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WATER'S CRISIS FACTS AND MYTHS

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INTRODUCTION

A history of man's activities relating to water would constitute a relatively comprehensive history of civilization itself. Any attempt to analize the role of water in socio-economic development is not fixed but assumes different meanings at different times and locations. The objectives of development include, at a minimum, a reduction of pain and suffering are associated with factors such as inadequate water suplly and health conditions, or a reduction in what has been called illfare. Experience in programs intended to accelerate development in developing nations and lesser developed regions of developed nations has emphasized the complexity of the water management process and the uniqueness of individual national and regional situations.

Although the total amount of water on earth is generally assumed to have remained virtually constant, the rapid growth of population, together with the expansion of irrigated agriculture and industrial development, are stressing the quantity and quality aspects of natural systems. Due to these increasing problems, society has begun to realize that it can no longer follow the philosophy of **use and discard** - either with water resources or any other natural resources. Morever, a rise in per capita water withdrawal may occur while the condition of the poorest segment, which may represent a significant proportion of a population, remains unchanged or even deteriorates. As a result, the need for a consistent policy of rational management of water resources has become evident.

WATER'S CRISIS IS A RESULT OF THE LOW PROFILE USE MODELS

Rational water management should be founded upon a fully understanding of water availability and use models or traditions.

When the 20th Century began, the world was home to about 1.6 billion human inhabitants. Although water pollution and environmental degradation have been common, the problems were local. The world as a whole seemed vast, with huge regions virtually untouched by its human inhabitants. As a result, the **exponential model** of the Industrial Revolution was based on the idea that stocks of water and other natural resources were unlimited and/or unlimited were the environmental capacity to reduce impacts on water quantity and quality characteristics.

By midcentury, communications systems had begun to shrink distances and bring the peoples of the world, now 2.5 billion, into closer contact. Industrial and urban population growth have multiplied per capita consumption of natural resources - and per capita pollution- in almost all countries. As result, a **compensating model** appears, in which some rich peoples sponser good actions concerning the environmental protection, similarly to the past philosophy in which cathedrals were constructed as reparation for a deadly sin.

As the 1970s begin, the **ecological approach** induces fundamental changes, but theirs scientific basis still remain very weak. Currently, the world's environmental dilemma is that the scale on which natural resources are being consumed and wastes are being produced is already imense, in spite of that many poor countries still lack and desperately need the benefits of industralization and economic development How this dilemma should be resolved is likely to dictate our planet's prospects for the coming century.

Our human world of 6 billion must make room in a finite environment for another human world, in which the population could stabilize at 10 billion sometime next century, according to United Nations projections.

One of the most chronic problem areas involves inefficiencies in domestic water supplies and sanitation. For example, economic problems, especially those arising from external debt, have played a major role over the past two decades in constraining the ability of Brazilian government to respond to social concerns.

Initially, pollution from domestic wastes and the sanilization of irrigation systems were the major problems. To them must now be added concern about heavy metals, nitrates and organic micropollutants. Morever, many of the regional and local water supply and sanitation problems are the result of ill-planned development, lack of domestic sewage treatment, or others forms of private and public mismanagement; others arise from the combination of urbanization pressure and land use tenure problems. Thus, much untreated domestic wastewater is discharged into rivers making the water unsuitable for drinking, even after conventional treatment. Another source of desease or other health hazards is untreated waste water used to irrigate vegetables grown for urban food supplies. Serious water shortages at certain geographic locations may be simultaneously accompaigned by major flooding at other locations. Mismanagement of drought-related problems may contributed to far-reaching social and political consequences. As a result, the need for a consistent policy of rational management of water resources has become evident.

The approach must be gradually expanded in order to cover not only hydrological processes considered in interrelationship with the environment and man activities, but also the ecological aspects of multi-purpose utilization and conservation of water resources to meet the needs of economic and social development.

GLOBAL NEEDS VERSUS RESOURCES

Water resources are those that can be used by people. They include practically all the waters of Earth: river, lake, oceans, groundwater, soil moisture, etc. They may be freshwater, that is, with total dissolved solids content (TDS) less than 1.000 mg/L, or mineralized (salinated). The latter is difficult to use directly without removing the salts, an expensive and highly energy-consumptive process. An estimate of the World's water volume would reveal that saltwater of the oceans accounts for 97.3 percent of the total 1.4 billion Km^3. Although the oceans water can not be directly used as drinking water, they are important for several purposes such as navigation, cooling water supply, and mainly by regulating the environmental conditions.

Of greater immediate significance for many water-using activities are freshwater resources (2.7 percent). However, most of the continental's fresh water is contained, far from the most human populated areas, in ice caps and glaciers (29 million Km^3). Most of the fresh water with potential for use is in the form of groundwater, with estimates of the amount in storage above 4,000 meters in depth ranging between 8.4 million to 10.5 million

Km^3. At any given time, the quantitiy of water contained in fresh water lakes and streams is estimated around 0.2 million Km^3, and only 0.013 million Km^3 of water is in the atmosphere (Peixoto and Oort, 1990)

Since only a small percentage (0.009%) of world's total water is available to humans as freshwater in rivers and lakes, water-business branch has used this fact as a symptom of scarcity.

Although the above data are of general interest in defining the physical dimensions of the water resources, the fact that water use is a recurring activity means that the most significant measure of water availability is the rate at which a particular fresh water source replenishes itself through the processes of the hydrologic cycle.

Nevertheless the availability of freshwater varies widely with geographic location. Earth's water cycle is an abundant provider. The replacement times for water at various stages in the cycle differ greatly. The global average for water in rivers is 18-20 days, but the atmospheric moisture is replaced even more rapidly- every 12 days. With rivers renewing so rapidly, humans have access to more than 40,000 Km^3 per year. Deep ground water requires several hundred years or more to renew, but its average world's discharge to streams ranges between less than 10 percent in arid-semiarid zones and more than 50 percent in the humid tropical belt. Although overall river runoff in a country may be high, seasonal fluctuations can result in water scarcities during parts of the year. Thus, from an economic point of view, groundwater storage is particularly important because it remains stable over time.

Traditionally, groundwater is divided into nonrenewable reserves and renewable resources. The division is somewhat artificial because all ground water is conserved and is thus renewable, although not all on a human time scale. Thus, if the amount of water locally withdrawn from rivers and aquifers does not exceed its renewal, humans can use all sources of freshwater indefinitely. Distribution of river runoff among continents is highly variable as indicated in Table 1.

Table 1- River runoff and its use (cubic kilometers per year)

Elements	Europe	Asia	Africa	North America	South America	Ocania	U.S.S.R	World Total
Total River Runoff	2,321	10,485	3,808	6,945	10,377	2,011	4,350	40,673
Groundwater Disc. to Rivers	845	2,879	1,464	2,222	3,736	483	1,020	12,689
Surface Runoff	1,476	7,606	2,720	4,723	6,641	1,528	3,330	27,984
Year 2000 projection								
Water Withdrawal	404	2,160	289	946	293	35	533	4,660
Consumptive Use	158	1,433	201	434	165	22	286	2,699
Waste and Returning Waters	246	727	88	512	128	12	247	1,960
Use (% of total river runoff)	17	21	7	14	3	2	12	11

Source: WRI- World Resources Institute, 1990

Obviously, generalized evaluation of runoff on a continental scale as presented in Table 1 is not an adequate basis for describing the water situation in any individual nation due to significant variation in supply among nations and within individual nations. Although the above data are of general interest, total renewable supplies have been estimated to be adequate for meeting the needs of five to ten times the year 2000 projection water withdrawal. Table 1 shows that South America enjoys the most abundant freshwater river discharges. If the ratio of total river discharges to total land area is used as an index, South America has twice the runoff of all the other continents taken together. Africa, with a runoff index only half the global value, has the least abundant flows. Rivers in North America and Asia correspond to the mean, and Europe's indexes are somewhat higher.

Much of the water that is withdrawn is later returned to its source, say, a river and thus can be withdrawn several times during its journey in continents. As the Table 1 shows, of the 4,660 Km^3 of water withdrawn for human use by the year 2000, some 2,700 Km^3 of water are for consumptive use; the remaining 2,000 Km^3 of wastewater are returned to rivers and other freshwater sources, frequently in a polluted condition. Wastewater is sometimes treated before it is returned to rivers and other freshwater resources, but all too often it is returned without treatment, mainly in developing countries. Even when it has been treated, wastewater usually needs to be diluted to reduce concentrations of pollutants still further before the water is fit for reuse. The potential for dilution of wastewater is increasingly limited because as water withdrawals increase, the amount of clean water remaining decreases and the volume of wastewater grows. This returned water is often reused farther downstream. Globally, wastewater can be diluted by clean water in a ratio of 1:25, but by the year 2000 this ratio is projected to worsen slightly in Europe and substantially in Asia (WRI, 1990).

It is important to distinguish between withdrawals and consumption. Consumptive uses of water include evaporation from irrigation systems or industrial cooling towers. Irrigation is extremely water intensive and, until recently, irrigation contributed little to the pollution of water basin. But the wide application of fertilizers and pesticides has heavily polluted irrigation returned flows, presenting a significant threat to the aquatic environment. The importance of livestock to water quality and quantity problems would seem to be less than other sectors of the economy.

EVALUATING WATER MANAGEMENT NEEDS

Additional perspective for evaluating water problems and needs is provided by considering the annual per capita potential of long terms average river discharges to satisfy current and future per capita demands. During the past three centuries, the amount of water withdrawn from freshwater resources by mankind has increased more than 35-fold, reaching the current average per capita rate of 660 cubic meters annually (domestic 8%, industry 23% and agriculture 69%). In the second half of the 20th Century, water withdrawals increased 4-8 percent annually. Water use is still growing in the developing world but is stabilizing in the industrial countries, with the result that the withdrawal rate increase is slowing. Withdrawals are expected to rise only 2-3 percent annually from now until year 2,000 (WRI, 1990).

The nature and extent of water management problems are related to the scarcity or water degradation levels within the area under consideration For example, despite the high per capita annual water availability in South America (35,000 cubic meters), domestic waste problems are especially critical, because little if any of the urban sewage is treated, and twice as many rivers as in other regions have fecal coliform counts of more than 100.000 per 100 ml. The World Health Organization (WHO) recommends a coliform count of 0 per 100 ml for drinking water.

Morever, in Brazil, for example, if the ratio of monthly billing water volume to total treated water volume injected in the network supply is used as an index, water supply compagnies have very low efficiency, between only 30 and 60 percent.

As the Figures from 1 to 4 show, the amount of freshwater per capita that is withdrawn (taken for use) from surface and subsurface sources is not correlated with either a country's economic wealth or the size of its internal renewable water resources. Many arid countries, such as Afghanistan, Sudan, Egypt, Republic of Yemen, Republic of Iran and Iraq, annually withdraw over 1,000 cubic meters per capita; most of this water is used in irrigation. Countries that use almost all or even more than their total renewable freshwater include: Egypt, Libya, Israel, Qatar, Saudi Arabia, United Arab Emirates, Republic of Yemen, and Malta. Some temperate and developed countries also use large amounts of freshwater. The United States, for example, uses 2,162 cubic meters per capita annually; its total use is higher than any other country. Canada, the Netherlands, Portugal, Bulgaria, Romania, Australia use over 1,000 cubic meters per capita annually. In South America only Argentine and Chile use more than 1,000 cubic meters per capita annually.

Domestic and municipal water needs have always been modest in relation to others, accounting for only about 7 percent of total withdrawals. Only about 4 percent of the world population uses as much as 300-400 liters per day per capita, or between 100 and 150 cubic meters per person annually. By the year 2,000, a projected 17 percent of the population will be using more than 300 liters per day, however 30 percent, some 1.8 billion people, will still be using fewer than 50 liters per day (WRI, 1990).

The structure of the water economy differs among countries, depending on natural climatic conditions; the availability, accessibility, and quality of water resources; and the economic and social development of a country. As Figure 5 shows, the lowest annual per capita water availability levels in the drought zone of Brazil (States of Ceará, Rio Grande do Norte, Paraiba and Pernambuco) are, in average, twice the per capita Germany's availability (1.100 m3), and are similar to values in many others countries in Europe. Nevertheless, total annual per capita withdrawals in those countries are three times higher than in the brazilian States.

Attempts to correlate the need for water management activity and the level of water demand have been undertaken on the basis of European water-use experience (Falkenmark and Lindh, 1976).This analysis indicates that few water problems occur and little management activity is needed when water demand is less than 5 percent of the long term average total river discharges. When demand is in the range of 5 to 10 percent of the total runoff, certain areas may encounter suplly difficulties although overall conditions are still considered favorable. Water supply commonly becomes a significant problem when demand is in the range of 10 to 20 percent of the total runoff, and a need arises for water planning and investment in water supply facilities. If demand exceeds 20 percent of average annual river discharges, severe water supply problems can be expected that require intensive management activity and increasingly heavy investment in planning and construction of facilities. Under these conditions, water supply may be a limiting factor in economic development. Of course, such generalizations are subject to limitations because of variations in conditions among geographic locations. Nevertheless, listing examples of current water problems only suggests what is urgently needed is the formulation of long-term development policies, on a sustaining basis, that reflect changing water supply and demand patterns, consistent with more rational and better management practicies.

Projections of water demand are not generally available at a level of detail adequate for meaningful assessment of the adequacy of supply. The Figure 6, however, indicates the potential for water-related problems. The extent to which such potential problems actually develop depends on water management activities undertaken to reach opportunities or mitigate problems. Mismanagement are likely to increase the frequency and/or severity of water problems. Such deficiencies can take several forms, including technical inadequacies, funding limitations, and institutional weaknesses.

In a number of countries, there is a need for the formulation of a national water policy within the framework consistent with the overall economic and social policies of the country concerned, with a view to helping raise the standard of living of the whole population.

CONCLUSIONS

Water management consists of all actions taken within a given society concerning the interface of that society with the water resource. These actions include adjustments in individual and social behavior in response to water resource conditions and, in all but the earliest stages of socio-economic development, involve attempts to improve the natural relationship between man and water by enhanching the positive attributes of water and controlling negative attributes. As demands for water-related services continue to increase in relation to a resource that is relatively fixed in supply and subject to degradation from many sources, water management efforts will become even more significant.

To conclude, the major problem in the area of water resources is not one of Malthusian spectre of impending scarcity, but one of instituting more rational and better management practicies. Water resources of different regions for which adequate data are not available have to be assessed, and based on such assessment, long-term development and management plans have to be established. Water and land should not appear as constraints in the overall planning process of a country, rather realistic development and production targets should be matched to their availability. What is urgently needed is the formulation of long-term development policies, on a sustaining basis, that reflect changing water supply and demand patterns, consistent with efficient use, and better understanding of the social and environmental implications so that adverse impacts can be minimized (Biswas, 1978). Water resource management is not an end in itself and generally cannot ensure socio-economic development in the absence of a variety of other conditions on which development depends. On the other hand, water shortage or other adverse water resource conditions can become a major constraint on the development if not adequately considered within a given development program.

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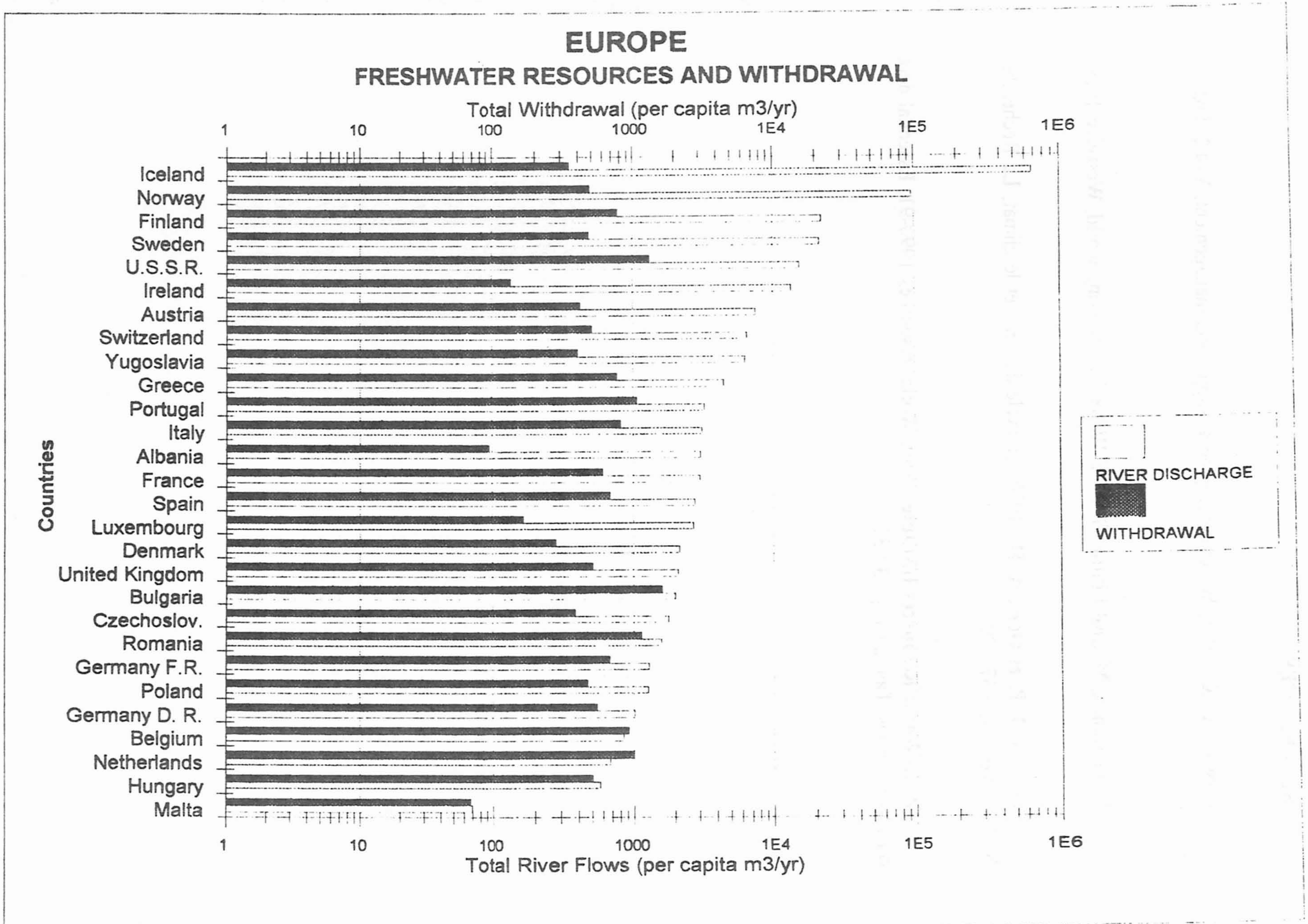

Figure 1. Annual per capita river flows and withdrawal in Europe (data from WRI, 1990)

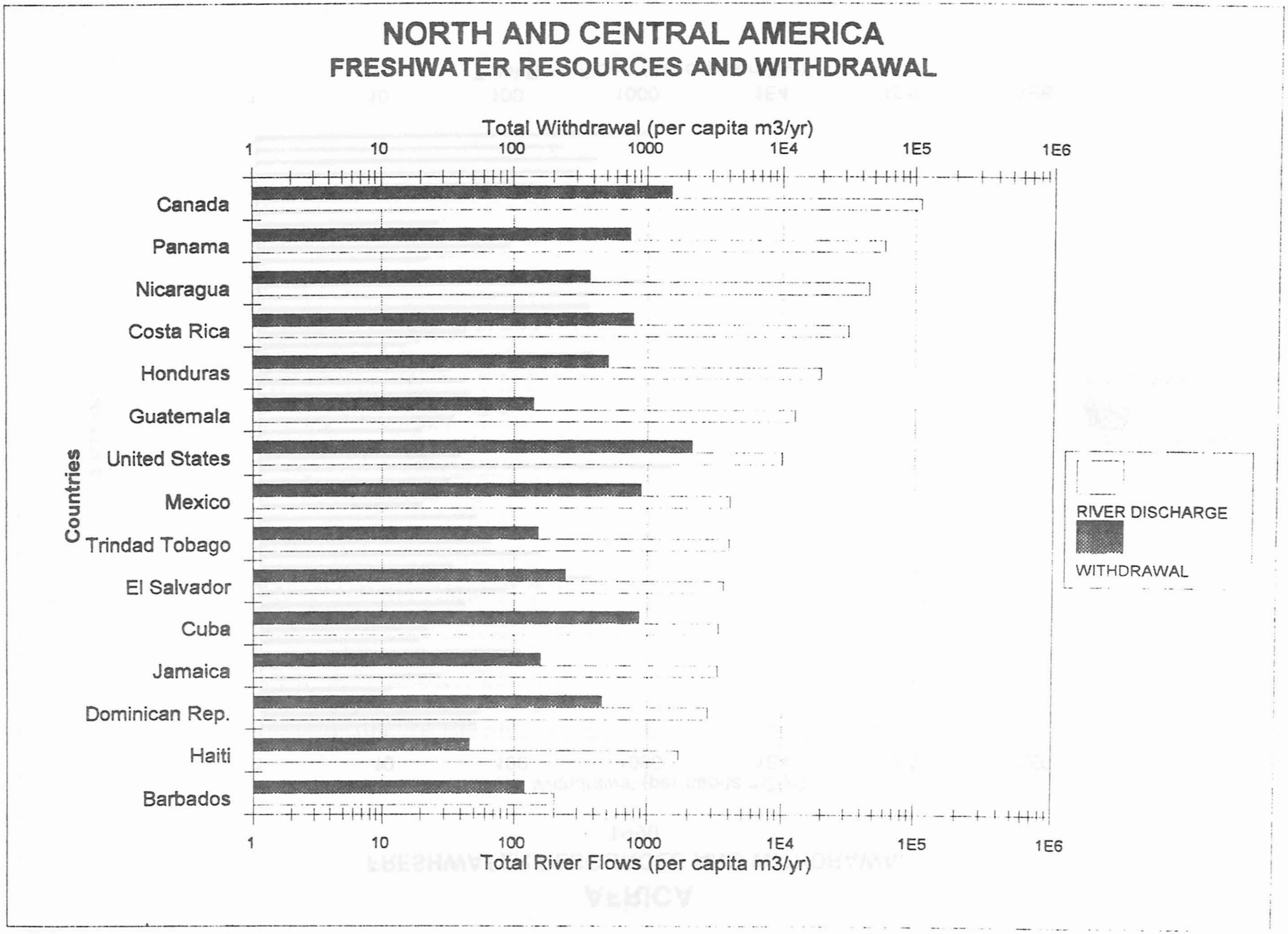

Figure 2. Annual per capita river flows and withdrawal in North and Central America (data from WRI, 1990)

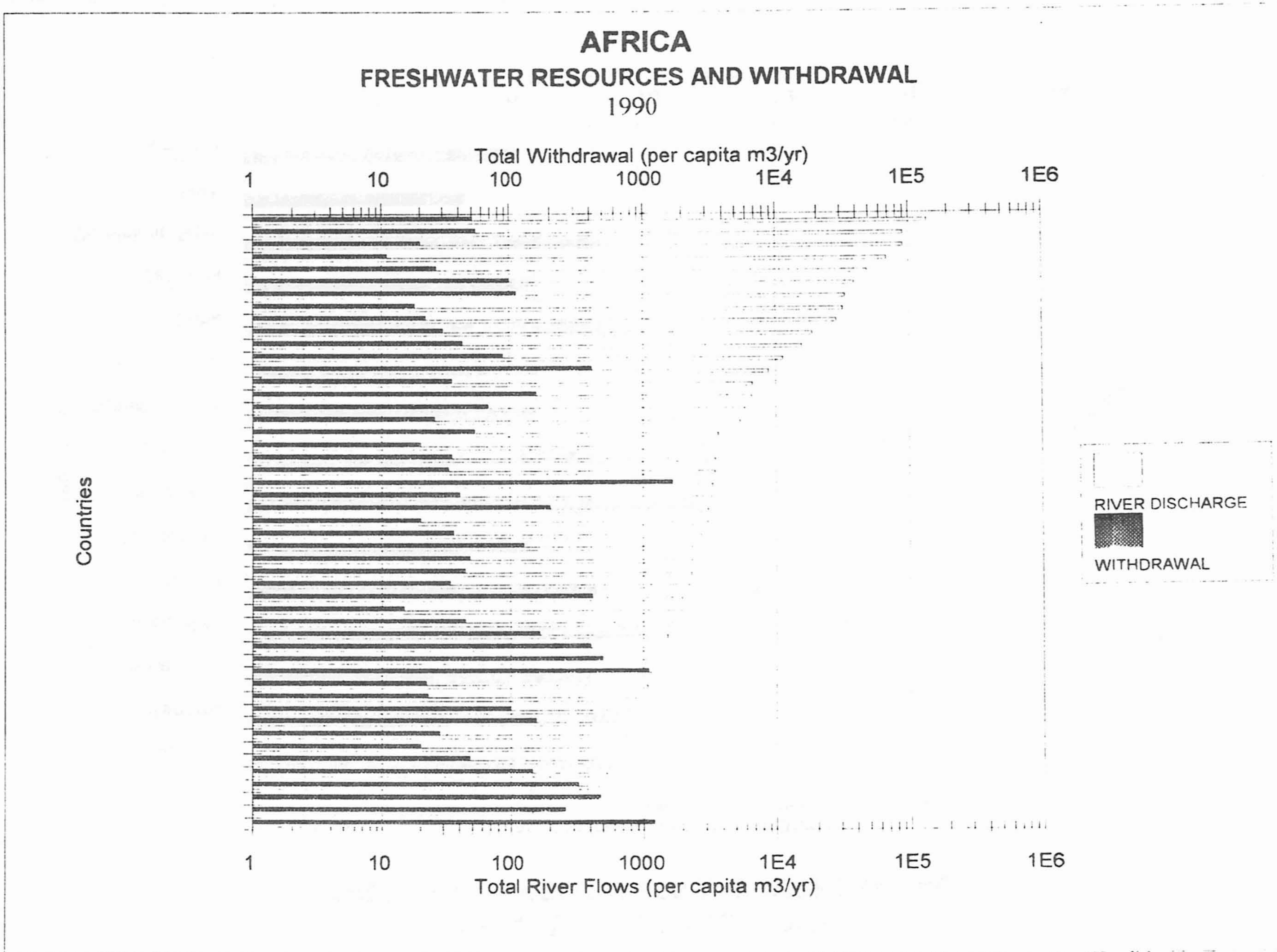

Figure 4. Annual per capita river flows and withdrawal in Africa (data from WRI, 1990)

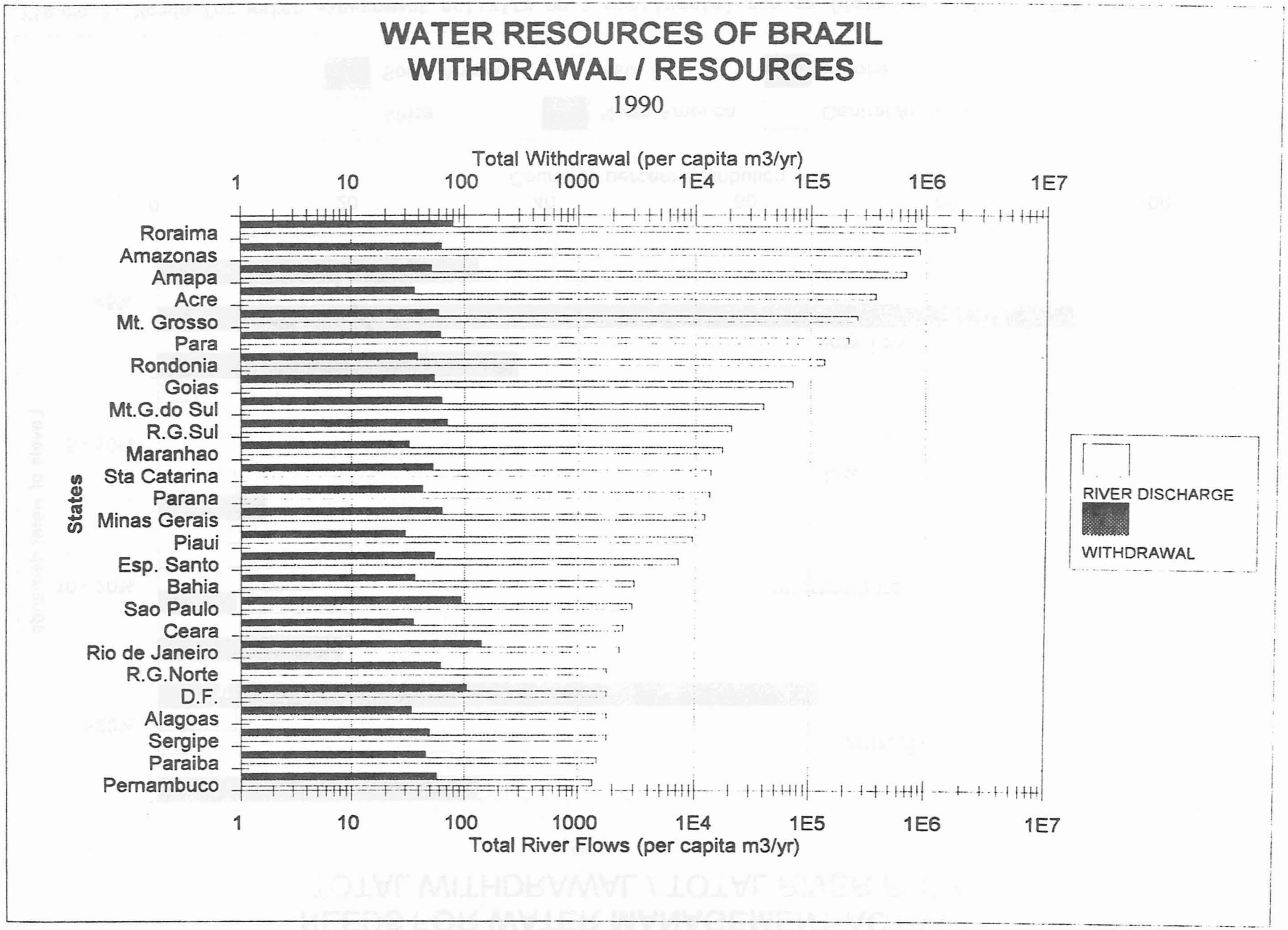

Figure 5. Annual per capita river flows and withdrawal in Brasil

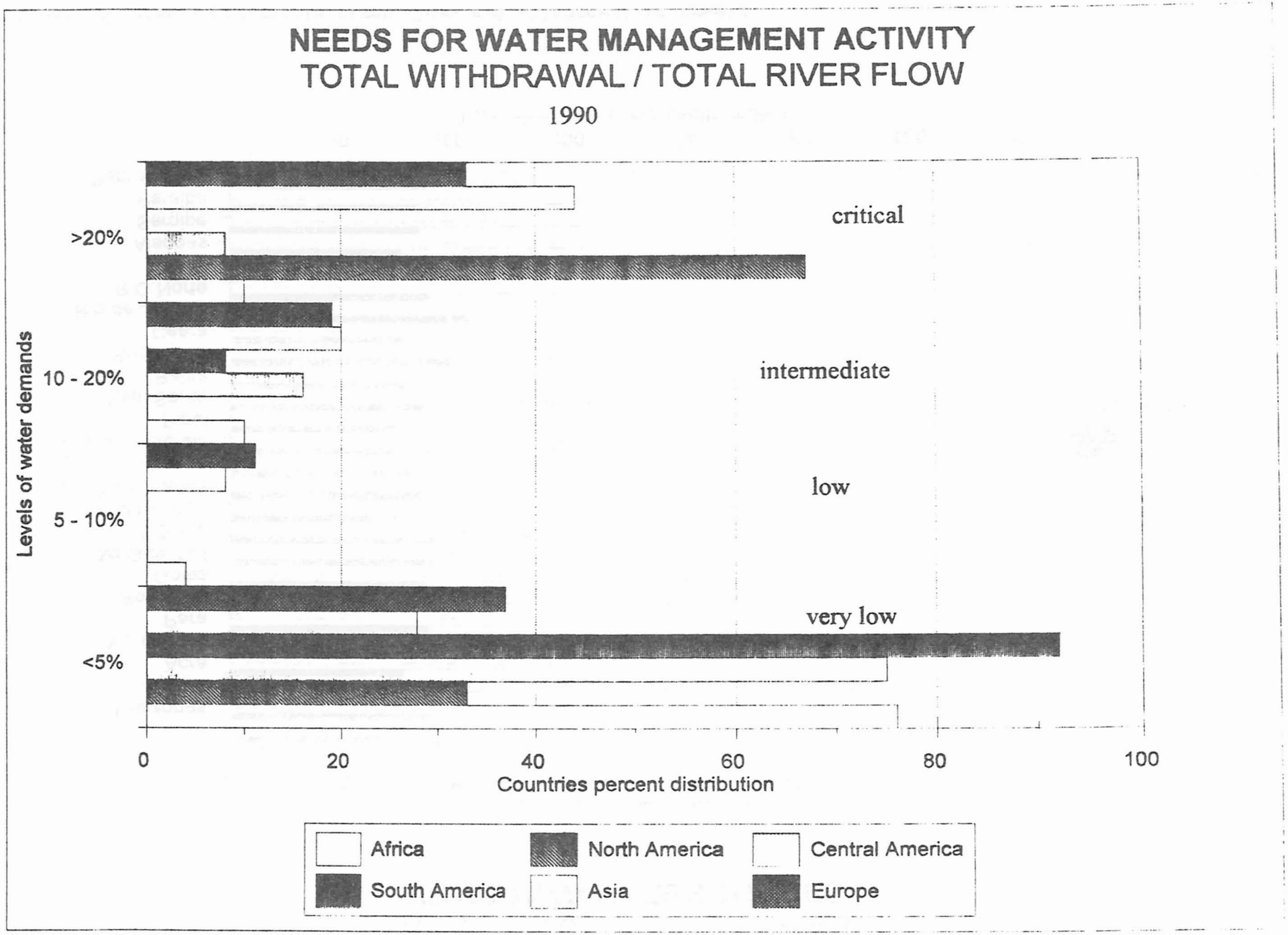

Figure 6. Needs for water management activity on a continental scales (data from WRI, 1990)

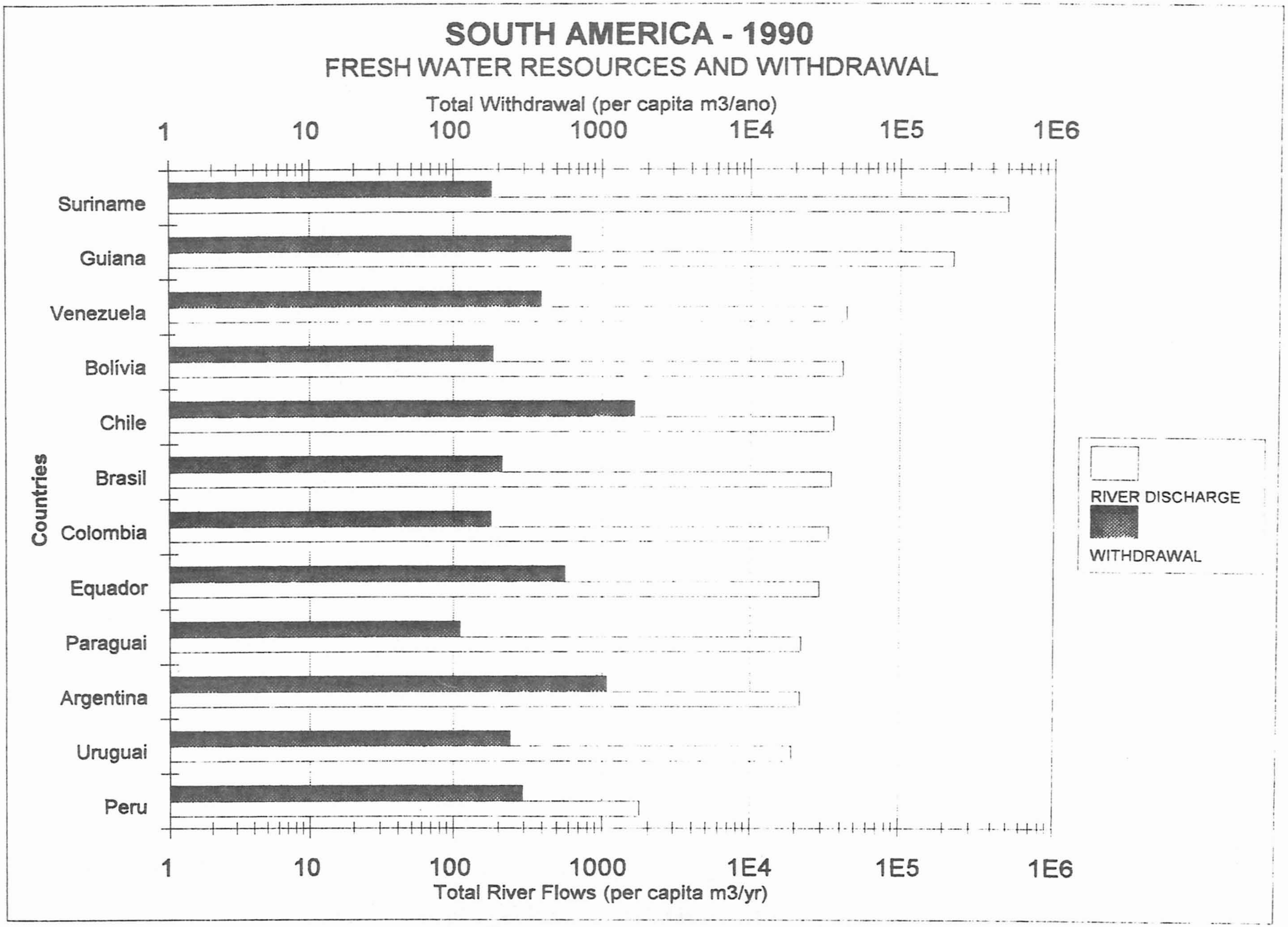

Figure 3. Annual per capita river flows and withdrawal in South America (data from WRI, 1990)