dba	S.AM(w)	0.389	0.512	20	0.815	0.000
len v dba	ASIA(a)	0.526	0.489	8	0.758	0.029
len v dba	ASIA(w)	0.278	0.529	7	0.773	0.042
mdrate v fpa	BOTH(a)	2.982	0.246	12	0.215	0.502
mdrate v fpa	BOTH(w)	3.018	0.242	11	0.214	0.528
mdrate v fpa	S.AM(w)	2.856	0.307	8	0.289	0.488
mdrate v fpa	ASIA(w)	3.446	0.070	3	0.070	0.955
catch v sdrmax/min	BOTH(a)	4.020	-5.45	8	0.19	0.639
cpua v mdrate	BOTH(a)	2.969	-0.38	8	0.27	0.512
catch v dba v fpa	S.AM(w)	1.17	-0.93 1.96	7	0.84	0.087
catch v dba v fpa	S.AM(w)(d)	-2.48	0.68 0.57	10	0.81	0.022

Once again, there is a major distinction between the relationships for South America and Asia. With a slope of 2.14 compared to 1.1 and much lower intercept, the relationship shows a rather more pronounced increase in catch in Asia with increasing discharge rate.

In attempt was made to relate the relative catch (catch per unit area) with the maximum seasonal discharge rate, a feature possibly most closely related to proneness to flood. However, whilst the correlation coefficient was quite high (0.816) the few points available did not render it significant at the $p = 0.05$ level (Table 3.1).

3.6 Catch and Social Factors

Since the fish catch is taken and eaten by people, it is reasonable to consider that the numbers of fishermen operating or the numbers of potential consumers may have a bearing on the quantity of fish caught.

Relating numbers of fishermen or total basin population to fish catch did not produce a significant relationship in either case (Table 3.1). However, the number of points available were very limited, so that, whilst quite high values of r were obtained, these could not be said to be significant.

3.7 Multiple Factors

To examine the predictive ability of using more than one factor to relate to fish catch, multiple regression analyses were conducted on catch and contributions of the three physical characteristics, which are strongly related in their own right. The highest correlation was achieved with a combination of river length and floodplain area for South American rivers. The relationship with drainage basin area was improved by excluding the rivers Atrato and Catatumbo. These rivers consistently appear as outliers in the South American relationships and analysis of the residuals and the Cook statistics suggests that these rivers are not described by the same relationship as the others. These rivers together with the Orinoco all have large deltaic floodplains. However their exclusion made little difference.

3.8 Summary of Significant Predictive Relationships

From the parameters itemised in Table 3.2, the relationships given below have been found to be significant.

(i) Catch (c) in tonnes/year and drainage basin area (dba) in km^2

All rivers (South America and Asia), whole basins
$c = 0.0048\ (dba)^{1.099}$

South America, whole basins
$c = 0.046\ (dba)^{0.901}$

South America, any part of river basin area
$c = 0.016\ (dba)^{0.99}$

(ii) Catch (c) in tonnes/year and river length (L) in km

All rivers entire length
$c = 0.127(L)^{1.42}$

All rivers, any part of river
$c = 0.384\ (L)^{1.27}$

South America, entire river
$c = 2.53 (L)^{0.98}$

Asia, any part of river
$c = 10.1^{-11} (L)^{4.8}$

(iii) Catch (c) in tonnes/year and floodplain area (fpa) in km^2

All rivers, whole basin
$c = 0.99 (fpa)^{1.19}$

All rivers, any part of river
$c = 0.746 (fpa)^{0.98}$

South America, whole basin
$c = 0.108 (fpa)^{1.05}$

South America, any part of river
$c = 2.8 (fpa)^{0.81}$

South America, whole basin but deltaic rivers excluded
$c = 1.08 (fpa)^{0.93}$

(iv) Catch (c) in tonnes/year and mean discharge rate (mdr) in m^3/sec

All rivers, any part of river
$c = 0.214 (mdr)^{1.33}$

South America, any part of river
$c = 0.186 (mdr)^{1.1}$

Discussion

4.1 Use of Database

The database, compiled from very disparate sources, is an extremely useful planning tool in its own right. For all major rivers in South America and Asia it is now possible to retrieve all their recorded basic physical, chemical, hydrological, fisheries and demographic data in a condensed form (see Appendix 1). Any future work involving engineering, environmental assessment, use of water resources, or use of natural resources will be able to use such a database to rapidly provide the basic information on the appropriate river basin without recourse to the literature. The fact that the information inputs have been cross-referenced to their original sources also means that these can be referred to as required. One further point has also become clear, that much of the information in the literature is often very imprecise as to exactly where, or when, or under what conditions, the data has been collected. The note fields on the database attempt to clarify this as far as possible. It is possible that use of the database by field scientists will encourage greater discipline in recording and presenting their results.

A good deal of the literature reviewed for the database did not contain any new factual information which could be included in the database. However, since much of this literature tends not to be in the mainstream of scientific literature, bibliography of source material on tropical rivers not included in the literature of the database is provided in Appendix 3. A combination of these two sources, together also with the reference, reviewed in Payne and Temple (1992), provided an extensive overview of information on tropical rivers from all sources.

From the primary database tables a summary has been made in which all variables have been reduced to single representative values which can be manipulated for analysis. In this form it is comparable to the database on African Lakes and Rivers constructed by FAO, Rome (Crul 1992), although the number of parameters included is rather greater. The FAO African database is, in itself, built upon the initial compilation of Welcomme (1974) and the amplification of the FAO inland fisheries source books for Africa (Van den Bosche and Bernacsek 1990). Together with the database now created by MRAG, compiled information now exists for all major tropical rivers.

A rapid perusal reveals a prominent feature of the database - a large number of gaps. Nowhere is this more evident than for Asian rivers. Catches are particularly poorly represented. In the context of Southern Asia, e.g. India, Pakistan, Bangladesh, a contributory feature has certainly been the lack of a scientific basis for the fisheries services from colonial times. Concern for fisheries has been entirely revenue driven with fisheries being auctioned to the highest bidder without catch records or management measures. In contrast, a scientific basis for fisheries services in Africa was installed from the earliest times. The situation in Southern Asia is only slowly being remedied.

A further use of the database, therefore is to identify areas of inquiry or data gathering or even as an aid to deciding upon research priorities. Some gaps are relatively easily remedied. A trusty pH probe or conductivity meter in the hands of an itinerant research scientist can rapidly fill in a gap for a river for which these had previously been unrecorded. Estimation of such features as basin-wide fish catch or mean annual discharge rate, however, is rather more demanding. Even in the latter case such information often exists at some local hydrological station whose results do not get past the large pile of files in a central office or perhaps a sectional annual report. It is often worth asking in the right quarter. Essentially therefore, the database should be sufficiently flexible for common use and should be updated as more information becomes available. Given the need for GIS systems in all aspects of resource planning, the database presents an important step in this direction.

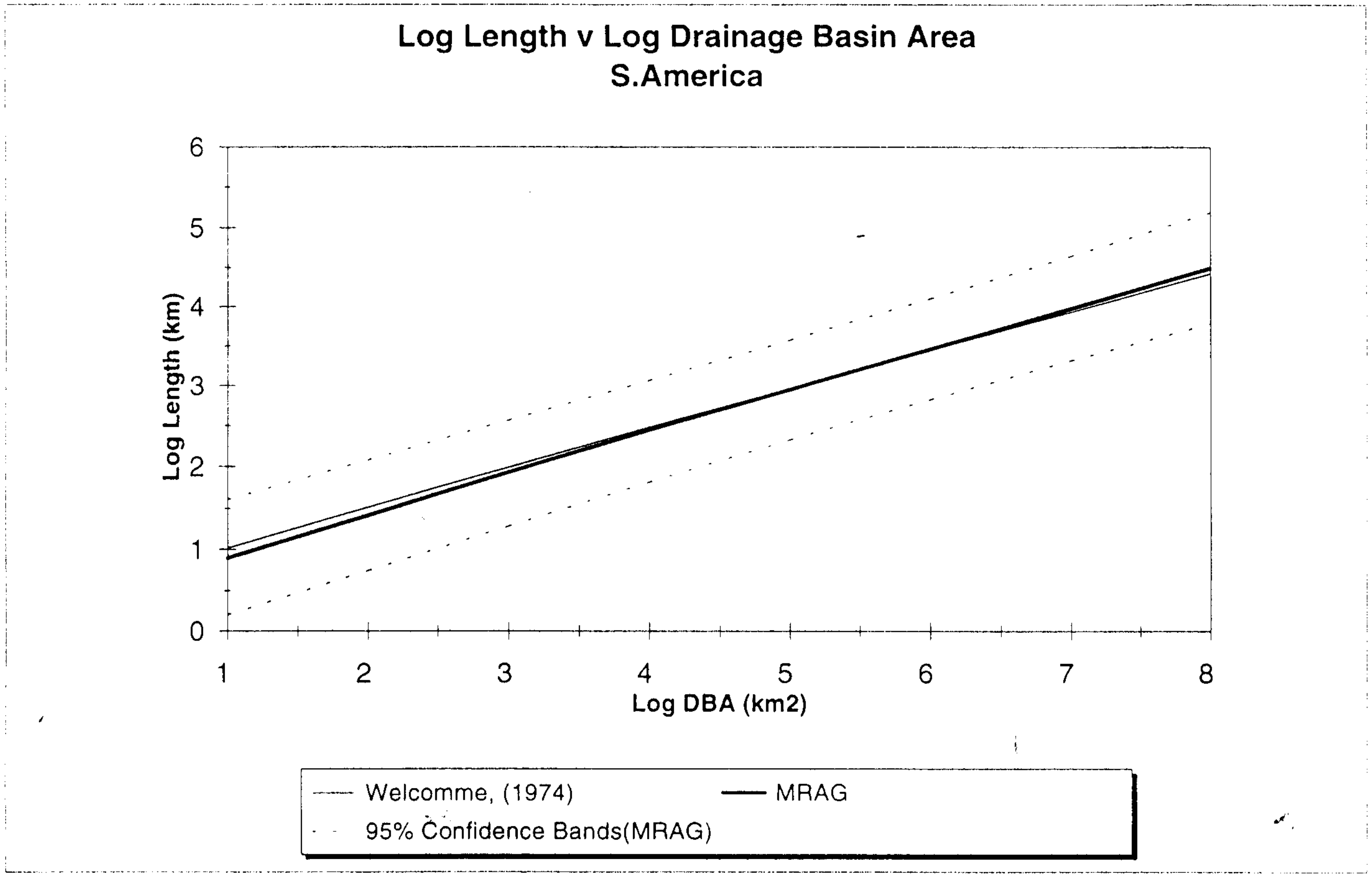

Figure 3.1
A comparison of the relationship between drainage basin area and river length for African (Welcomme, 1974) and South American rivers

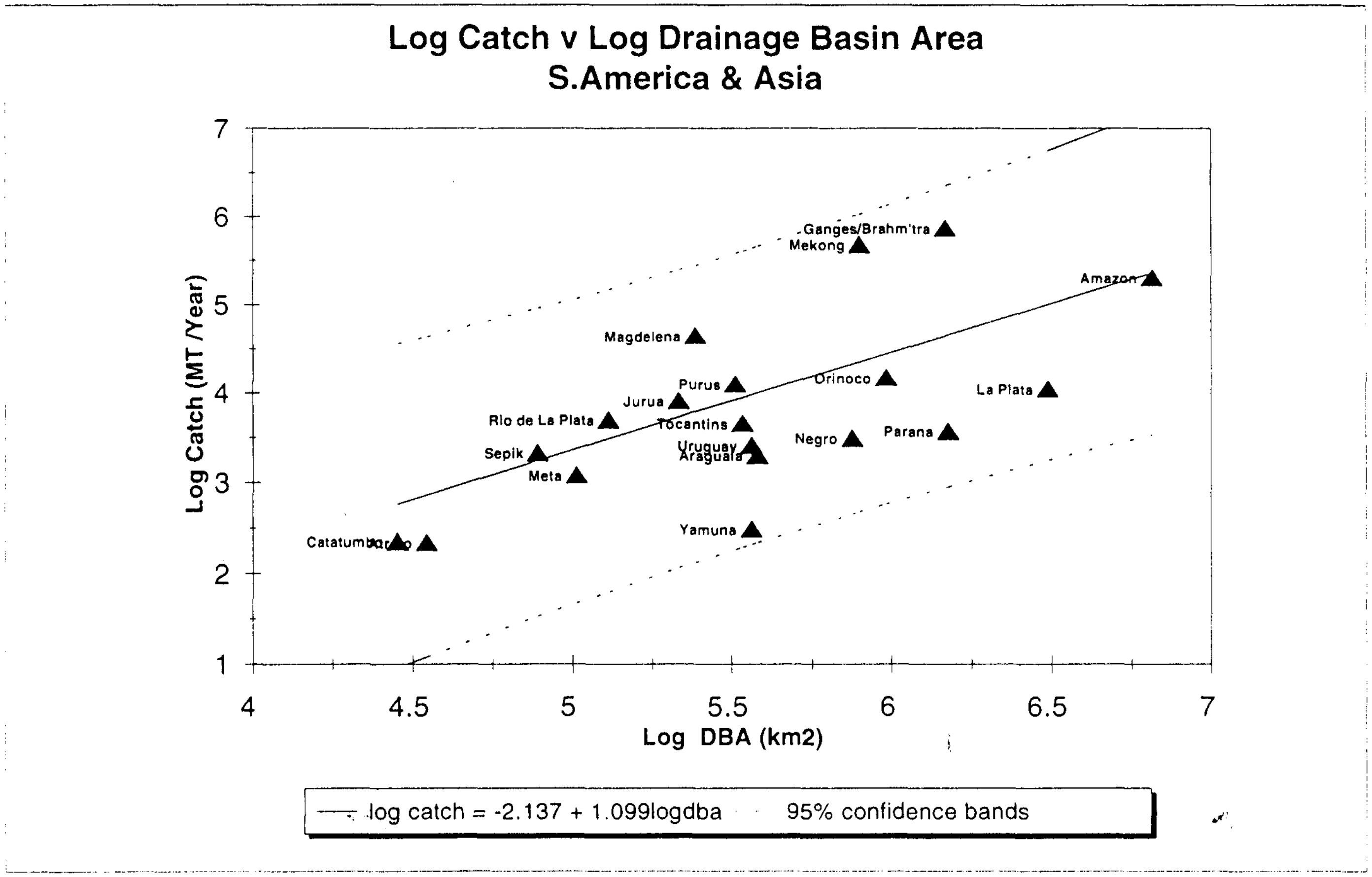

Figure 3.2
The relationship between catch and drianage basin area for all rivers in South America and Asia for which data are available

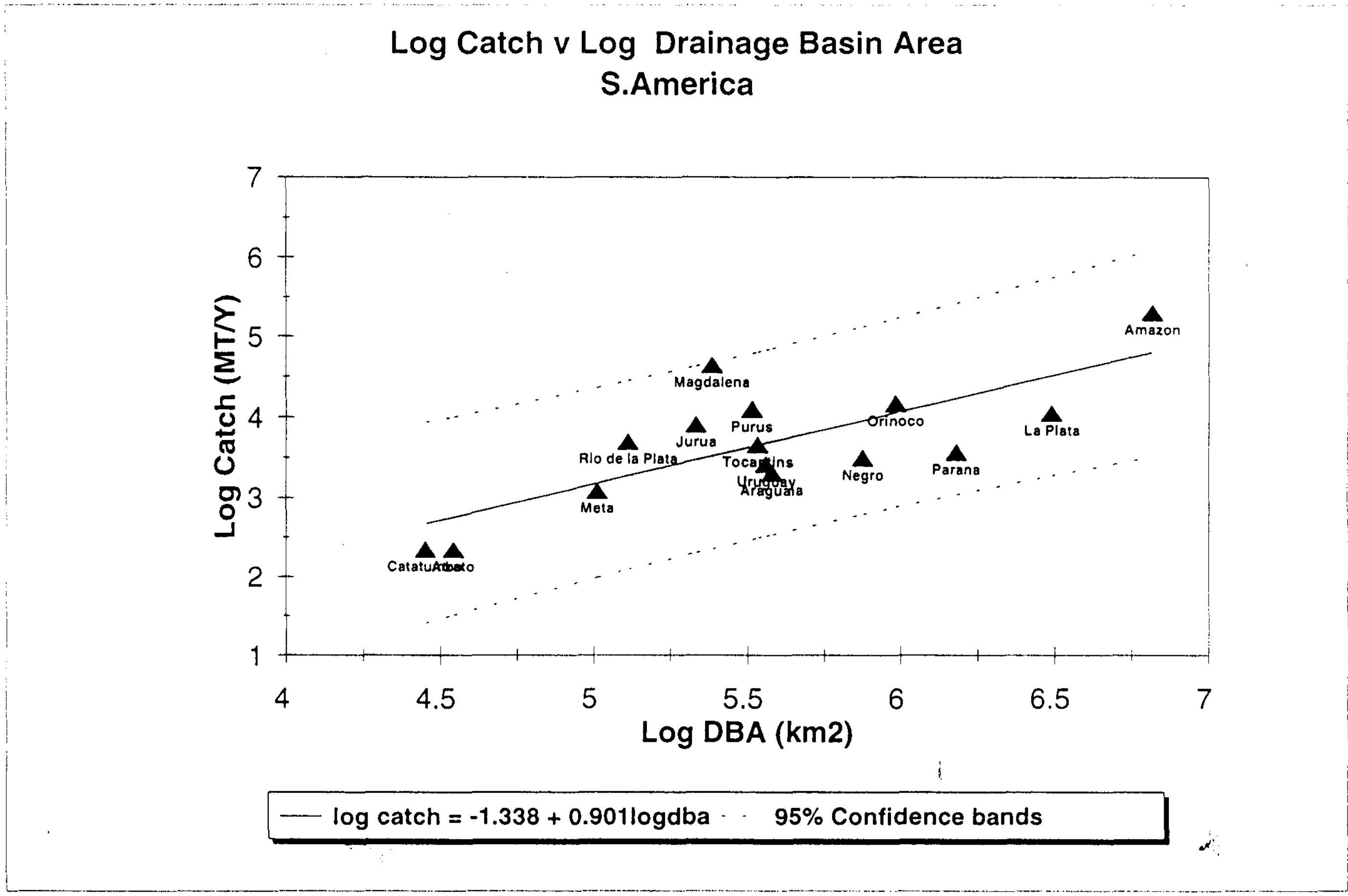

Figure 3.3
The relationship between catch and drianage basin area for all rivers in South America for which data are available

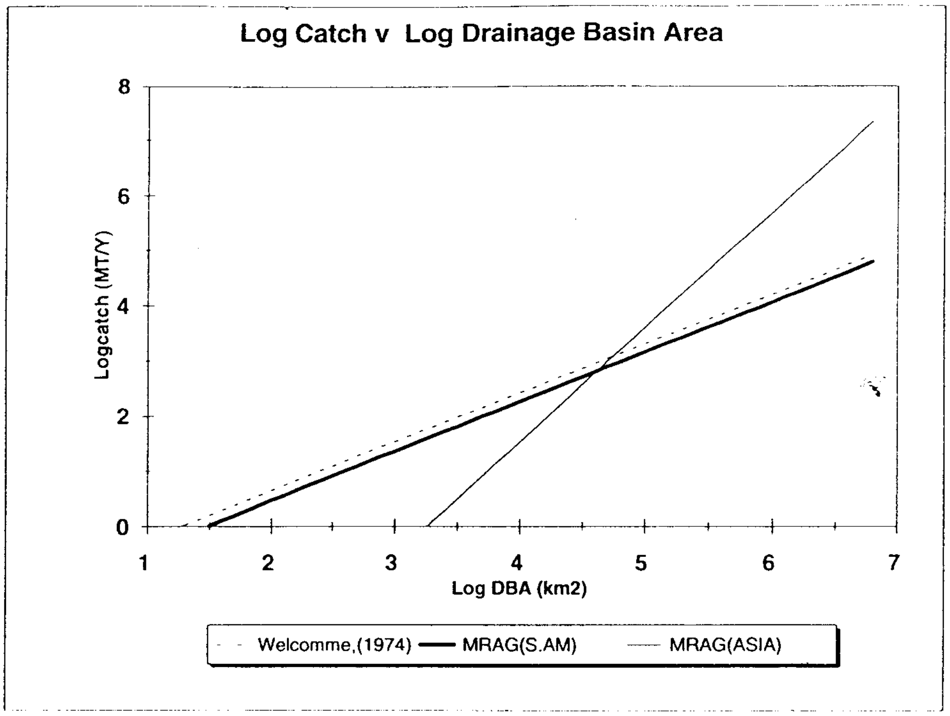

Figure 4.1
A comparison of the regression lines describing the relationship between log catch and log drainage basin area for African (Welcomme, 1974), South American and Asian rivers

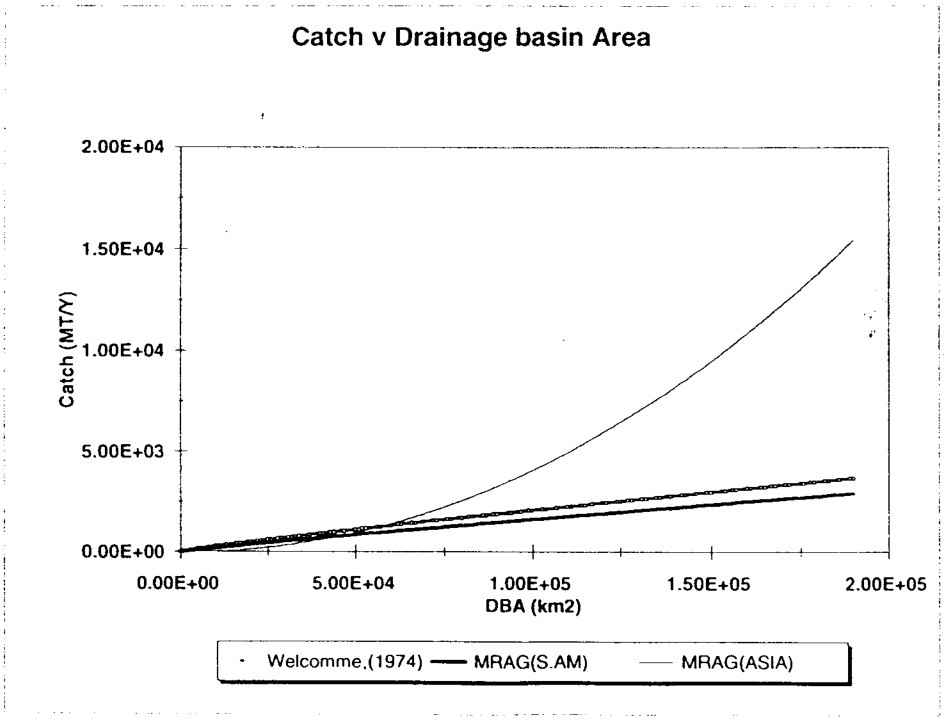

Figure 4.2
A comparison of the regression lines describing the relationship between catch and drainage basin area for African, South American and Asian rivers plotted on an arithmetic scale

4.2 The Significance of the Relationships

4.2.1 Relationships to Physical Factors

From the relationships established in Section 3 it is now possible to obtain an estimate of fish catch from a South American river, given the river length or drainage area, and also for a floodplain if its area is known. The ability to predict catches from Asian rivers presents fewer options; only for river length has a significant relationship emerged. Nevertheless, it is possible that the relationships between catch and these physical features is different to those of South American rivers.

Similar relationships between catch and these three physical dimensions have also been found for African rivers (Welcomme 1974; Crul 1992). Remarkably, that obtained by Crul (1992) for the relationship of catch to the drainage basin area for African rivers is similar to that found here for South American rivers (Fig 4.1 and 4.2). This perhaps suggests that the resources available to the fish populations are a function of the area of the basin rather than of some quality of the river itself. Bayley (1981) estimated the fish catch of the Amazon basin using the predictive relationship obtained for African rivers by Welcomme (1974). This was a considerable assumption, but the relationship found here validates that assumption to some extent. How might the apparent differences of Asian rivers be interpreted? The evidence that exists suggests that Asian rivers, particularly larger ones, have a rather greater fish catch than would be expected from South American or African standards. Much of this evidence, however, stems from the various sections of the Mekong. Possible reasons for the apparent differences could include:

(i) Asian rivers are actually more productive than those of South America or Africa;
(ii) Asian rivers are much more fully exploited than those of Africa or South America;
(iii) Recorded catch in Asia includes both subsistence and commercial catches
(iv) The results are an artefact as a result of too few points.

It is almost certainly true that some Asian rivers, for example, the floodplains of the Brahmaputra and Ganges in Bangladesh and probably the Mekong itself, are very intensively utilised. As catch estimates do take at least some recognition of subsistence fishing, this perhaps puts them ahead of production estimates of other continents, Welcomme (1974) clearly states that most of his data came from recognised landing areas, ie commercial fisheries, and that 60% of Africa fish catch probably came from lower order streams at an unrecorded subsistence level. Similarly, the catch records and fisheries in South America often target relatively few species, unlike Asia where virtually all fish are used. This also probably explains the slightly higher level of catches in the African rivers compared to those of South America (Fig 4.1). There could therefore be an element of increased exploitation and recording from some Asian rivers. This is unlikely to include the Ganges, however, since most records, e.g. Jhingran (1991), are taken from commercial landings. Recent work in Bangladesh suggests that, in fact, commercial fisheries may account for only 20-30% of the catch on the Gangetic floodplain in that country (Payne and Temple 1992), but the role of fish and fishing is different in most of India compared to Bengal. In fact much of the fish harvested from the Ganges is sent by rail to Calcutta, the 'capital' of Bengal. Subsistence fishing may, therefore, not be so great in India as in Bangladesh. The lowest point on the graph is for the Sepik river from Papua New Guinea. This river is an oddity since it exists east of Wallace's line and has a very attenuated fish fauna. A current UNDP project is looking at vacant niches for further introductions. Its production there is almost certainly disproportionately poor. It could be that the combination of the exceptionally high yield from the Mekong, with the disproportionately low one from the Sepik, gives the Asian line.

The surprising point is that irrespective of how the fish are caught, the catches appear disproportionately high in the Mekong and Ganges. The fact is that like many Asian rivers, the floodplains of the rivers are highly modified, with much being given over to rice and other crops, unlike those of Africa and South America which are relatively natural and unmodified. These modified floodplains, therefore, still maintain high rates of fish production.

The fact remains that the Mekong and/or the Ganges could be a special case. Until there are a few more points on the graph, such as the Indus, the Irrawady or the Chao Phrya, the precise orientation remains to be seen. However, because of the unknowns, it is in Asia that predictive relationships are most needed. From this point of view, therefore, it is possible to use the relationship for Asian rivers between catch and river length (Table 3.2). However, until the problem of unrepresentative data availability is solved it is probably safer to make an assumption of gross comparability and use the relationships for all rivers (Table 3.2). At present there are several ODA/MRAG projects which are examining floodplain production in Asia which will augment the catch/floodplain area relationship.

Just as it is surprising that a heavily modified floodplain, such as the Mekong, lies beyond the typical South American/African relationships for unmodified floodplains, it is equally surprising that the Rio Negro lies fully within it (Fig 3.3). The Rio Negro poses extreme environmental conditions for a river, with an exceptionally acidic pH and virtually demineralised water (see Section 3.4 above). This has always been seen as a recipe for low production, as is implicit in the subtitle of the recent book by Goulding et al. (1988), *Rio Negro - rich life in poor water*, which accentuates the diversity but plays down production. Welcomme (1974) also regards such 'black waters' as a potential deviation from standard relationships. He mentions the Zaire Oubangué in this connection, although on his graph the Oubangué falls into line with the other African rivers, just as the Rio Negro does with those of South America. The extreme edaphic conditions of the blackwater rivers, therefore, does not seem to differentiate them from the main body of rivers with regard to fish production as represented by catch.

4.2.2 The Role of Edaphic Factors

The edaphic factors, pH and conductivity bare no relationship to fish catch at all. This is consistent with the Rio Negro, a chemically extreme water conforming to the main relationship for South American rivers. Welcomme (1974) indicated that the geological mosaic of most river basins is such, that by the time the tributaries have collected into the main stem, most large rivers have a similar composition. Even so, as mentioned above, there can be considerable differences between tributaries in the same basin and between rivers, although by no means the range of variation found in lakes. There is, however, a more fundamental consideration. Conductivity is a measure of ionic concentration in the water, which in freshwater is related to the inorganic carbon reserves of bicarbonate, which is frequently the major anion. The pH is also related to this. In standing water systems driven by in situ primary production from phytoplankton, the reserves of inorganic carbon are often a major limiting factor for photosynthesis. This is why successful simple predictive models for lakes, such as the morphoedaphic index (MEI), incorporate conductivity or total dissolved solids as a factor (Payne and Temple 1992). Rivers, by contrast, are rarely driven by phytoplankton systems. They rely heavily on allochthonus material being washed into the river, or material gained from the land following flooding. In this respect, therefore, reserves of the water are immaterial, providing they are within the tolerance limits of the organisms. The crucial organisms in this respect are probably the bacterial and saprophytic organisms and those animals, including some species of fish, which reduce large pieces of organic material, such as fruits and leaves, to small pieces. It is probably no coincidence that the major proportion of the ichthyomass of many rivers consists of mud and detrital feeders, including *Prochilodus* in the La Plata system (Bowen 1988) and *Citharhinus* and *Labeo* in some of the eastward flowing rivers of Africa (Payne

1986). They are the main beneficiaries of this type of system rather than the plankton feeders. Given this situation the fact that fish catch is strongly related to drainage basin area or floodplain area takes on a biological significance. Rivers receive their material and energy inflow from basin-wide sources and, more specifically, from areas submerged on the floodplain.

4.2.3 Hydrology and the Future

To develop this further, it is perhaps one of the most significant findings of the present project, that there is a strong and positive relationship between fish catch and mean discharge rate of the river (Tables 3.1, 3.2). In the first place, this provides yet a further series of empirical predictive relationships using information often available from government hydrological services or from engineering concerns. Beyond this, however, it demonstrates a testable link between the production system and the hydrological regime. Higher rates of discharge may increase the probability of material being washed into the river from the basin and also can be linked with the tendency of the river to flood, both of which could be inclined to increase resources for fish production. There is every probability that fish production in rivers is driven by the hydrological cycle and is heavily influenced by both the amplitude and predictability of seasonal variation (Payne and Temple 1992). Mean discharge rate is a relatively crude index of the hydrological regime and will require a more detailed analysis of the interaction of more sensitive hydrological indicators with the response of various categories of fish, probably at the population level, in order to develop a more dynamic predictive model of fish production in rivers, which would also provide clear guidelines for management options, related to the preliminary attempt by Welcomme and Hagborg (1975), more than twenty years ago.

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APPENDICES

Appendix 1

Database Output

(i) List of Rivers Included in the Database

(ii) Key to Abbreviated Column Headings

(iii) Example of Primary Information for Database using La Plata River System

(iv) Database Summary

Part (i): List of Rivers Included in the Database

AMAZON
AMAZON (FP)
AMAZON (FP)(LAKES)
AMAZON (LOWER)
AMAZON (MID)
AMAZON (MID/LOWER)
AMAZON (TRIBS)
AMAZON (UPPER/MID)
AMAZON (UPPERTRIBS)
AMAZON/NEGRO
AMAZON/SOLIMOES (FP)
AMAZONAS
AMAZONAS (FP)
AMAZONAS (LOWER)
AMAZONAS (UPPER)
ANGOLA
APURE (FP)
ARAGUARI
ARAGUIA
ARAUCA
ATRATO
BANGLADESH (FP)
BENGO
BENI
BERMEJO
BRAHMAPUTRA
BRANCO
CAMBI
CATATUMBO
CAUCA
CAUIGIA
CAUVERY
CHAO-PHRYA
COARI
CUIABA
DIOMBE
EUPHRATES
GANDAK
GANGA
GANGES
GANGES (FP)
GANGES (LOWER)
GANGES (LOWER FP)
GANGES (MID)
GANGES (MIDDLE)
GANGES (TRIBS)
GANGES (UPPER)
GANGES/BRAHMAPUTRA
GHAGHARA
GODAVARI
GOMBAK
GRAND LAC
GRAND LAC/TONLE SAP
GUAPORE
GUAVIARE
ICA
INDUS
INDUS (FP)
INIRIDA
IRRAWADDY
ITACUAIUNAS
JAPURA
JAVARI
JURAS
JURU
JURUA
JURURA
JUTAI
KILUNDI
KOSI
KRISHNA
KWANZA
LA PLATA
LA PLATA (FP)
LA PLATA (LOWER)
MACHADO
MADEIRA
MADIERA
MADREDEDIOS
MAGDALENA
MAGDALENA (FP)
MAGDALENA (LOWER)
MAGDALENA (MID)
MAHANADI
MAMORE
MARANON
MARO
MEKONG
MEKONG (FP)
MEKONG (LOWER)
MEKONG (LOWER FP)
MEKONG (UPPER)
MEKONG (UPPER TRIBS)
MEKONG/TONLE SAP(FP)
META
META (UPPER)
MOGI GUASSU
MOGI GUASSU (FP)

MONG
MUN
NAPO
NARMADA
NEGRO
NEGRO (LOWER)
NEGRO (UPPER)
ORINOCO
ORINOCO (FP)
ORINOCO (MID)
ORINOCO (MID) (FP)
PARAGUAY
PARAGUAY (FP)
PARAGUAY/PARANA
PARAIBA
PARANA
PARANA (FP)
PARANA (LOWER)
PARANA (MID)
PARANA (UPPER)
PARNAIBA
PENNER
PILCOMAYO
PURARI
PURUS
RAMGANGA
RIO DE LA PLATA
RUPUNUNI
SAN JORGE
SAO FRANCISCO
SAO FRANCISCO (MOUTH)
SEPIK
SEPIK/RAMU
SHATT-AL-ARAB
SOLIMOES
SOLIMOES (FP)
SOLIMOES (L.CAMALEAO)
SOLIMOES (LOWER)
SOLIMOES (UPPER)
SOLIMOES (UPPER.TRIB
SOLIMOES/AMAZONAS
SOLIMOES/JAPURA
SON
TAPAJOS
TAPI
TEFE
TIGRE
TIGRIS
TIGRIS/EUPHRATES
TOCANTINS
TOCANTINS (LOWER)
TOCANTINS (UPPER)
TONLE SAP
TUCURI RESERVIOR
TUCURUI RESERVOIR
UCAYALI
UCAYALI/APURIMAC
URUGUAY
XINGU
YAMUNA

Part (ii): Key to Abbreviated Column Headings

Abbreviation	Description	Units
CITREF	Citation reference number	N/A
CONTINEN	Continent (eg Asia, S.America *etc*)	N/A
RBNAME	River basin name	N/A
RNAME	River Name	N/A
CNAME	Country name	N/A
YEAR	Year (to which data applies)	N/A
LEN	River length	km
DBA	Drainage basin area	km^2
R ALT	River altitude (elevation at headwaters)	m
FPA	Floodplain area	km^2
FLOODPLAIN	Floodplain present (Y/N)	N/A
NOTES	Any pertinent information	N/A
MDRATE	Mean discharge rate	m^3s^{-1}
MIN SDRATE	Minimum seasonal discharge rate	m^3s^{-1}
MAX SDRATE	Maximum seasonal discharge rate	m^3s^{-1}
MIN ANWL	Minimum annual water level	m
MAX ANWL	Maximum annual water level	m
ANN AMPWL	Annual amplitude of water level change	m
FLBEG	Start of flood period (month)	N/A
FLEND	End of flood period (month)	N/A
FL DUR	Duration of flood period	Integer (1-12)
WREGS	Flood regulators present (Y/N)	N/A
COND	Water conductivity	k_{20} μmhos cm^{-1}
PH	pH (hydrogen ion concentration)	N/A
SEDLOAD	Annual suspended sediment discharge	tonnes $year^{-1}$
POLLUT	Pollution present (Y/N)	N/A
RSBEG	Start of rainy season (month)	month
RSEND	End of rainy season (month)	month
RSDUR	Duration of rainy season	N/A
ANNRAIN	Mean annual rainfall	mm
WTEMP	Mean annual water temperature	°C
ATEMP	Mean annual water temperature	°C
BASPOP	River basin population (millions)	N/A
FPPOP	River floodplain population	N/A
PCFCONS	Per capita fish consumption	kg $year^{-1}$
FMEN	Number of fishermen	N/A
LANDUSE	Description of landuse	N/A
ANNCATCH	Total annual catch	tonnes $year^{-1}$
CPUA	Catch per unit area	kg $hectare^{-1}$
EFFORT	Type of fishing effort (subsistence (S) / commercial (C))	N/A

*Part (iii): Example of Primary Information from Database Using La Plata River System Data:*RIVER DIMENSIONS TABLE

CITREF	CONTINEN	RBNAME	RNAME	CNAME	YEAR	LEN	DBA	R_ALT	FPA	FLOODPLAIN	NOTES
15	S.AMERICA	LA PLATA	LA PLATA	ARG/BOL/BRAZ/PARAG/U	0	0	3200000	0	0	0	0
10	S.AMERICA	LA PLATA	LA PLATA	ARG/BRAZ/PARAG/URUG	0	0	2830000	0	0	0	0
112	S.AMERICA	LA PLATA	LA PLATA	ARG/BRAZ/PARAG/URUG	0	4400	3100000	0	0	0	for whole basin inc. all tribs.
115	S.AMERICA	LA PLATA	LA PLATA	ARG/BRAZ/PARAG/URUG	0	0	3200000	0	0	0	0
54	S.AMERICA	LA PLATA	LA PLATA	WHOLE BASIN	0	8300	3100000	0	0	0	0
12	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0	0.96	Y	FP AREA: not partic.extensive.
54	S.AMERICA	LA PLATA	PARAGUAY	ARG/BOL/BRAZ/PARAG	0	2500	1095000	0	0	0	0
10	S.AMERICA	LA PLATA	PARAGUAY	ARG/BRAZIL/PARAGUAY	0	2550	0	0	0	0	0
112	S.AMERICA	LA PLATA	PARAGUAY	ARG/BRAZIL/PARAGUAY	0	0	181970	0	0	0	0
1	S.AMERICA	LA PLATA	PARAGUAY	BRAZIL/BOLIVIA/PARAG	0	0	0	0	0	Y	FP AREA: includes 1.Chaco Swamps 2.Gran Pantanal (80 - 140 km2, prone to sheet flooding b/o exceptionally flat terrain, most extensive flooding in S.Am.) 3.fringing FP + internal delta (below Pantanal) 4.Swamp regions.
206	S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZIL/PARAGUAY	0	0	0	0	156000	Y	FP AREA: = value given = max. flooded area for Gran Pantanal only.
112	S.AMERICA	LA PLATA	PARAGUAY (FP)	BRAZIL	0	0	0	0	156000	Y	FP AREA: value given = max. area of Gran Pantanal only.
1	S.AMERICA	LA PLATA	PARAGUAY (FP)	BRAZIL/BOLIVIA/PARAG	0	0	0	0	90000	Y	FP AREA: value given = mean est. for Gran Pantanal only; range of ests. = 80 000- 100 000km2.
12	S.AMERICA	LA PLATA	PARAGUAY (FP)	BRAZIL/BOLIVIA/PARAG	0	0	0	0	140000	Y	FP AREA: value given = for Gran Pantanal only.
211	S.AMERICA	LA PLATA	PARAGUAY (FP)	BRAZIL/BOLIVIA/PARAG	0	0	0	0	220000	Y	FP AREA: value given = for Gran Pantanal only; area in Brazil = 139 000km2; covers 3 countries; main R's = Paraguay, Cuiaba, Taquari, Aquidauana + Miranda.
58	S.AMERICA	LA PLATA	PARAGUAY (FP)	0	0	0	0	0	10500	0	Maximum flooded area
10	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	4880	0	0	0	0	0
12	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	4880	3100000	0	0	0	0
54	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	4000	1510000	0	0	0	Significant geomorphological differences between upper reaches and lower reaches(flat lanscape wide valley)
58	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	30000	0	LENGTH: upper eaches stepped/uneven, ith rapids/falls AND low- gradient FP's. FPA; INCLUDES 20000 in middle parana with 10000 delta
61	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	4695	2800000	0	0	0	LENGTH: 809km = Brazilian territory; 483km are running waters.
1	S.AMERICA	LA PLATA	PARANA	ARG/PARAG/URUG	0	0	0	0	20000	0	0
60	S.AMERICA	LA PLATA	PARANA	ARGENTINA	0	2000	0	0	33000	0	0
112	S.AMERICA	LA PLATA	PARANA	ARGENTINA	0	0	0	0	0	Y	FP AREA: value given = max FP area; 20 000km2 = middle reaches; 100 000km2 = lower reaches. The 100000 seems improbable is it a typo of 10000
8	S.AMERICA	LA PLATA	PARANA	0	0	0	0	700	0	0	0
60	S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZIL/PARAGUAY	0	1100	0	0	33000	0	0
59	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA	0	1500	98000	0	0	0	PILCOMAYO IS A TRIBUTARY OF LA PLATA/PARANA RIVER SYSTEM
1	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	1612	230000	0	0	0	DNG.AREA: NB ref.1 gives two ests.
1	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	0	384000	0	0	0	0
10	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	2500	0	0	0	0	0
10	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	2550	0	0	0	0	0
15	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	1500	0	0	0	0	0
54	S.AMERICA	LA PLATA	RIO DE LA PLATA	ARGENTINA/URUGUAY	0	200	130000	0	0	0	0
10	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	1593	0	0	0	0	0
54	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	1600	365000	0	0	0	0
58	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	0	0	0	0	0	LENGTH: lower reaches: 1. widens + deepens before confluence with Parana Delta distributaries 2.right bank becomes flat + prone to flooding.
112	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	0	223872	0	10500	Y	FP AREA: value given = max.

RIVER HYDROLOGY TABLE

CITREF	CONTINEN	RBNAME	RNAME	CNAME	YEAR	MDRATE	MIN SDRATE	MAX SDRATE	MIN ANWL	MAX ANWL	ANN AMPWL	FLBEG	FLEND	FL DUR	WREGS	NOTES
115	S.AMERICA	LA PLATA	BERMEJO	ARGENTINA	0	354.9	0	0	0.2	4.4	4.2	0	0	0	0	WATER LEVEL at Presid. Roca. DISCHARGE: mean = 11.2 E9 m3/yr.
58	S.AMERICA	LA PLATA	LA PLATA	ARG/BRA/PARA/URU/BOL	0	23000	0	0	0	0	0	0	0	0	0	WATER LEVEL: upper reaches = v.shallow,mean depth 1.2m.
10	S.AMERICA	LA PLATA	LA PLATA	ARG/BRAZ/PARAG/URUG	0	14903	0	0	0	0	0	0	0	0	0	DISCHARGE: = 470km3/yr.
54	S.AMERICA	LA PLATA	LA PLATA	ARG/BRAZ/PARAG/URUG	0	23000	0	0	0	0	0	0	0	0	0	DISCHARGE:value given = mean of all ests (range = 23 000-25 000 m3/sec).
54	S.AMERICA	LA PLATA	PARAGUAY	ARG/BRAZIL/PARAGUAY	0	4500	0	0	0	0	0	JAN	FEB	2	0	FLOOD PERIOD: Jan-Feb = wet sn.at Gran Pantanal (headwaters).
115	S.AMERICA	LA PLATA	PARAGUAY	ARG/BRAZIL/PARAGUAY	0	0	0	0	2.1	4.6	2.5	0	0	0	0	at Formosa.
206	S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	OCT	MAR	6	0	FLOOD PERIOD: for Pantanal FP area, falling water = April to mid-June; dry sn. = mid- June to mid- Oct.
1	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	14900	6300	25130	0	0	0	0	0	0	0	SNL.DISCHARGE: value given = for mouth.
12	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	0	0	0	0	WATER LEVEL: Pantanal FP lakes = mean depth 0.5-4.0m.
54	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	13500	0	0	0	0	0	0	0	0	0	0
58	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	0	0	0	Y	WATER REGS.: several present,esp.on upper + middle reaches (see text for egs.).
61	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	0	0	0	Y	WATER REGS.: 45 existing reservoirs...more are planned..one of most intensively dammed R's of S.Am.
201	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	1987	0	0	0	0	0	0	0	0	0	Y	WATER REGS.: many HEP dams installed.. has severely altered flood cycle.
15	S.AMERICA	LA PLATA	PARANA	ARG/PARAG/URUG	0	0	0	0	0	0	0	FEB	MAR	2	0	WATER LEVEL: fluctns.in middle reaches are complicated by various tribs.; FLOOD PERIOD: Feb-Mar = period of max.levels at Santa Fe (is also the hottest period); min.levels = Aug-Sept.
115	S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZIL/PARAGUAY	0	0	0	65000	2.2	4.5	2.3	0	0	0	0	WATER LEVEL at Rosario. DISCHARGE: value given = max. during exceptnl. yrs.
59	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA	1985	237	34	668	0	0	0	DEC	APR	5	0	DISCHARGE:value given = annual mean 1984-5 at Villa Montes. WATER LEVEL: max.depth (exceptional) = 8.8m (March 1984).
59	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA	1980	199	0	0	0	0	0	DEC	APR	5	0	DISCHRGE.: value given = annual mean 1940-1980 at Villa Montes.
59	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA	1984	561	0	0	0	0	0	0	0	0	0	DISCHARGE:value given = annual mean 1983-4 at Villa Montes; mean for Feb 1983-4 = 668mm.at Villa Montes.
1	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	3900	0	0	0	0	0	0	0	0	0	0
54	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	5000	0	0	0	0	0	0	0	0	0	0
8	S.AMERICA	LA PLATA	URUGUAY	0	0	14893	0	0	0	0	0	0	0	0	0	MEAN DISCHARGE: = 47 E10 m3/yr

WATER CHEMISTRY

CITREF	CONTINENT	RBNAME	RNAME	CNAME	YEAR	COND	PH	SEDLOAD	POLLUT	NOTES
10	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	1972	0	0	1.29e+08	0	0
54	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	0	0	0	129	0	SED.LOAD:value given = at mouth; TDS = 70x10E6 t/yr.
10	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	1968	0	0	82000000	0	0
10	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	1983	0	0	92000000	0	0
58	S.AMERICA	LA PLATA	PARAGUAY	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	After confluence with Parana (until beginning of Delta) = decrease in suspended load,increases in dissolved load + biomass; has high suspended load/nutrients (cf.Upper Parana)b/o R.Bermejo.
1	S.AMERICA	LA PLATA	PARAGUAY	BRAZIL/BOLIVIA/PARAG	0	335	8.2	0	0	CONDCTVTY.: NB. ref 1 gives 2 values;chemistry of headwaters (esp.conductvty.)is dominated by atmospheric pptn.; PH: NB.ref 1 gives 2 values.
1	S.AMERICA	LA PLATA	PARAGUAY	BRAZIL/BOLIVIA/PARAG	0	69.7	6.9	0	0	CONDCTVTY.and pH: NB.ref 1 gives 2 values for each. SED.LOAD: value = 39 t/km2.
1	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	148	0	0	0	CONDCTVTY.: value given = mean for middle reaches, range = 112-184. Chemistry of headwaters (esp.condctvty.)is dominated by atmos.pptn.
12	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	17	5.8	0	0	CONDCTVTY.: mean for Pantanal FP lakes = 17-50. pH ranges 5.8-7.6
54	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	1965	88	8.6	9.68e+09	0	
58	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	Tidal effects are felt for up to 300km from R.mouth.
61	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	1988	47.6	7.4	0	0	PH & CONDCTVTY.: value given = mean for main R.upstream 1987-88.
61	S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZIL/PARAGUAY	1988	25.9	6.7	0	0	PH & CONDCTVTY.: value given = mean for FP lagoons 1987-88.
61	S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZIL/PARAGUAY	1988	55.5	7.6	0	0	PH & CONDCTVTY.: value given = mean for FP 1987-88.
61	S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZIL/PARAGUAY	1988	25.2	7	0	0	PH & CONDCTVTY.: value given = mean for FP channels 1987-88.
115	S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZIL/PARAGUAY	1964	88	7.1	0	0	CONDCTVTY. + pH: valueS given = mean at Santa Fe 1964- 1966; CONDCTVTY.: range = 40- 140; pH: range = 6.38- 8.55
59	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA	1971	960	0	0	0	CONDCTVTY: value given = annual mean (range = 541 in wet sn to 1 378 in dry sn.);TDS = v.high; calcium = 37.9-76.4 mg/l (v.high); sodium = 52-165 mg/l (v.high).
54	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	0	0	17000000	0	TDS at mouth = 8E6 t/yr.
58	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	0	0	0	0	Nutrient levels = lower than Upper Parana.
1	S.AMERICA	LA PLATA	URUGUAY	BRAZIL/URUGUAY	0	0	0	15200000	0	0

CLIMATIC FEATURES TABLE

CITREF	CONTINENT	RBNAME	RNAME	CNAME	YEAR	RSBEG	RSEND	RSDUR	ANNRAIN	WTEMP	ATEMP	NOTES
12	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0	0	19	0	WATER TEMP.: value given = mean for winter (high-water).
12	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0	0	30	0	WATER TEMP.: value given = mean for summer (rising-water).
1	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	NOV	APR	6	889	0	0	WET SN.: Nov-Apr = period with pptn. > 70mm/mnth (max. = 124mm in April); PPTN.: value given = mean for Argentina.
54	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	1988	0	0	0	0	24	0	CLIMATE: wet sn.coincides with warm sn.;2 climatic zones in basin..1.'tropical'(large part of basin,with or without dry sn.)...2.'sub-tropical'(warm + more temperate); WATER TEMP.:value given = mean of all annual ests. (range = 23-24.8); AIR TEMP: mean annual v
59	S.AMERICA	LA PLATA	PILCOMAYO	BOLIVIA	0	0	0	0	0	23.5	0	WATER TEMP.:value given = mean,all yr.at Villa Montes (range = 19-27 C).

DEMOGRAPHIC FEATURES TABLE

CITREF	CONTINENT	RBNAME	RNAME	CNAME	YEAR	BASPOP	FPPOP	PCFCONS	FMEN	LANDUSE	PCLANDUSE	NOTES
58	S.AMERICA	LA PLATA	LA PLATA (LOWER)	ARG/BRAZIL/URUGUAY	1984	0	0	0	1643	0	0	NO.F'MEN: value given = those reported 1982- 4
12	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	1987	0	0	0	15	0	0	NO.F'MEN: value given = active + professional only.
64	S.AMERICA	LA PLATA	PARAGUAY	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	GEOLOGY:large area of basin = wetlands; before confluence with Parana, R.drains Tropical Brazilian Shield; lower reaches 1.have tribs.which drain Andes Mnts. and 2.are covered by sediment, some metamorphosed; middle reaches drain Loess- and Silt-mantled Arg
64	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	GEOLOGY: much vrtn.throughout basin; upper reaches = 1.drained by Precambrian Shield and 2.covered by sediment + basalts.
58	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	GEOLOGY: in terms of geomorph. + limnol.,upper reaches are v.different to lower + middle reaches; upper reaches = rocky.
61	S.AMERICA	LA PLATA	PARANA	ARG/BRAZIL/PARAGUAY	0	0	0	0	0	0	0	BASIN POP.: one of most densely pop. basins in S. Am.
112	S.AMERICA	LA PLATA	PARANA (LOWER)	ARGENTINA	1984	0	0	0	1643	0	0	NO.F'MEN: value given = mean for lower reaches only 1945- 1984.
58	S.AMERICA	LA PLATA	URUGUAY	ARG/BRAZIL/URUGUAY	0	0	0	0	0	0	0	GEOLOGY: R.bed = predom.rocky + resembles Upper Parana.

BIOTIC FEATURES TABLE

CITREF	CONTINENT	RBNAME	RNAME	CNAME	YEAR	ANNCATCH	CPUA	EFFORT	NOTES
12	S.AMERICA	LA PLATA	CUIABA	BRAZIL	1983	5437	0	0	CATCH: value given = total landings. [inc. Pantanal??]. Curimbata: commercial fishing = Jun- Nov; 1981 CPUE = 353kg/man/day; 1982 CPUE = 216 kg/man/day; efficiency = similar to curimbata fishery of Upper Paraguay.
207	S.AMERICA	LA PLATA	CUIABA	BRAZIL	1983	1444	0	0	0
207	S.AMERICA	LA PLATA	CUIABA	BRAZIL	1982	817	0	0	0
207	S.AMERICA	LA PLATA	CUIABA	BRAZIL	1981	630	0	0	0
207	S.AMERICA	LA PLATA	CUIABA	BRAZIL	1980	1600	0	0	0
58	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	0	11119	0	C	CATCH: value given = total for Argentinian part of basin. Catch from Parana, Uruguay Rio de la plata. Does not include Paraguay and upper parana.
112	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	1984	11119	3.5	0	CATCH/AREA: value given = mean for Argentinian basin only 1946- 1984. CATCH: value given = mean 1945- 1984.
112	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	1982	0	7.5	0	CATCH/AREA: value given = mean for Argentinian basin only 1982- 1984.
58	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	0	0	0	0	CATCH: prochilodus spp. = mean est. = 73% of catch (range of ests. = 56- 98%); CPUE: mean 614.5 kg/f'man/day (range = 109- 1127.4 kg/f'man/day). Fishery based mainly on 4 - 6 year class. Generally exploitation is light
61	S.AMERICA	LA PLATA	LA PLATA	ARGENTINA	0	0	0	0	fish fauna dominated by Characiformes (42.4%) and Siluriformes (44.2%), as th.whole of S. America.
58	S.AMERICA	LA PLATA	LA PLATA (FP)	ARGENTINA	0	0	0	0	mean fish biomass in FP lagoons = 876 kg/l, range = 66- 6700 (assumes 1 count = 1 fish = 1kg).
58	S.AMERICA	LA PLATA	LA PLATA (LOWER)	ARGENTINA	1960	0	0	C	CATCH/AREA: value given = mean 1945- 84 (excl. upper Parana catch). P.platensis 73% total catch
1	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0	P. Scrofa = up to 60% total catch.
12	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	1943	58.8	625	0	fisheries well-documented b/o piracema mgtns. by curimbata; CATCH: value given = total for 1942-3 (?? curimbata only??); CATCH/AREA: value given = pdctn. in a 30km stretch of R.
12	S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	1934	61.2	0	0	CATCH: value given = mean 1929- 34.

Part (iv): Database Summary for La Plata River System Example - RIVER DIMENSIONS

CONTINENT	RBNAME	RNAME	CNAME	LEN	DBA	R_ALT	FPA
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	BANGLADESH	0	924000	0	0
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	INDIA	820	258000	0	0
ASIA	CHAO-PHRYA	CHAO-PHRYA	THAILAND	0	107793	0	0
ASIA	GANGES	GANGES	INDIA/BANG/CHINA/NEP	2490	1025500	0	0
ASIA	GANGES	GANGES (FP)	INDIA/BANGLADESH	0	0	0	0
ASIA	GANGES	GANGES (LOWER)	INDIA/BANGLADESH	470	0	0	0
ASIA	GANGES	GANGES (MIDDLE)	INDIA	1006	0	0	28800
ASIA	GANGES	GANGES (UPPER)	INDIA/CHINA/NEPAL	770	0	0	0
ASIA	GANGES	YAMUNA	INDIA	1250	366223	0	0
ASIA	GANGES/BRAHMAPUTRA	GANGES/BRAHMAPUTRA	BANGLADESH	5426	1480000	0	93000
ASIA	GOMBAK	GOMBAK	MALAYSIA	0	0	0	0
ASIA	MEKONG	GRAND LAC	KAMPUCHEA	0	11000	0	8500
ASIA	MEKONG	GRAND LAC/TONLE SAP	KAMPUCHEA/VIETNAM	0	0	0	13000
ASIA	MEKONG	MEKONG	LAO PDR	0	0	0	0
ASIA	MEKONG	MEKONG	N.E. THAILAND	0	0	0	0
ASIA	MEKONG	MEKONG	THA/LAO/VIE/KAM/CH/M	4350	793633	0	54333
ASIA	MEKONG	MEKONG (DELTA)	VIETNAM/THAILAND	0	220000	0	0
ASIA	MEKONG	MEKONG (FP)	THAILAND/LAO/KAM	0	0	0	0
ASIA	MEKONG	MEKONG (LOWER)	THAI/LAO/VIETNAM/KAM	2400	0	0	0
ASIA	MEKONG	MEKONG (UPPER)	CHINA/BURMA	1600	181000	0	0
ASIA	MEKONG	MEKONG (UPSTREAMTRIB	CHINA/BURMA/VIETNAM	0	0	0	0
ASIA	MEKONG	MEKONG/TONLE SAP(FP)	THAILAND/LAO/KAM	0	0	0	0
ASIA	MEKONG	MUN	INDONESIA	0	0	0	0
ASIA	MEKONG	TONLE SAP	KAMPUCHEA	0	0	0	0
ASIA	MEKONG	TRIBUTARIES	0	0	0	0	0
ASIA	SEPIK	SEPIK	PNG	1100	78000	0	7600
ASIA	TIGRIS/EUPHRATES	TIGRIS/EUPHRATES	IRAN/IRAQ/SYR/TUR	1900	1050000	0	50000
S.AMERICA	AMAZON	AMAZON	AMAZ.STATE	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BOL/BRAZ/COL/PERU	6511	6571882	0	157500
S.AMERICA	AMAZON	AMAZON	BOLIVIA	0	0	0	33760
S.AMERICA	AMAZON	AMAZON	BRAZIL	0	1570000	0	0
S.AMERICA	AMAZON	AMAZON	COLOMBIA	120	350000	0	0
S.AMERICA	AMAZON	AMAZON	PARA.STATE	0	0	0	21720
S.AMERICA	AMAZON	AMAZON	PERU	0	0	0	36480
S.AMERICA	AMAZON	AMAZON (FP)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	AMAZON (TRIBS)	PERU	0	0	0	0
S.AMERICA	AMAZON	AMAZON (UPPER/MID)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	AMAZONAS	BRAZIL	0	0	0	37070
S.AMERICA	AMAZON	AMAZONAS (UPPER)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	BRANCO	BRAZIL/ARGENTINA	0	0	0	11300
S.AMERICA	AMAZON	JURUA	BRAZIL	3283	217000	0	6710

S.AMERICA	AMAZON	MADEIRA	BRAZIL	0	691831	0	0
S.AMERICA	AMAZON	MAMORE	BOLIVIA/BRAZIL	1931	0	0	0
S.AMERICA	AMAZON	MARANON	PERU	1905	0	0	3950
S.AMERICA	AMAZON	NAPO	PERU	0	0	0	0
S.AMERICA	AMAZON	NEGRO	BRAZIL/COLOMBIA	2253	755000	0	7197
S.AMERICA	AMAZON	PURUS	BRAZIL	2211	327000	0	9711
S.AMERICA	AMAZON	SOLIMOES	BRAZIL	1609	0	0	49530
S.AMERICA	AMAZON	SOLIMOES (FP)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (LOWER)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER.TRIB	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES/JAPURA	BRAZIL	0	0	0	47113
S.AMERICA	AMAZON	TIGRE	PERU	0	0	0	0
S.AMERICA	AMAZON	TUCURI RESERVIOR	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	UCAYALI	PERU	0	0	0	2115
S.AMERICA	ATRATO	ATRATO	COLOMBIA	750	35000	0	5300
S.AMERICA	CATATUMBO	CATATUMBO	VENEZUELA	180	28416	0	5000
S.AMERICA	LA PATA	PILCOMAYO	BOLIVIA/PARAGUAY	1790	307000	0	0
S.AMERICA	LA PLATA	CUIABA	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0.96
S.AMERICA	LA PLATA	MOGI GUASSU (FP)	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZ/PARAG	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY/PARANA	ARG/BRAZ/PARAGUAY	0	0	0	0
S.AMERICA	LA PLATA	PARAIBA	BRAZIL	1140	57000	0	0
S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZ	1100	0	0	0
S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZ	0	0	0	0
S.AMERICA	LA PLATA	PARANA (UPPER)	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	PARNAIBA	BRAZIL	1575	362000	0	0
S.AMERICA	LA PLATA (LOWER)	PARAGUAY	ARG/BRAZ/PARAGUAY	2525	1095000	0	142000
S.AMERICA	LA PLATA (LOWER)	PARANA	ARG/BRAZ	4880	1510000	0	30000
S.AMERICA	LA PLATA (LOWER)	RIO DE PLATA	ARGENTINA	200	130000	0	0
S.AMERICA	LA PLATA (LOWER)	URUGUAY	ARG/BRAZ/URUG	1693	365000	0	10500
S.AMERICA	LA PLATA (LOWER)	WHOLE SYSTEM	ARG/BRA/BOL/PAR/URAG	4400	3100000	0	0
S.AMERICA	MAGDALENA	MAGDALENA	COLOMBIA	1534	243866	0	20000
S.AMERICA	MAGDALENA	MAGDALENA (FP)	COLOMBIA	0	0	0	0
S.AMERICA	META	META	COLOMBIA	1114	103000	0	0
S.AMERICA	META	META (UPPER)	COLOMBIA	0	0	0	0
S.AMERICA	ORINOCO	APURE (FP)	VENEZUELA	0	0	0	1225
S.AMERICA	ORINOCO	ORINOCO	VENEZUELA/COLOMBIA	2140	963333	0	90000
S.AMERICA	ORINOCO	ORINOCO (FP)	VENEZUELA	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO (MID)	VENEZUELA	0	0	0	0
S.AMERICA	PURARI	PURARI	PNG	630	33670	0	0
S.AMERICA	RUPUNUNI	RUPUNUNI	GUYANA	0	800	0	6500
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO	BRAZIL	2780	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (LOWER)	BRAZIL	0	0	0	2000
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (MOUTH)	BRAZIL	0	0	0	0
S.AMERICA	TAPAJOS	TAPAJOS	BRAZIL	1992	500000	0	0

S.AMERICA	TOCANTINS	ARAGUAIA	BRAZIL	0	382000	0	0
S.AMERICA	TOCANTINS	TOCANTINS	BRAZIL	2699	343000	0	0
S.AMERICA	TOCANTINS	TOCANTINS (LOWER)	BRAZIL	0	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS (UPPER)	BRAZIL	0	0	0	0

SUMMARY TABLE - RIVER HYDROLOGY

CONTINENT	RBNAME	RNAME	CNAME	MDRATE	SDRMIN	SDRMAX	ANWLMIN	ANWLMAX	ANWLDIF	FLBEG	FLEND	FLMON	FLREGS
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	BANGLADESH	0	2680	0	0	0	0	0	0	3	0
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	INDIA	0	0	0	0	0	0	0	0	0	0
ASIA	CHAO-PHRYA	CHAO-PHRYA	THAILAND	0	32	3363	0	0	0	0	0	0	0
ASIA	GANGES	GANGES	INDIA/BANG/CHINA/NEP	18700	1170	61200	12	20	8	JUL	SEP	3	0
ASIA	GANGES	GANGES (FP)	INDIA/BANGLADESH	0	0	0	0	0	0	0	0	0	0
ASIA	GANGES	GANGES (LOWER)	INDIA/BANGLADESH	12166	0	0	0	0	0	0	0	0	0
ASIA	GANGES	GANGES (MIDDLE)	INDIA	7100	0	14158	0	0	0	0	0	0	0
ASIA	GANGES	GANGES (UPPER)	INDIA/CHINA/NEPAL	1300	188	3159	0	0	0	0	0	0	0
ASIA	GANGES	YAMUNA	INDIA	2200	115	1982	0	0	0	0	0	0	0
ASIA	GANGES/BRAHMAPUTRA	GANGES/BRAHMAPUTRA	BANGLADESH	18601	0	72460	0	0	0	JUL	SEP	0	0
ASIA	GOMBAK	GOMBAK	MALAYSIA	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	GRAND LAC	KAMPUCHEA	0	0	0	0	0	9	MAY	OCT	6	0
ASIA	MEKONG	GRAND LAC/TONLE SAP	KAMPUCHEA/VIETNAM	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG	LAO PDR	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG	N.E. THAILAND	13425	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG	THA/LAO/VIE/KAM/CH/M	0	1750	52000	0	0	0	AUG	DEC	4	0
ASIA	MEKONG	MEKONG (DELTA)	VIETNAM/THAILAND	0	0	66800	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG (FP)	THAILAND/LAO/KAM	0	0	0	0	5	0	0	0	0	0
ASIA	MEKONG	MEKONG (LOWER)	THAI/LAO/VIETNAM/KAM	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG (UPPER)	CHINA/BURMA	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG (UPSTREAMTRIB)	CHINA/BURMA/VIETNAM	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MEKONG/TONLE SAP(FP)	THAILAND/LAO/KAM	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	MUN	INDONESIA	0	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	TONLE SAP	KAMPUCHEA	2663	0	0	0	0	0	0	0	0	0
ASIA	MEKONG	TRIBUTARIES	0	0	0	0	0	0	0	0	0	0	0
ASIA	SEPIK	SEPIK	PNG	7500	4363	10963	3.02	8.38	2.46	DEC	FEB	3	0
ASIA	TIGRIS/EUPHRATES	TIGRIS/EUPHRATES	IRAN/IRAQ/SYR/TUR	1400	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	AMAZ.STATE	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BOL/BRAZ/COL/PERU	201804	89300	0	0	10	11.2	MAR	JUL	5	0
S.AMERICA	AMAZON	AMAZON	BOLIVIA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BRAZIL	120000	0	203700	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	COLOMBIA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	PARA.STATE	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	PERU	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON (FP)	BRAZIL	0	0	0	0	0	4	0	0	0	0
S.AMERICA	AMAZON	AMAZON (TRIBS)	PERU	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON (UPPER/MID)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZONAS	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZONAS (UPPER)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	BRANCO	BRAZIL/ARGENTINA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	JURUA	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	MADEIRA	BRAZIL	0	0	0	0	0	0	SEP	APR	7	0
S.AMERICA	AMAZON	MAMORE	BOLIVIA/BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	MARANON	PERU	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	NAPO	PERU	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	NEGRO	BRAZIL/COLOMBIA	53871	0	0	18	29	11.3	NOV	JUN	7	0
S.AMERICA	AMAZON	PURUS	BRAZIL	10813	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES	BRAZIL	0	0	0	0	12	10	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (FP)	BRAZIL	0	0	0	2	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (LOWER)	BRAZIL	0	0	0	0	0	0	0	0	0	0

S.AMERICA	AMAZON	SOLIMOES (UPPER)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER.TRIB	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES/JAPURA	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	TIGRE	PERU	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	TUCURI RESERVIOR	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	AMAZON	UCAYALI	PERU	0	0	0	0	0	0	0	0	0	0
S.AMERICA	ATRATO	ATRATO	COLOMBIA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	CATATUMBO	CATATUMBO	VENEZUELA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PATA	PILCOMAYO	BOLIVIA/PARAGUAY	215	34	668	0	0	0	DEC	APR	5	0
S.AMERICA	LA PLATA	CUIABA	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU (FP)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZ/PARAG	0	0	0	0	0	0	OCT	MAR	6	0
S.AMERICA	LA PLATA	PARAGUAY/PARANA	ARG/BRAZ/PARAGUAY	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARAIBA	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZ	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZ	0	0	65000	2.2	4.5	0	0	0	0	0
S.AMERICA	LA PLATA	PARANA (UPPER)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARNAIBA	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	PARAGUAY	ARG/BRAZ/PARAGUAY	4500	0	0	2.1	4.6	2.5	JAN	FEB	2	0
S.AMERICA	LA PLATA (LOWER)	PARANA	ARG/BRAZ	13500	6300	25130	0	0	2.3	FEB	MAR	2	0
S.AMERICA	LA PLATA (LOWER)	RIO DE PLATA	ARGENTINA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	URUGUAY	ARG/BRAZ/URUG	4450	0	0	0	0	0	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	WHOLE SYSTEM	ARG/BRA/BOL/PAR/URAG	23000	0	0	0	0	0	0	0	0	0
S.AMERICA	MAGDALENA	MAGDALENA	COLOMBIA	7500	3900	10000	2.6	6.7	4	APR	NOV	6	0
S.AMERICA	MAGDALENA	MAGDALENA (FP)	COLOMBIA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	META	META	COLOMBIA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	META	META (UPPER)	COLOMBIA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	ORINOCO	APURE (FP)	VENEZUELA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO	VENEZUELA/COLOMBIA	32912	7520	46200	0	0	12	JUL	OCT	4	0
S.AMERICA	ORINOCO	ORINOCO (FP)	VENEZUELA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO (MID)	VENEZUELA	0	0	0	0	0	0	0	0	0	0
S.AMERICA	PURARI	PURARI	PNG	2607	0	0	0	0	0	0	0	7	0
S.AMERICA	RUPUNUNI	RUPUNUNI	GUYANA	0	0	0	0	0	5	MAY	AUG	4	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (LOWER)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (MOUTH)	BRAZIL	2977	0	0	0	0	0	0	0	0	0
S.AMERICA	TAPAJOS	TAPAJOS	BRAZIL	7102	0	0	0	0	6.5	SEP	MAR	6	0
S.AMERICA	TOCANTINS	ARAGUAIA	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS	BRAZIL	4400	0	0	0	0	0	FEB	APR	3	0
S.AMERICA	TOCANTINS	TOCANTINS (LOWER)	BRAZIL	0	0	0	0	0	0	0	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS (UPPER)	BRAZIL	0	0	0	0	0	0	0	0	0	0

SUMMARY TABLE - WATER CHEMISTRY

CONTINENT	RBNAME	RNAME	CNAME	PH	COND	SEDLOAD
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	BANGLADESH	0	0	0
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	INDIA	7.3	150	0
ASIA	CHAO-PHRYA	CHAO-PHRYA	THAILAND	0	0	12700000
ASIA	GANGES	GANGES	INDIA/BANG/CHINA/NEP	7.9	471	1.63e+09
ASIA	GANGES	GANGES (FP)	INDIA/BANGLADESH	0	0	0
ASIA	GANGES	GANGES (LOWER)	INDIA/BANGLADESH	8	0	0
ASIA	GANGES	GANGES (MIDDLE)	INDIA	8	0	0
ASIA	GANGES	GANGES (UPPER)	INDIA/CHINA/NEPAL	8	0	0
ASIA	GANGES	YAMUNA	INDIA	8.02	0	0
ASIA	GANGES/BRAHMAPUTRA	GANGES/BRAHMAPUTRA	BANGLADESH	0	0	0
ASIA	GOMBAK	GOMBAK	MALAYSIA	6.86	36	0
ASIA	MEKONG	GRAND LAC	KAMPUCHEA	8.8	0	0
ASIA	MEKONG	GRAND LAC/TONLE SAP	KAMPUCHEA/VIETNAM	0	0	0
ASIA	MEKONG	MEKONG	LAO PDR	0	0	0
ASIA	MEKONG	MEKONG	N.E. THAILAND	0	0	0
ASIA	MEKONG	MEKONG	THA/LAO/VIE/KAM/CH/M	7.6	0	1.90e+08
ASIA	MEKONG	MEKONG (DELTA)	VIETNAM/THAILAND	0	0	0
ASIA	MEKONG	MEKONG (FP)	THAILAND/LAO/KAM	0	0	0
ASIA	MEKONG	MEKONG (LOWER)	THAI/LAO/VIETNAM/KAM	6.6	0	0
ASIA	MEKONG	MEKONG (UPPER)	CHINA/BURMA	0	0	0
ASIA	MEKONG	MEKONG (UPSTREAMTRIB	CHINA/BURMA/VIETNAM	0	0	0
ASIA	MEKONG	MEKONG/TONLE SAP(FP)	THAILAND/LAO/KAM	0	0	0
ASIA	MEKONG	MUN	INDONESIA	0	0	0
ASIA	MEKONG	TONLE SAP	KAMPUCHEA	8.2	0	0
ASIA	MEKONG	TRIBUTARIES	0	0	0	0
ASIA	SEPIK	SEPIK	PNG	7	180	0
ASIA	TIGRIS/EUPHRATES	TIGRIS/EUPHRATES	IRAN/IRAQ/SYR/TUR	0	0	0
S.AMERICA	AMAZON	AMAZON	AMAZ.STATE	0	0	0
S.AMERICA	AMAZON	AMAZON	BOL/BRAZ/COL/PERU	7.3	140	4.06e+08
S.AMERICA	AMAZON	AMAZON	BOLIVIA	0	0	0
S.AMERICA	AMAZON	AMAZON	BRAZIL	6.7	0	0
S.AMERICA	AMAZON	AMAZON	COLOMBIA	0	0	0
S.AMERICA	AMAZON	AMAZON	PARA.STATE	0	0	0
S.AMERICA	AMAZON	AMAZON	PERU	7.2	156	0
S.AMERICA	AMAZON	AMAZON (FP)	BRAZIL	6.35	0	0
S.AMERICA	AMAZON	AMAZON (TRIBS)	PERU	0	0	0
S.AMERICA	AMAZON	AMAZON (UPPER/MID)	BRAZIL	0	0	0
S.AMERICA	AMAZON	AMAZONAS	BRAZIL	0	67.8	0
S.AMERICA	AMAZON	AMAZONAS (UPPER)	BRAZIL	0	100	0
S.AMERICA	AMAZON	BRANCO	BRAZIL/ARGENTINA	6	14.9	0
S.AMERICA	AMAZON	JURUA	BRAZIL	0	0	0
S.AMERICA	AMAZON	MADEIRA	BRAZIL	6.71	84	0
S.AMERICA	AMAZON	MAMORE	BOLIVIA/BRAZIL	0	0	0
S.AMERICA	AMAZON	MARANON	PERU	6.45	136	0
S.AMERICA	AMAZON	NAPO	PERU	0	0	0
S.AMERICA	AMAZON	NEGRO	BRAZIL/COLOMBIA	4.8	9.44	1.50e+08
S.AMERICA	AMAZON	PURUS	BRAZIL	5.99	47	0
S.AMERICA	AMAZON	SOLIMOES	BRAZIL	6.95	69	0
S.AMERICA	AMAZON	SOLIMOES (FP)	BRAZIL	0	0	0
S.AMERICA	AMAZON	SOLIMOES (LOWER)	BRAZIL	0	76	0
S.AMERICA	AMAZON	SOLIMOES (UPPER)	BRAZIL	0	157	0
S.AMERICA	AMAZON	SOLIMOES (UPPER.TRIB	BRAZIL	0	0	0
S.AMERICA	AMAZON	SOLIMOES/JAPURA	BRAZIL	0	0	0
S.AMERICA	AMAZON	TIGRE	PERU	0	0	0
S.AMERICA	AMAZON	TUCURI RESERVIOR	BRAZIL	0	0	0
S.AMERICA	AMAZON	UCAYALI	PERU	7.8	286.4	0
S.AMERICA	ATRATO	ATRATO	COLOMBIA	0	0	0
S.AMERICA	CATATUMBO	CATATUMBO	VENEZUELA	0	0	0
S.AMERICA	LA PATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	960	0
S.AMERICA	LA PLATA	CUIABA	BRAZIL	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU (FP)	BRAZIL	0	0	0
S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZ/PARAG	0	0	0
S.AMERICA	LA PLATA	PARAGUAY/PARANA	ARG/BRAZ/PARAGUAY	0	0	0
S.AMERICA	LA PLATA	PARAIBA	BRAZIL	0	0	0
S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZ	7.6	37	0
S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZ	7.1	88	0
S.AMERICA	LA PLATA	PARANA (UPPER)	BRAZIL	0	0	0

S.AMERICA	LA PLATA	PARNAIBA	BRAZIL	0	0	0
S.AMERICA	LA PLATA (LOWER)	PARAGUAY	ARG/BRAZ/PARAGUAY	7.55	175	0
S.AMERICA	LA PLATA (LOWER)	PARANA	ARG/BRAZ	7.2	94.5	96800000
S.AMERICA	LA PLATA (LOWER)	RIO DE PLATA	ARGENTINA	0	0	0
S.AMERICA	LA PLATA (LOWER)	URUGUAY	ARG/BRAZ/URUG	0	0	16100000
S.AMERICA	LA PLATA (LOWER)	WHOLE SYSTEM	ARG/BRA/BOL/PAR/URAG	0	0	0
S.AMERICA	MAGDALENA	MAGDALENA	COLOMBIA	7.2	430	2.20e+08
S.AMERICA	MAGDALENA	MAGDALENA (FP)	COLOMBIA	0	0	0
S.AMERICA	META	META	COLOMBIA	0	0	0
S.AMERICA	META	META (UPPER)	COLOMBIA	0	0	0
S.AMERICA	ORINOCO	APURE (FP)	VENEZUELA	0	0	0
S.AMERICA	ORINOCO	ORINOCO	VENEZUELA/COLOMBIA	0	0	96900000
S.AMERICA	ORINOCO	ORINOCO (FP)	VENEZUELA	0	0	0
S.AMERICA	ORINOCO	ORINOCO (MID)	VENEZUELA	0	0	0
S.AMERICA	PURARI	PURARI	PNG	7.6	118	0
S.AMERICA	RUPUNUNI	RUPUNUNI	GUYANA	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO	BRAZIL	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (LOWER)	BRAZIL	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (MOUTH)	BRAZIL	0	0	6000000
S.AMERICA	TAPAJOS	TAPAJOS	BRAZIL	6.5	13.4	0
S.AMERICA	TOCANTINS	ARAGUAIA	BRAZIL	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS	BRAZIL	7.39	150	0
S.AMERICA	TOCANTINS	TOCANTINS (LOWER)	BRAZIL	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS (UPPER)	BRAZIL	0	0	0

SUMMARY TABLE - BASIN CLIMATE

CONTINENT	RBNAME	RNAME	CNAME	RSBEG	RSEND	RSDUR	ANRAIN	WTEMP	ATEMP
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	BANGLADESH	0	0	0	0	0	0
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	INDIA	0	0	0	0	0	0
ASIA	CHAO-PHRYA	CHAO-PHRYA	THAILAND	0	0	0	0	0	0
ASIA	GANGES	GANGES	INDIA/BANG/CHINA/NEP	0	0	4	1333	24.8	22.5
ASIA	GANGES	GANGES (FP)	INDIA/BANGLADESH	0	0	0	0	0	0
ASIA	GANGES	GANGES (LOWER)	INDIA/BANGLADESH	0	0	0	0	0	0
ASIA	GANGES	GANGES (MIDDLE)	INDIA	0	0	0	0	27	0
ASIA	GANGES	GANGES (UPPER)	INDIA/CHINA/NEPAL	0	0	0	0	0	0
ASIA	GANGES	YAMUNA	INDIA	0	0	0	0	25	0
ASIA	GANGES/BRAHMAPUTRA	GANGES/BRAHMAPUTRA	BANGLADESH	0	0	0	1877	0	0
ASIA	GOMBAK	GOMBAK	MALAYSIA	0	0	6	0	28	0
ASIA	MEKONG	GRAND LAC	KAMPUCHEA	0	0	5	0	0	0
ASIA	MEKONG	GRAND LAC/TONLE SAP	KAMPUCHEA/VIETNAM	0	0	0	0	0	0
ASIA	MEKONG	MEKONG	LAO PDR	0	0	0	0	0	0
ASIA	MEKONG	MEKONG	N.E. THAILAND	0	0	0	0	0	0
ASIA	MEKONG	MEKONG	THA/LAO/VIE/KAM/CH/M	0	0	5	1360	28	30
ASIA	MEKONG	MEKONG (DELTA)	VIETNAM/THAILAND	0	0	0	0	0	0
ASIA	MEKONG	MEKONG (FP)	THAILAND/LAO/KAM	0	0	0	0	0	0
ASIA	MEKONG	MEKONG (LOWER)	THAI/LAO/VIETNAM/KAM	0	0	6	1672	28.5	0
ASIA	MEKONG	MEKONG (UPPER)	CHINA/BURMA	0	0	0	0	0	0
ASIA	MEKONG	MEKONG (UPSTREAMTRIB	CHINA/BURMA/VIETNAM	0	0	0	0	0	0
ASIA	MEKONG	MEKONG/TONLE SAP(FP)	THAILAND/LAO/KAM	0	0	0	0	0	0
ASIA	MEKONG	MUN	INDONESIA	0	0	0	0	0	0
ASIA	MEKONG	TONLE SAP	KAMPUCHEA	0	0	0	0	0	0
ASIA	MEKONG	TRIBUTARIES	0	0	0	0	0	0	0
ASIA	SEPIK	SEPIK	PNG	0	0	6	3000	28	28
ASIA	TIGRIS/EUPHRATES	TIGRIS/EUPHRATES	IRAN/IRAQ/SYR/TUR	0	0	0	195.5	0	25.4
S.AMERICA	AMAZON	AMAZON	AMAZ.STATE	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BOL/BRAZ/COL/PERU	0	0	6	2350	28	27.8
S.AMERICA	AMAZON	AMAZON	BOLIVIA	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	COLOMBIA	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	PARA.STATE	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON	PERU	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON (FP)	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON (TRIBS)	PERU	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZON (UPPER/MID)	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	AMAZONAS	BRAZIL	0	0	0	2500	28.65	27
S.AMERICA	AMAZON	AMAZONAS (UPPER)	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	BRANCO	BRAZIL/ARGENTINA	0	0	0	0	0	0
S.AMERICA	AMAZON	JURUA	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	MADEIRA	BRAZIL	0	0	8	0	0	0
S.AMERICA	AMAZON	MAMORE	BOLIVIA/BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	MARANON	PERU	0	0	0	0	0	0
S.AMERICA	AMAZON	NAPO	PERU	0	0	0	0	0	0
S.AMERICA	AMAZON	NEGRO	BRAZIL/COLOMBIA	0	0	5	0	30	28.8
S.AMERICA	AMAZON	PURUS	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (FP)	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (LOWER)	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER)	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER.TRIB	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES/JAPURA	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	TIGRE	PERU	0	0	0	0	0	0
S.AMERICA	AMAZON	TUCURI RESERVIOR	BRAZIL	0	0	0	0	0	0
S.AMERICA	AMAZON	UCAYALI	PERU	0	0	0	0	0	0
S.AMERICA	ATRATO	ATRATO	COLOMBIA	0	0	0	0	0	0
S.AMERICA	CATATUMBO	CATATUMBO	VENEZUELA	0	0	0	0	0	0
S.AMERICA	LA PATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	0	0	0	23.5	0
S.AMERICA	LA PLATA	CUIABA	BRAZIL	0	0	0	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	0	24.5	0
S.AMERICA	LA PLATA	MOGI GUASSU (FP)	BRAZIL	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZ/PARAG	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY/PARANA	ARG/BRAZ/PARAGUAY	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARAIBA	BRAZIL	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZ	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZ	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARANA (UPPER)	BRAZIL	0	0	0	0	0	0
S.AMERICA	LA PLATA	PARNAIBA	BRAZIL	0	0	0	0	0	0

S.AMERICA	LA PLATA (LOWER)	PARAGUAY	ARG/BRAZ/PARAGUAY	0	0	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	PARANA	ARG/BRAZ	0	0	6	889	24	0
S.AMERICA	LA PLATA (LOWER)	RIO DE PLATA	ARGENTINA	0	0	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	URUGUAY	ARG/BRAZ/URUG	0	0	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	WHOLE SYSTEM	ARG/BRA/BOL/PAR/URAG	0	0	0	0	0	0
S.AMERICA	MAGDALENA	MAGDALENA	COLOMBIA	0	0	3	934.7	30	26.3
S.AMERICA	MAGDALENA	MAGDALENA (FP)	COLOMBIA	0	0	0	0	0	0
S.AMERICA	META	META	COLOMBIA	0	0	0	0	0	0
S.AMERICA	META	META (UPPER)	COLOMBIA	0	0	0	0	0	0
S.AMERICA	ORINOCO	APURE (FP)	VENEZUELA	0	0	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO	VENEZUELA/COLOMBIA	0	0	6	972.8	0	0
S.AMERICA	ORINOCO	ORINOCO (FP)	VENEZUELA	0	0	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO (MID)	VENEZUELA	0	0	0	0	0	0
S.AMERICA	PURARI	PURARI	PNG	0	0	0	0	0	0
S.AMERICA	RUPUNUNI	RUPUNUNI	GUYANA	0	0	4	178	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO	BRAZIL	0	0	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (LOWER)	BRAZIL	0	0	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (MOUTH)	BRAZIL	0	0	0	0	0	0
S.AMERICA	TAPAJOS	TAPAJOS	BRAZIL	0	0	0	0	28.8	0
S.AMERICA	TOCANTINS	ARAGUAIA	BRAZIL	0	0	0	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS	BRAZIL	0	0	7	1600	0	0
S.AMERICA	TOCANTINS	TOCANTINS (LOWER)	BRAZIL	0	0	0	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS (UPPER)	BRAZIL	0	0	0	0	0	0

SUMMARY TABLE - DEMOGRAHIC FEATURES

CONTINENT	RBNAME	RNAME	CNAME	BASPOP	FPPOP	PCFCONS	FMEN
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	BANGLADESH	0	0	0	0
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	INDIA	0	0	0	0
ASIA	CHAO-PHRYA	CHAO-PHRYA	THAILAND	0	0	0	0
ASIA	GANGES	GANGES	INDIA/BANG/CHINA/NEP	242	0	0	24000
ASIA	GANGES	GANGES (FP)	INDIA/BANGLADESH	0	0	0	0
ASIA	GANGES	GANGES (LOWER)	INDIA/BANGLADESH	0	2.9	0	0
ASIA	GANGES	GANGES (MIDDLE)	INDIA	200	0	0	0
ASIA	GANGES	GANGES (UPPER)	INDIA/CHINA/NEPAL	0	0	0	0
ASIA	GANGES	YAMUNA	INDIA	0	0	0	0
ASIA	GANGES/BRAHMAPUTRA	GANGES/BRAHMAPUTRA	BANGLADESH	0	0	0	0
ASIA	GOMBAK	GOMBAK	MALAYSIA	0	0	0	0
ASIA	MEKONG	GRAND LAC	KAMPUCHEA	0	0	0	0
ASIA	MEKONG	GRAND LAC/TONLE SAP	KAMPUCHEA/VIETNAM	0	0	0	0
ASIA	MEKONG	MEKONG	LAO PDR	0	0	10.2	7500
ASIA	MEKONG	MEKONG	N.E. THAILAND	0	0	11.5	215000
ASIA	MEKONG	MEKONG	THA/LAO/VIE/KAM/CH/M	0	0	25.6	0
ASIA	MEKONG	MEKONG (DELTA)	VIETNAM/THAILAND	0	0	0	0
ASIA	MEKONG	MEKONG (FP)	THAILAND/LAO/KAM	0	0	0	0
ASIA	MEKONG	MEKONG (LOWER)	THAI/LAO/VIETNAM/KAM	38	0	0	0
ASIA	MEKONG	MEKONG (UPPER)	CHINA/BURMA	0	0	0	0
ASIA	MEKONG	MEKONG (UPSTREAMTRIB	CHINA/BURMA/VIETNAM	0	0	0	0
ASIA	MEKONG	MEKONG/TONLE SAP(FP)	THAILAND/LAO/KAM	0	0	0	0
ASIA	MEKONG	MUN	INDONESIA	0	0	0	0
ASIA	MEKONG	TONLE SAP	KAMPUCHEA	0	0	0	0
ASIA	MEKONG	TRIBUTARIES	0	0	0	0	0
ASIA	SEPIK	SEPIK	PNG	0	0.0687	58.4	11400
ASIA	TIGRIS/EUPHRATES	TIGRIS/EUPHRATES	IRAN/IRAQ/SYR/TUR	8	0	0	0
S.AMERICA	AMAZON	AMAZON	AMAZ.STATE	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BOL/BRAZ/COL/PERU	6	0	0	35363
S.AMERICA	AMAZON	AMAZON	BOLIVIA	0	0	0	0
S.AMERICA	AMAZON	AMAZON	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	AMAZON	COLOMBIA	0	0	0	0
S.AMERICA	AMAZON	AMAZON	PARA.STATE	0	0	0	0
S.AMERICA	AMAZON	AMAZON	PERU	1.2	0	0	3360
S.AMERICA	AMAZON	AMAZON (FP)	BRAZIL	0	0	277	0
S.AMERICA	AMAZON	AMAZON (TRIBS)	PERU	0	0	0	0
S.AMERICA	AMAZON	AMAZON (UPPER/MID)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	AMAZONAS	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	AMAZONAS (UPPER)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	BRANCO	BRAZIL/ARGENTINA	0	0	0	0
S.AMERICA	AMAZON	JURUA	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	MADEIRA	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	MAMORE	BOLIVIA/BRAZIL	0	0	0	0
S.AMERICA	AMAZON	MARANON	PERU	0	0	0	0
S.AMERICA	AMAZON	NAPO	PERU	0	0	0	0
S.AMERICA	AMAZON	NEGRO	BRAZIL/COLOMBIA	0	0	0	247
S.AMERICA	AMAZON	PURUS	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (FP)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (LOWER)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER)	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES (UPPER.TRIB	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	SOLIMOES/JAPURA	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	TIGRE	PERU	0	0	0	0
S.AMERICA	AMAZON	TUCURI RESERVIOR	BRAZIL	0	0	0	0
S.AMERICA	AMAZON	UCAYALI	PERU	0	0	0	0
S.AMERICA	ATRATO	ATRATO	COLOMBIA	0	0	0	170
S.AMERICA	CATATUMBO	CATATUMBO	VENEZUELA	0	0	0	0
S.AMERICA	LA PATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	0	0	0
S.AMERICA	LA PLATA	CUIABA	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	0	0	0	15
S.AMERICA	LA PLATA	MOGI GUASSU (FP)	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZ/PARAG	0	0	0	0
S.AMERICA	LA PLATA	PARAGUAY/PARANA	ARG/BRAZ/PARAGUAY	0	0	0	0
S.AMERICA	LA PLATA	PARAIBA	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZ	0	0	0	0
S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZ	0	0	0	0
S.AMERICA	LA PLATA	PARANA (UPPER)	BRAZIL	0	0	0	0
S.AMERICA	LA PLATA	PARNAIBA	BRAZIL	0	0	0	0

S.AMERICA	LA PLATA (LOWER)	PARAGUAY	ARG/BRAZ/PARAGUAY	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	PARANA	ARG/BRAZ	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	RIO DE PLATA	ARGENTINA	0	0	0	1643
S.AMERICA	LA PLATA (LOWER)	URUGUAY	ARG/BRAZ/URUG	0	0	0	0
S.AMERICA	LA PLATA (LOWER)	WHOLE SYSTEM	ARG/BRA/BOL/PAR/URAG	0	0	0	1643
S.AMERICA	MAGDALENA	MAGDALENA	COLOMBIA	20	0	0	34000
S.AMERICA	MAGDALENA	MAGDALENA (FP)	COLOMBIA	0	0	0	0
S.AMERICA	META	META	COLOMBIA	0	0	0	0
S.AMERICA	META	META (UPPER)	COLOMBIA	0	0	0	0
S.AMERICA	ORINOCO	APURE (FP)	VENEZUELA	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO	VENEZUELA/COLOMBIA	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO (FP)	VENEZUELA	0	0	0	0
S.AMERICA	ORINOCO	ORINOCO (MID)	VENEZUELA	0	0	0	500
S.AMERICA	PURARI	PURARI	PNG	0.5	0.01	0	0
S.AMERICA	RUPUNUNI	RUPUNUNI	GUYANA	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO	BRAZIL	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (LOWER)	BRAZIL	0	0	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (MOUTH)	BRAZIL	0	0	0	0
S.AMERICA	TAPAJOS	TAPAJOS	BRAZIL	0	0	0	0
S.AMERICA	TOCANTINS	ARAGUAIA	BRAZIL	0	0	0	0
S.AMERICA	TOCANTINS	TOCANTINS	BRAZIL	0	0	0	12000
S.AMERICA	TOCANTINS	TOCANTINS (LOWER)	BRAZIL	0	0	0	4270
S.AMERICA	TOCANTINS	TOCANTINS (UPPER)	BRAZIL	0	0	0	0

SUMMARY TABLE - BIOTIC FEATURES

CONTINENT	RBNAME	RNAME	CNAME	ANNCATCH	CPAREA
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	BANGLADESH	0	0
ASIA	BRAHMAPUTRA	BRAHMAPUTRA	INDIA	0	0
ASIA	CHAO-PHRYA	CHAO-PHRYA	THAILAND	0	0
ASIA	GANGES	GANGES	INDIA/BANG/CHINA/NEP	681	50.5
ASIA	GANGES	GANGES (FP)	INDIA/BANGLADESH	0	50
ASIA	GANGES	GANGES (LOWER)	INDIA/BANGLADESH	0	10.4
ASIA	GANGES	GANGES (MIDDLE)	INDIA	621	25.9
ASIA	GANGES	GANGES (UPPER)	INDIA/CHINA/NEPAL	14.8	0
ASIA	GANGES	YAMUNA	INDIA	306	0
ASIA	GANGES/BRAHMAPUTRA	GANGES/BRAHMAPUTRA	BANGLADESH	727000	78.17
ASIA	GOMBAK	GOMBAK	MALAYSIA	0	0
ASIA	MEKONG	GRAND LAC	KAMPUCHEA	36000	0
ASIA	MEKONG	GRAND LAC/TONLE SAP	KAMPUCHEA/VIETNAM	35000	45
ASIA	MEKONG	MEKONG	LAO PDR	25000	0
ASIA	MEKONG	MEKONG	N.E. THAILAND	70000	0
ASIA	MEKONG	MEKONG	THA/LAO/VIE/KAM/CH/M	475000	0
ASIA	MEKONG	MEKONG (DELTA)	VIETNAM/THAILAND	200000	0
ASIA	MEKONG	MEKONG (FP)	THAILAND/LAO/KAM	82500	136
ASIA	MEKONG	MEKONG (LOWER)	THAI/LAO/VIETNAM/KAM	88000	40.74
ASIA	MEKONG	MEKONG (UPPER)	CHINA/BURMA	0	0
ASIA	MEKONG	MEKONG (UPSTREAMTRIB	CHINA/BURMA/VIETNAM	0	0
ASIA	MEKONG	MEKONG/TONLE SAP(FP)	THAILAND/LAO/KAM	225000	0
ASIA	MEKONG	MUN	INDONESIA	0	0
ASIA	MEKONG	TONLE SAP	KAMPUCHEA	20000	0
ASIA	MEKONG	TRIBUTARIES	0	0	0
ASIA	SEPIK	SEPIK	PNG	2141	0
ASIA	TIGRIS/EUPHRATES	TIGRIS/EUPHRATES	IRAN/IRAQ/SYR/TUR	0	0
S.AMERICA	AMAZON	AMAZON	AMAZ.STATE	85000	14.7
S.AMERICA	AMAZON	AMAZON	BOL/BRAZ/COL/PERU	199000	0
S.AMERICA	AMAZON	AMAZON	BOLIVIA	2690	0.8
S.AMERICA	AMAZON	AMAZON	BRAZIL	150000	0
S.AMERICA	AMAZON	AMAZON	COLOMBIA	3472	0
S.AMERICA	AMAZON	AMAZON	PARA.STATE	45612	21
S.AMERICA	AMAZON	AMAZON	PERU	52696	14.5
S.AMERICA	AMAZON	AMAZON (FP)	BRAZIL	23395	10
S.AMERICA	AMAZON	AMAZON (TRIBS)	PERU	9344	0
S.AMERICA	AMAZON	AMAZON (UPPER/MID)	BRAZIL	0	0
S.AMERICA	AMAZON	AMAZONAS	BRAZIL	22560	0
S.AMERICA	AMAZON	AMAZONAS (UPPER)	BRAZIL	21000	0
S.AMERICA	AMAZON	BRANCO	BRAZIL/ARGENTINA	706	6.3
S.AMERICA	AMAZON	JURUA	BRAZIL	8070	12
S.AMERICA	AMAZON	MADEIRA	BRAZIL	0	18.6
S.AMERICA	AMAZON	MAMORE	BOLIVIA/BRAZIL	740	0
S.AMERICA	AMAZON	MARANON	PERU	1015	0
S.AMERICA	AMAZON	NAPO	PERU	8	0
S.AMERICA	AMAZON	NEGRO	BRAZIL/COLOMBIA	3090	4.1
S.AMERICA	AMAZON	PURUS	BRAZIL	12510	13.2
S.AMERICA	AMAZON	SOLIMOES	BRAZIL	40119.3	8.1
S.AMERICA	AMAZON	SOLIMOES (FP)	BRAZIL	0	0
S.AMERICA	AMAZON	SOLIMOES (LOWER)	BRAZIL	9600	0
S.AMERICA	AMAZON	SOLIMOES (UPPER)	BRAZIL	43620	0
S.AMERICA	AMAZON	SOLIMOES (UPPER.TRIB	BRAZIL	0	0
S.AMERICA	AMAZON	SOLIMOES/JAPURA	BRAZIL	8235	2.4
S.AMERICA	AMAZON	TIGRE	PERU	58	0
S.AMERICA	AMAZON	TUCURI RESERVIOR	BRAZIL	0	0
S.AMERICA	AMAZON	UCAYALI	PERU	6380	0
S.AMERICA	ATRATO	ATRATO	COLOMBIA	220	0.41
S.AMERICA	CATATUMBO	CATATUMBO	VENEZUELA	224	0
S.AMERICA	LA PATA	PILCOMAYO	BOLIVIA/PARAGUAY	0	0
S.AMERICA	LA PLATA	CUIABA	BRAZIL	5437	0
S.AMERICA	LA PLATA	MOGI GUASSU	BRAZIL	60	6.25
S.AMERICA	LA PLATA	MOGI GUASSU (FP)	BRAZIL	0	0
S.AMERICA	LA PLATA	PARAGUAY (FP)	ARG/BRAZ/PARAG	0	11
S.AMERICA	LA PLATA	PARAGUAY/PARANA	ARG/BRAZ/PARAGUAY	0	0
S.AMERICA	LA PLATA	PARAIBA	BRAZIL	0	0
S.AMERICA	LA PLATA	PARANA (FP)	ARG/BRAZ	0	0
S.AMERICA	LA PLATA	PARANA (MID)	ARG/BRAZ	0	0
S.AMERICA	LA PLATA	PARANA (UPPER)	BRAZIL	0	0
S.AMERICA	LA PLATA	PARNAIBA	BRAZIL	0	20
S.AMERICA	LA PLATA (LOWER)	PARAGUAY	ARG/BRAZ/PARAGUAY	0	0

S.AMERICA	LA PLATA (LOWER)	PARANA	ARG/BRAZ	3679	0
S.AMERICA	LA PLATA (LOWER)	RIO DE PLATA	ARGENTINA	4960	7.5
S.AMERICA	LA PLATA (LOWER)	URUGUAY	ARG/BRAZ/URUG	2660	0
S.AMERICA	LA PLATA (LOWER)	WHOLE SYSTEM	ARG/BRA/BOL/PAR/URAG	11119	0
S.AMERICA	MAGDALENA	MAGDALENA	COLOMBIA	43932	37.5
S.AMERICA	MAGDALENA	MAGDALENA (FP)	COLOMBIA	0	0
S.AMERICA	META	META	COLOMBIA	1200	0
S.AMERICA	META	META (UPPER)	COLOMBIA	209	0
S.AMERICA	ORINOCO	APURE (FP)	VENEZUELA	1226	10
S.AMERICA	ORINOCO	ORINOCO	VENEZUELA/COLOMBIA	14762	45.3
S.AMERICA	ORINOCO	ORINOCO (FP)	VENEZUELA	0	0
S.AMERICA	ORINOCO	ORINOCO (MID)	VENEZUELA	7293	0
S.AMERICA	PURARI	PURARI	PANG	0	0
S.AMERICA	RUPUNUNI	RUPUNUNI	GUYANA	0	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO	BRAZIL	2167	0
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (LOWER)	BRAZIL	23400	117
S.AMERICA	SAO FRANCISCO	SAO FRANCISCO (MOUTH)	BRAZIL	111	0
S.AMERICA	TAPAJOS	TAPAJOS	BRAZIL	0	0
S.AMERICA	TOCANTINS	ARAGUAIA	BRAZIL	2000	0
S.AMERICA	TOCANTINS	TOCANTINS	BRAZIL	4500	0
S.AMERICA	TOCANTINS	TOCANTINS (LOWER)	BRAZIL	2695	0
S.AMERICA	TOCANTINS	TOCANTINS (UPPER)	BRAZIL	1424	0

Appendix 2

Statistics Applied to Relationships

(i) **Simple Linear regression**

Analysis of the Significance of a Simple Linear Regression

Regression Diagnostics

(ii) **Multiple Linear Regression**

Analysis of the Significance of a Multiple Linear Regression

Appendix 2: Statistics Applied to Relationships

(i) Simple Linear Regression

The functional dependence between two variables is termed a regression; simple linear regression refers to the fact that only two variables are being considered and that the relationship between the two variables is a straight line. The simplest functional relationship of one variable to another is expressed as;

$$\hat{Y} = \alpha + \beta X$$

where Y is the dependent variable
X is the independent variable
α is the constant (intercept on the Y axis where X = 0)
β is the regression coefficient (the slope of the regression line)

The regressions of the variables studied were calculated using SYSTAT 5.03. This software simultaneously produces a graphical output of the regression line (including 95% confidence limits) (see Figure A3.1) with various diagnostic plots (Figures A3.2..A3.4) and a summary of calculated regression parameters and statistics(Table A3.1) required to test the significance of the regression. This example output based upon the regression of log drainage basin area and log length for rivers in South America, and will be used throughout this first section on simple linear regression to demonstrate the methodology and analysis used in this report to select significant predictive models. In this example the regression equation gives log α = 0.389, β = 0.512.

Analysis of the significance of a regression

The coefficient of determination (r^2)

The coefficient of determination (r^2) describes the total variation in Y accounted for by the fitted regression. This statistic may be thought of as a measure of the strength (or accuracy) of the relationship, and is frequently used to compare the predictive value of relationships. In our example r^2 (multiple) is 0.66 or 66%. (Table A3.1). The value to the left of this figure is simply the square root of r^2 and is referred to as the correlation coefficient (r) This quantity provides a measure of the intensity of association between two variables. This value (among others) was used to compare the merit of relationships studied (Tables 3.1 & 3.2).

The standard error of the regression ($s_{Y.X}$)

The standard error of the regression estimate provides a measure of the accuracy with which the fitted regression function predicts the dependence of Y on X. It may also be considered as a measure of how variable we can expect the estimates to be and therefore can also be used to assess the merit or otherwise of the model. The standard error for Y is given by the square root of the residual mean square ($s^{2Y.X}$) which in the example is $\sqrt{0.058}$ = 0.24 (Table A3.1). This quantity is required for hypotheses testing (see below).

Hypotheses testing about estimated values for β

To reject the null hypothesis $H_0 : \beta = 0$, that is to say no dependence of Y on X exists and therefore to accept the alternative hypothesis $H_A: \beta \neq 0$ that some form of dependence does exist at the 95% level, the probability 'P' given for the coefficient should not exceed 0.05. This is also true for the value of 'P' given for the regression as a whole. In our example, the value for P given in Table A3.1 is well below 0.05 (0.00) allowing us to reject the null hypothesis at well below the

0.05 level. We can therefore assume that a dependent relationship exists for Y on X. For Further information on Hypotheses testing see Sokal & Rohlf, 1980, Zar, 1984)

Confidence intervals around $\hat{Y}$

Confidence intervals provide a means of predicting the value of Y for a given value of X at a given percentage level, usually taken to be 95%. 95% confidence intervals around the value for $\hat{Y}$ is given by:

$$\hat{Y} \pm t_{\alpha(2)(n-2)} s_{\hat{Y}i}$$

where α = 0.05
t = test statistic
n = number of observations
$s_{\hat{Y}i}$ = standard error of $\hat{Y}$

Confidence limits were calculated for all points on regression lines for example (see Figure A3.1) The distance from the regression line and the degree of curvature of the confidence limits provides an initial means by which to assess the predictive capacity of the regression.

Regression Diagnostics (Assumptions of Regression Analysis)

Certain basic assumptions must be satisfied in order to test validly hypotheses about regressions or to set confidence intervals for regression parameters, (Zar,1984). For each regression calculated, the following assumptions were tested by examining the appropriate graphical output from SYSTAT.

The residuals (Y_i - $\hat{Y}$) are normally distributed

If the residuals are normally distributed they fall approximately on a diagonal straight line in a plot of 'Expected Value' against the 'Residual' (see Figure A3.4). If the sample size is small, as in the example shown, the line may be quite jagged. In this instance, two data points appear extraneous, though in this case we had no theoretical grounds to exclude them from the data set.

The residuals have constant variance

This was examined by plotting the residuals against the estimated values for Y.
The residuals should be arranged in a horizontal band around zero (as in Figure A3.3). This procedure also allowed identification of values with very large residuals (outliers and extraneous points not homogenous with the data set).

The errors are independent

The residuals should be randomly scattered above and below the zero horizontal if plotted against estimated values as above. (see Figure A3.3). With the exception of two outliers this pattern may be observed in the example.

All members of the population are described by the same linear model

This was analysed by plotting Cook's distance against estimated values. Cook's distance measures the influence of each sample observation on the coefficient estimates. Observations that are far from the average of all the independent variable values or that have large residuals have a large Cook's distance value. In the example given (Figure A3.5), the plot suggested that the Catatumbo and Rio de La Plata rivers have a large influence on the coefficient estimates due to their comparatively short lengths.

(ii) Multiple Regression

The functional dependence of a variable on two or more independent variables is termed a multiple regression.
The form of the function is given by:

$$\hat{Y} = \alpha + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots + \beta_m X_m$$

where α = constant
β_1, β_2 = Partial regression coefficients (each express only part of the dependence relationship)
m = number of independent variables.

β_1 expresses how much $\hat{Y}$ would change for a unit change in X_1 if X_2 were held constant, β_2 describes the rate of change of $\hat{Y}$ as X_2 changes, with X_1 being held constant.

SYSTAT was used in the same way as for the simple linear regression described above, to calculate partial regression coefficients, the constant and the statistics used to determine the significance of the regression for a limited number of variables (see Table 3.1 & 3.2). Graphical output of the regressions are not included since they are generally misleading and difficult to interpret. An example of the statistical output obtained from a multiple regression of catch, drainage basin area and floodplain area for South American rivers is given in Table A3.2. This output is used to describe the methodology and analysis used to assess models based upon two or more independent variables.

Analysis of the significance of a multiple linear regression

The same statistics and interpretation were applied to the multiple regression output as for the simple linear regression described above with regards to r^2, r, and standard errors. In the example given, the value of r was comparatively high (0.84), although the P value for the regression exceeded the 0.05 level (0.087). If any of the partial regression coefficients are non-significant, that is, if at least one H_o: $\beta = 0$ can not be rejected due to its associated 'P' value exceeding 0.05 then the procedure is to drop the least significant variable from the regression and a new regression equation computed before deleting any other variables. In the example (Table A3.2) the value of P associated with the partial regression coefficient for logDBA exceeds 0.05 (0.243) and therefore the DBA variable should be dropped from the regression and replaced with a new variable.

Standardised partial regression coefficients

Standardised partial regression coefficients are used to indicate the relative importance of the independent variables in determining the value of the dependent variable, Y. These quantities are unitless and therefore a high value is indicative that its associated X is having a high degree of influence on Y. This parameter provided a useful criterion for selecting or rejecting independent variables. In the example, the value of the standardised coefficient for logdba is low (-0.717), thereby supporting the criteria outlined above to drop or remove this variable from the regression.

Hypotheses testing concerning partial regression coefficients

If the independent variables, X_1 & X_2 are correlated, the partial regression coefficients associated with them (b_1 & b_2) can not be assumed to reflect the dependence of Y on X_1 or Y on X_2. Such multicollinearity between independent variables may be detected within the correlation matrix of regression coefficients of the regression output (see Table A3.2) In the example, the correlation between floodplain area (FPA) and drainage basin area (DBA) was very high (-0.818) and therefore conclusions regarding the significance of the regression are likely to be spurious. When intercorrelation is present, the standard errors of the partial correlation coefficients are often large implying that they are imprecise estimates of the relationship. As a consequence, a partial regression coefficient may not be declared statistically significant as shown by T value (as a general rule, the value of T should exceed 2.0) even when X and Y are related.

TABLE A.3.1

SUMMARY OF STATISTICS FOR A SIMPLE LINEAR REGRESSION

LOGLEN v LOGDBA

VARIANCE PROPORTIONS

	1	2
CONSTANT	0.003	0.997
LOGDBA	0.003	0.997

DEP VAR: LOGLEN N:20 MULTIPLE R: 0.815 SQUARED MULTIPLE R 0.663
ADJUSTED SQUARED MULTIPLE R: .645 STANDARD ERROR OF ESTIMATE: 0.240

VARIABLE	COEFFICIENT	STD ERROR	STD COEF	TOLERANCE	T	P(2 TAIL)
CONSTANT	0.389	0.475	0.000	. 0.81	0.423	
LOGDBA	0.512	0.086	0.815	1.000	5.957	0.000

CORRELATION MATRIX OF REGRESSION COEFFICIENTS

	CONSTANT	LOGDBA
CONSTANT	1.000	
LOGDBA	-0.994	1.000

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	2.051	1	2.051	35.489	0.000
RESIDUAL	1.040	18	0.058		

TABLE A.3.2

SUMMARY OF STATISTICS FOR A FOR MULTIPLE LINEAR REGRESSION

LOGCATCH v LOGDBA v LOGFPA

VARIANCE PROPORTIONS

	1	2	3
CONSTANT	0.001	0.756	0.243
LOGDBA	0.000	0.016	0.984
LOGFPA	0.000	0.165	0.835

DEP VAR: LOGCATCH N:7 MULTIPLE R: 0.840 SQUARED MULTIPLE R: 0.705
ADJUSTED SQUARED MULTIPLE R: .558 STANDARD ERROR OF ESTIMATE: 0.462

VARIABLE	COEFFICIENT	STDERROR	STD COEF	TOLERANCE	T	P(2 TAIL)
CONSTANT	1.171	2.069	0.000	0.566	0.602	
LOGDBA	-0.933	0.681	-0.717	0.269	-1.369	0.243
LOGFPA	1.960	0.751	1.366	0.269	2.610	0.059

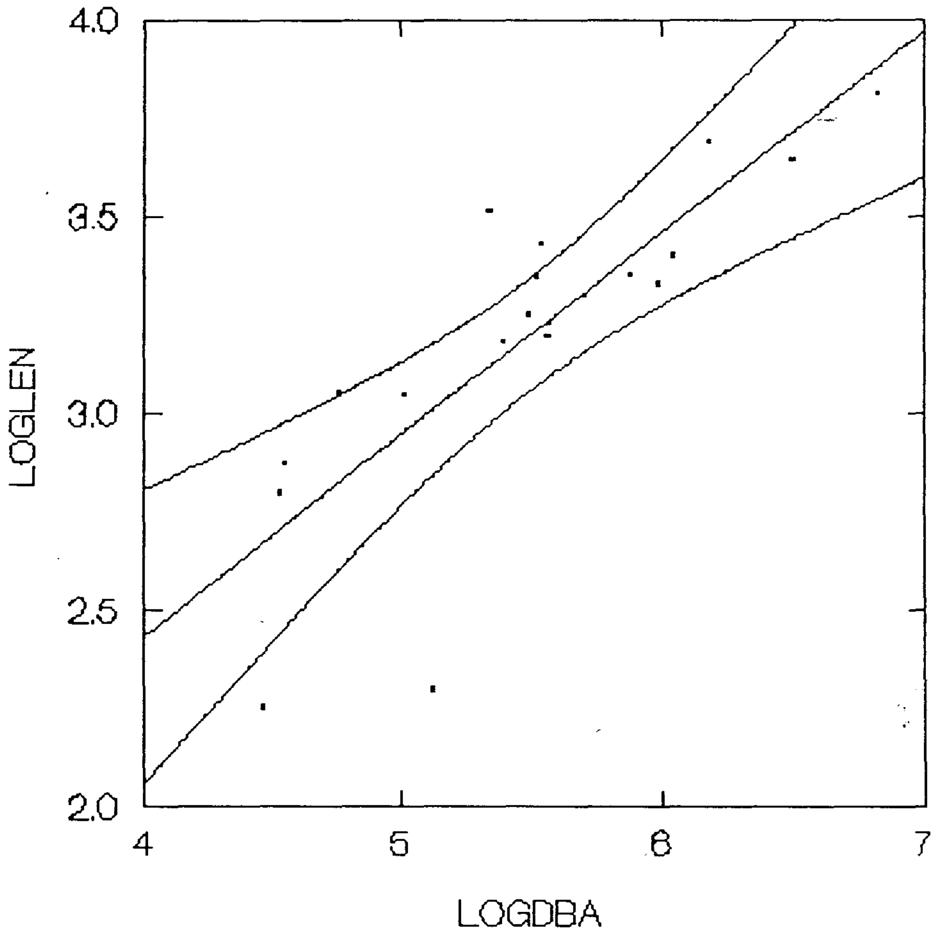
CORRELATION MATRIX OF REGRESSION COEFFICIENTS

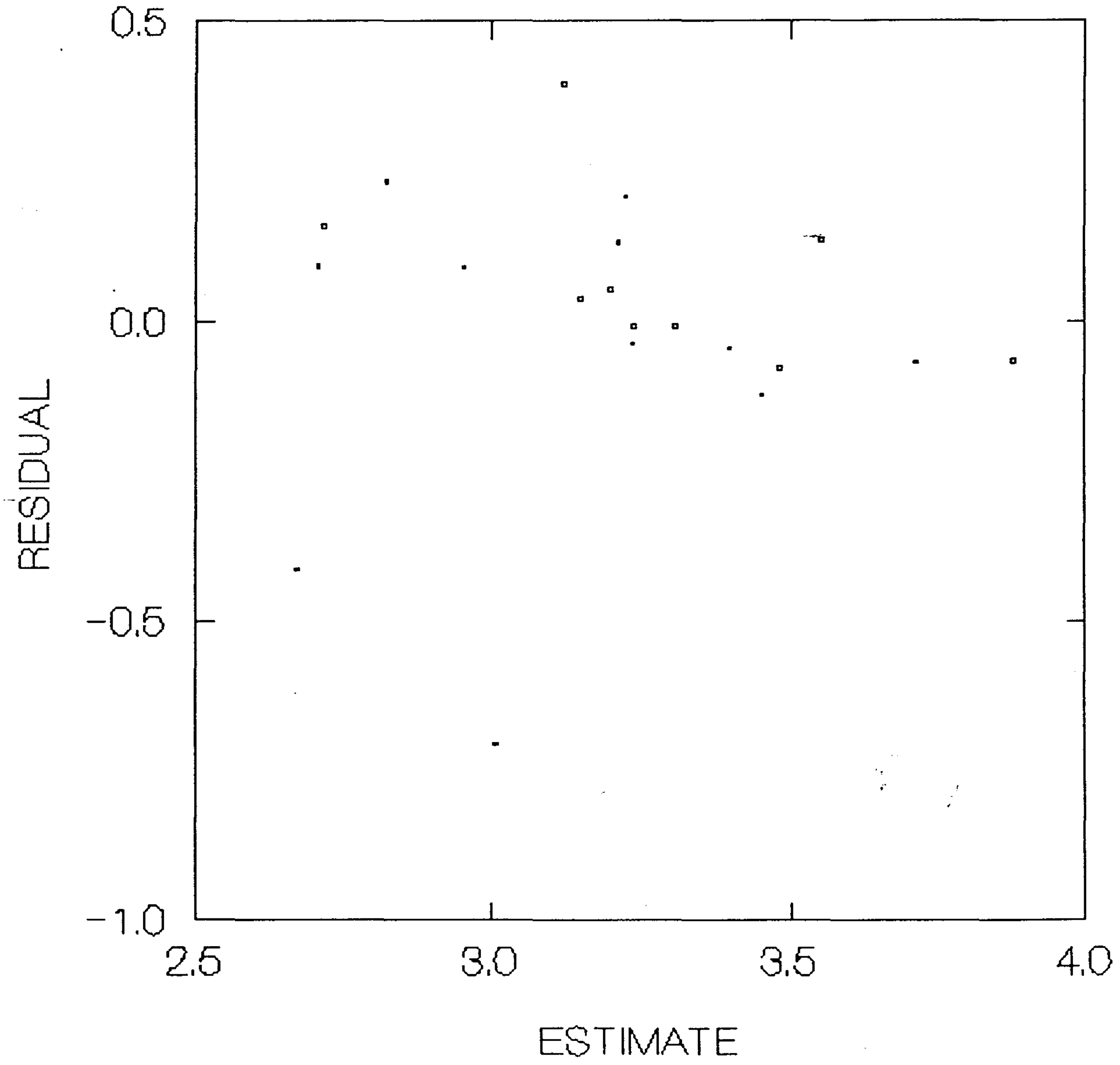
	CONSTANT	LOGDBA	LOGFPA
CONSTANT	1.000		
LOGDBA	-0.598	1.000	
LOGFPA	0.098	-0.855	1.000

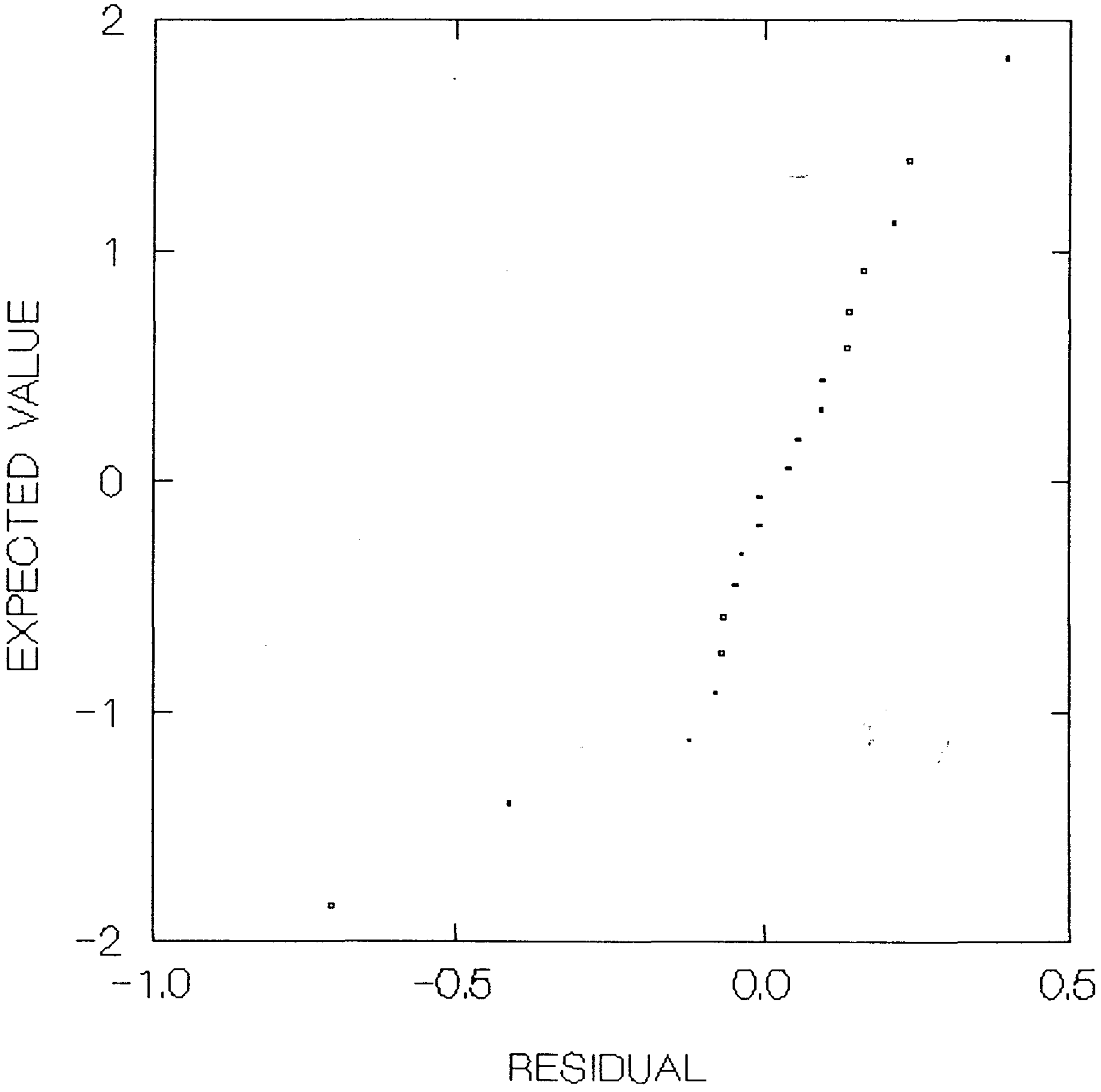
ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	2.041	2	1.021	4.791	0.087
RESIDUAL	0.852	4	0.213		

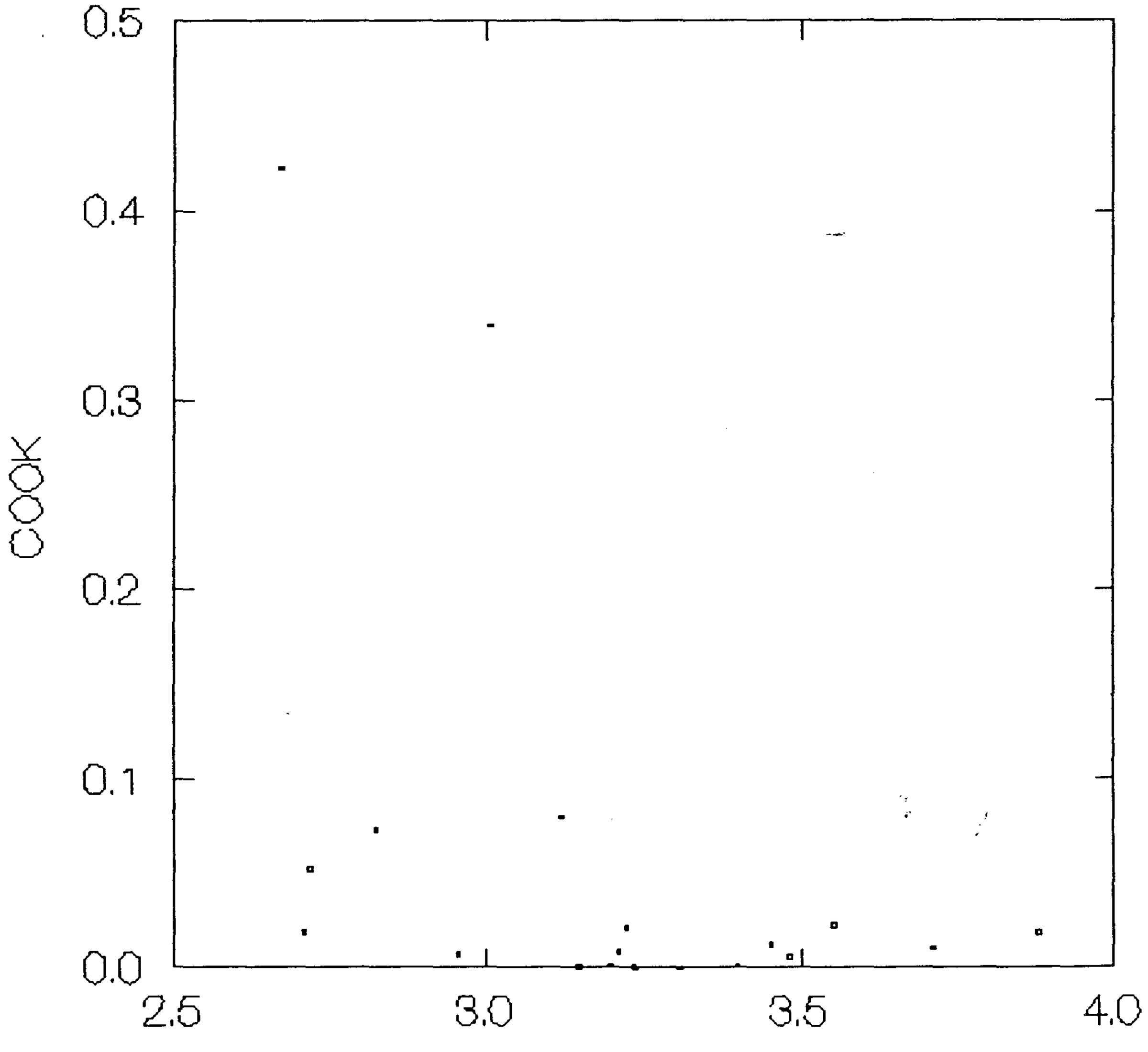
LOG length vs LOG dba [whole] (SAM)




0.5
0.0
-0.5
-1.0
RESIDUAL
2.5
3.0
3.5
4.0
ESTIMATE



2
1
0
-1
-2
EXPECTED VALUE
-1.0
-0.5
0.0
0.5
RESIDUAL



0.5
0.4
0.3
0.2
0.1
0.0
COOK
2.5
3.0
3.5
4.0
ESTIMATE

Appendix 3

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Appendix 3: Bibliography for Database

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