

HYDRO ENVIRONMENTAL PLAN OF CAPIBARIBE AND IPOJUCA RIVER BASINS – PERNAMBUCO – BRAZIL

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ABSTRACT

The Hydro Environmental Plan (PHA) of Capibaribe and Ipojuca river basins reflects the interest of the Government of Pernambuco and Basin Committees to provide the water resources management with instruments to solve major problems, whether water, environmental or socioeconomic, that affect the basin area. From the hydro environmental diagnostic, considering water resources, the environment and socioeconomics, trend and sustainable scenarios were developed for the time horizons of 2015 and 2025, being adopted to this analysis the following indicators: agricultural expansion, water quality, variation in GDP, micro-regional dynamics and FIRJAN municipal development index, besides water availability, modeled by the software MAGRE. In this modeling, hydrological series were updated and consisted for the period 1933-2009, which enabled the calibration of the model rainfall/flow, MODHAC. Finally, Investment Plans were developed for both basins, aiming to achieve sustainable scenario.

Key-words: Modeling; basin management, sustainable development.

INTRODUCTION

The Hydro Environmental Plans (PHA) of Capibaribe and Ipojuca river basins (Figure 1) were signed between the Government of Pernambuco, through the Water and Energy Resources Department (SRHE-PE), and Projotec – Projetos Técnicos Ltda and BRL Ingénierie Consortium, with resources of PROÁgua Nacional / World Bank.

In its context, the PHAs cover a Diagnostic - containing hydrological, environmental and socioeconomic studies - analyzing the trend and sustainable scenarios, and propose. Furthermore, these products were made available on SRHE-PE web-site, for free access by the population concerned.

In the case of Capibaribe river basin, it covers an area of 7,454.88 km² and is located in the northeast of the State of Pernambuco. The other, Ipojuca river basin, has an area of 3,435.34 km², which represents 3.49% of the territory of Pernambuco, and is located in Atlântico Nordeste river basin district. For the regional coverage of both (agreste, mata and coast), there is a complex environment in which climatic, relief, soil, vegetal cover and socioeconomic contrasts are highlighted, which require a model of water and environmental management that meets their subregional and local peculiarities.

Thus, given the scope and focus of these studies, it is presumed that they will be an important instrument for managing the water resources of the State of Pernambuco, especially for the performance of the functions legally established by the Basin Committees of Capibaribe (COBH Capibaribe) and Ipojuca (COBH Ipojuca) rivers.



Figure 1 - Location of Capibaribe and Ipojuca River Basins.

METHODOLOGY

Hydro Environmental Diagnostic

The elaboration of Capibaribe and Ipojuca PHAs involved a Hydro Environmental Diagnostic where the basins are regionalized into four units of analysis (UA1, UA2, UA3 and UA4), adopted according to the Master Plan of these basins (PDRH Capibaribe, 2002; PDRH Ipojuca, 2002). Simultaneously, meetings were held with organized sectors of these basins for obtaining aspects of the local realities.

Spatially, the studies covered the whole river basin of Capibaribe and Ipojuca Rivers, with emphasis on urban areas highlighting issues related to pollution of water sources, and, in rural areas, issues related to production systems, water supply and sanitation.

For the temporal scope, it was sought to portray the current situation of the basins in its different potentialities and fragilities, both as regards the use of its waters, as on the occupation of their land and socio-economic phenomena that express pace with their natural resources are being appropriated.

The analysis of the water potential and availability of the basins was carried out from the calibration and verification of MODHAC (Self Calibrated Hydrological Model) in order to determine parameters to be used for the extension and the generation of flow series in the Units of Analysis (UAs) of the basins.

82 and 47 rainfall stations were used respectively for the Capibaribe and Ipojuca river basins for the calibration and validation of the hydrological model with precipitation and flow data from the hydro meteorological net of the National Water Agency (ANA), from the consisted database of Atlas Northeast - Urban Water Supply (ANA-2006) and data provided by LAMEPE (Laboratory of Meteorology of Pernambuco). In addition, the potential evaporation vector of the stations located in the region was used. The model rainfall / flow (MODHAC) was calibrated for hydrological series from 1933-2009.

Trend and Sustainable Scenarios

The analysis of the scenarios was based and developed from the Hydro Environmental Diagnostic, as well as the Model of Utilization and Management of Water Resources - MAGRE, meetings with the Technical Chamber of COBHs and the conduction of workshops with the participation of the community from the basins.

The trend scenario considered the determining variables to express motion lines of the environmental, social and economic dynamic, which in the absence of active forces in the opposite direction tend to prevail in a near future. The sustainable scenario goes beyond projections of technical or economic indicators, and thus, required a qualitative assessment of the diagnostic data, and a long-term vision for restructuring and reorganization of growth with responsible use of natural resources.

Three macro zones were defined for a greater representation of the basins as regards the analysis of water, environmental, economic and social scenarios (Figure 2).

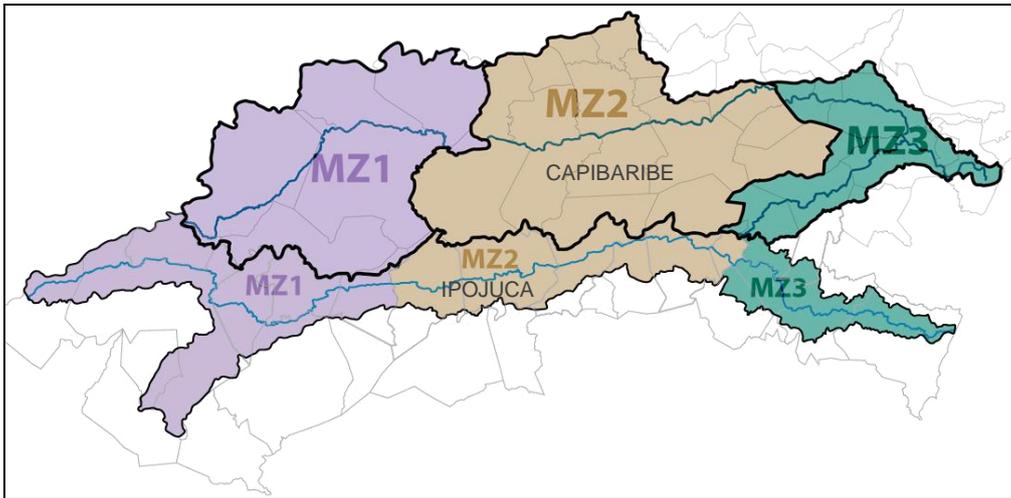


Figure 2 – MAGRE's Distribution of Macro Zones (MZ) for Capibaribe and Ipojuca river basins.

Representative elements were analyzed for the construction of consistent indicators that could reflect the temporal cuts in 2015 and 2025. Thereby, four approaches were considered for the construction of the scenarios: water, environmental, economic and social development.

In this work, four critical uncertainties and two extreme hypotheses were considered for the elaboration of the scenarios, one for each dimension of the analysis: water, environmental, economic and social. The hypothesis A is related to the maintenance of current trends, therefore, result of a pessimistic look on reality. The hypothesis B presents situations of positive resolution regarding the critical uncertainties.

The were formulated as responses to the different problems and potentials identified in the Hydro Environmental Diagnostic, which provided the basis for the establishment of the trend and sustainable scenarios for 2015 and 2025 and pointed the interventions and reformulations required for the sustainable development of the basins.

The proposition of these plans for the basins initially considered the collective knowledge expressed by technical experts and participants of meetings and workshops of social mobilization. And, having the Hydro Environmental Diagnostic it was possible to estimate and spatialize many of those environmental problems that affect the remaining vegetation, surface and ground water, soil, urban and rural populations, as well as the potentialities offered by the basins for the socioeconomic development.

For this purpose, 23 plans for Capibaribe river basin and 20 plans for Ipojuca river basin were elaborated aiming to contemplate and to meet environmental, water and social problems that were identified in the basins. These plans were defined in three areas: Socio-environmental, Water Infrastructure and Water Management.

The calculation report used in the Investment Plans was based on the price list of the National Department of Transport Infrastructure - DNIT, whose last update is dated 16/08/2010.

FINDINGS AND DISCUSSIONS

Hydro Environmental Diagnostic (simulation with MODHAC)

This section presents the calibration and validation of MODHAC (Self Calibrated Hydrological Model) for basins. The goal was to find parameters that can be used for the extension and the generation of flow series in the analysis units (UAs).

Capibaribe River Basin

After calibrating and validating MODHAC, simulations were performed to the generation of flow in the UAs from jan/1933 to dec/2009. Table 1 presents the summary of the simulations with the set of parameters used in each UA and the flow generated. Figure 3 shows the summary of the flows generated for the period corresponding to the decade of the 2000s.

Table 1 – Potentiality data, average and specific flows for simulating the model.

UA	Station	Average flow (m ³ /s)	Specific flow (L/s/km ²)	Potentiality (10 ⁶ m ³ /year)
1	Toritama	3,42	1,38	107,81
2	Limoeiro	1,71	1,00	54,07
3	Limoeiro	4,43	2,39	139,83
4	São Lourenço da Mata	13,74	9,79	433,39

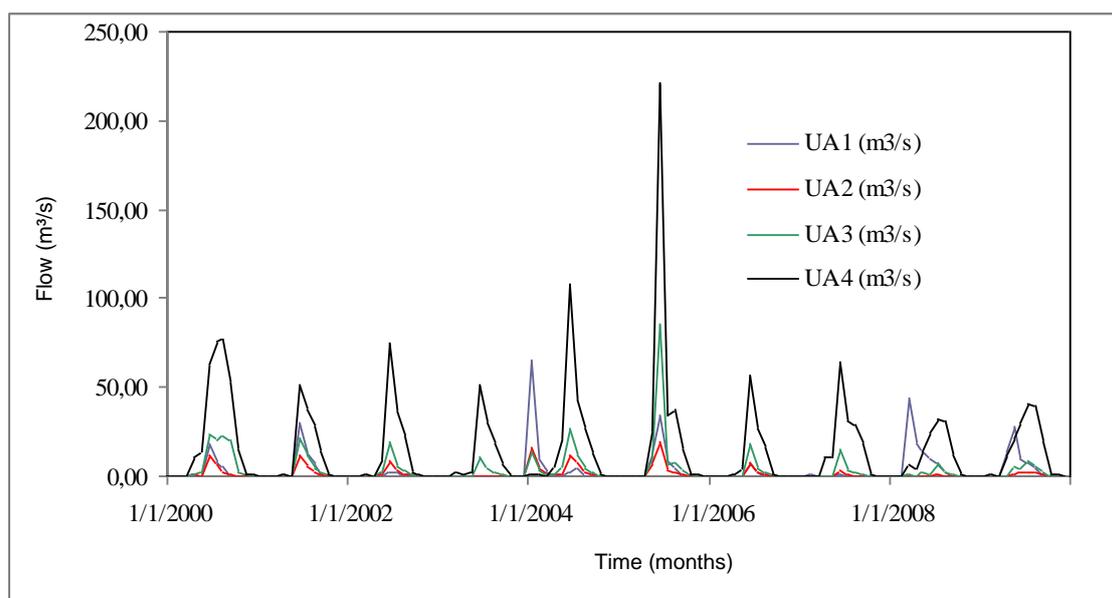


Figure 3 - Flow simulated in the UAs (cut for the 2000s).

Finally, Table 2 presents the values of calibration parameters determined for each fluviometric station studied.

Table 2 - Parameters of model calibration.

Variables	Toritama	Limoeiro	São Lourenço da Mata
RSPX	28,3600	29,1700	48,1300
RSSX	134,3000	204,6000	274,4000
RSBX	0,0000	10,5800	39,2900
RSBY	0,0000	3,6420	0,0000
IMAX	208,7000	122,2000	148,4000
IMIN	15,4500	0,1381	4,9490
IDEC	0,4138	0,1947	0,0218
ASP	0,2621	0,7153	0,1729
ASS	0,1712	0,0319	0,2880
ASBX	0,0000	1,0000	1,0000
ASBY	0,0000	0,0139	1,0000
CEVA	0,3000	0,0072	0,9510
CHET	0,6000	0,8500	0,8500

After calibrating and validating MODHAC, simulations were performed to the generation of flow in the UAs from jan/1933 to dec/2009. Table 3 presents the summary of the simulations with the set of parameters used in each AU and the flow generated. Figure 4 shows the summary of the flows generated for the period corresponding to the decade of the 2000s.

Table 3 - Summary of the flows generated by MODHAC.

UA	Parameters	Average flow (m ³ /s)	Specific flow (L/s/km ²)	Potentiality (10 ⁶ m ³ /ano)
1	Caruaru	2,33	1,56	73,57
2	Caruaru	0,66	0,87	20,71
3	Engenho Tabocas	2,82	4,92	88,91
4	Engenho Tabocas	10,22	16,68	322,26

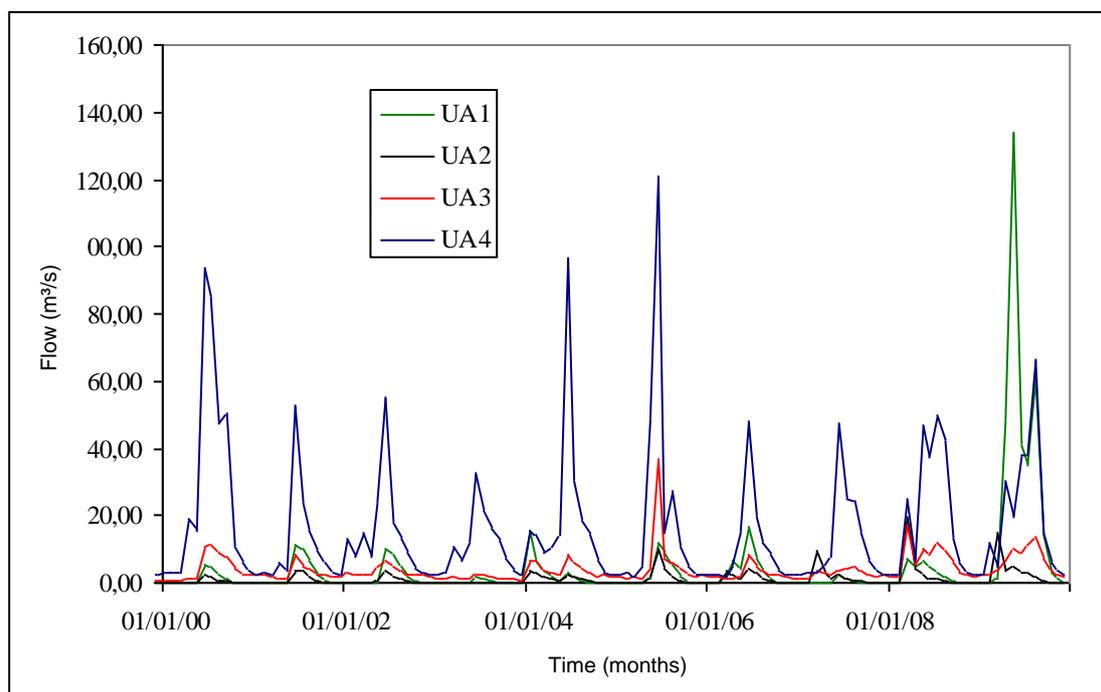


Figure 4 – Flow simulated in the UAs (cut for the 2000s).

Finally, Table 4 presents the values of calibration parameters determined for each fluviometric station studied.

Table 4 - Parameters of model calibration.

Variables	Caruaru	Engenho Tabocas
RSPX	5,0000	63,8700
RSSX	60,0000	287,6000
RSBX	0,0000	130,8000
RSBY	0,0000	50,0000
IMAX	30,0000	91,4600
IMIN	5,0000	8,3830
IDEC	0,9000	0,2425

Table 4 - Parameters of model calibration.

Variables	Caruaru	Engenho Tabocas
ASP	0,0010	0,9172
ASS	0,0010	0,3000
ASBX	0,0000	0,1456
ASBY	0,0000	0,1997
CEVA	0,4000	0,04758
CHET	0,7000	0,5000

Scenario Analysis

Capibaribe River Basin

Trend Scenario - Water Analysis (MAGRE)

MAGRE's water analysis showed that the extrapolation of the current situation including new pipelines foreseen for Capibaribe river basin would have as result the persistence of the deficit in the high part of the basin (macro zone 1), which can be eliminated with the contribution of the transposition of São Francisco River. The macro zone 3 also shows a deficit for public supply, which could be eliminated only with changes in the current operation of Tapacurá system.

The demands for irrigation and industry present a deficit generally higher during the dry years, however, the optimization of the management of major reservoirs would allow reducing them significantly. For this, it would be necessary a system to manage those demands and adapt the management of dams dynamically.

The inclusion of ecological flows on water balance has an impact of 22% over the human supply in the macro zones 2 and 3 (more specifically in the UA2 and UA4) in 2025 for the downstream of Tapacurá and a deficit of industrial demand in the macro zone 3, increased by 7% in 2015.

Regarding the analysis of the environmental, social and economic elements considered, one can conclude that, as there is no significant changes in current policies, the variables follow their historical trends, with growth of GDP throughout the basin; increasing in the population growth rate across the basin; FIRJAN development index indicating in 2025, moderate classification for the three macro zones; increasing of the planted area in the macro zones 2 and 3; and growth of the remaining load of pollutants.

Sustainable Scenario - Water Analysis (MAGRE)

The following scenes are expected for the water analysis of MAGRE:

- In the Macro Zone 1 (MZ1), it will be necessary to regularize volumes to satisfy the demand for irrigation and industry in a partial way (rationing to ensure human supply as fully) until the arrival of water from São Francisco River, when it will be possible to lower the rationing rate;
- In the Macro Zone 2 (MZ2), the demands for irrigation and industry will be met by connecting Jucazinho reservoir that will provide an appropriate regularized volume, requiring a minimum rationing for such demands in order to obtain maximum assurance for human supply;
- In the Macro Zone 3 (MZ3), a sustained scenario will be possible with the regularization of the dams in the area to minimize irrigation and industry deficits. If this regularization provokes a negative impact on the guarantee of attendance of the human supply, a minimum rationing in the demand for irrigation and industry will be necessary to obtain maximum guarantee of human supply. In this region, the ecological flow causes deficit in some demands, requiring more detailed studies to provide an adequate balance between water use and conservation of ecological balance.

In the analysis of environmental, social and economic elements for the sustainable scenario, the Macro Zone 1 still has a higher rate of growth of GDP and GDP per capita. Between 2015 and 2025 the annual average rate reaches around 20%, higher than the trend scenario which was 15%. The same behavior is observed in the other Macro Zones. Production intensification policies take effect causing an increase in the integration of the various municipalities and in the small sustainable production.

Regarding the population growth, Macro Zone 1 stills with the highest growth rates. However, given the social policies, investments in urban infrastructure and the income increasing, this more intense growth of the population will not lead to an increase in social pressures. Urban services will largely accompany the growth of demand in cities.

FIRJAN index shows significant improvement in this scenario, it is expected an improvement in the pattern of development in all Macro Zones.

Environmental issues will be better equalized through the expansion of rural enterprises of family farming, incentives for creating private reserves, recovery actions in deforested areas and agricultural practices more efficient. However, this setting will only be viable with the implementation of group of policies and public actions, which, in the Hydro Environmental Plan are proposed in the Investment Plans.

It is recommended to the water resources and environment management: to evaluate and equalize the sanitation projects along with the population growth and capacity of absorption of the reservoirs; to seek the financial sustainability of the supply system; to deploy an effective system of monitoring, as well as to develop contingency plans; to ensure the recovery of degraded areas by deforestation, mining and erosion, and restoration of riparian areas and springs, as well as degraded areas by landfills; programs for rational use of water by industries and agriculture with alternative reuse are quite commendable; to bring the Hydro Environmental Plan for each municipality in the basin, ensuring the minimum conditions for its implementation associated to a strong popular participation, as essential conditions for sustainability; to ensure housing conditions for the populations in rural areas of the basin.

From the economic point of view it is essential that the planning is tied to sustainability strategies. Thus, the attraction of new ventures should be part of the process of productive linkages with small-scale production of the region, with an integrated view of the entire basin, promoting environmental awareness. The actions should encourage family farms with activities linked to sustainable agro-ecological practices, such as beekeeping, organic production and other similar features.

Finally, local entrepreneurship must be stimulated from small urban business support in areas of commerce and services in areas less developed from community or family agro-industries for the processing of raw materials, adding quality and value to products and services; and it must be ensured throughout the process of implementation of the Plan the qualified institutional participation via civil society, water users and public institutions representations, with direct involvement of Capibaribe Basin Committee.

Ipojuca River Basin

Trend Scenario - Water Analysis (MAGRE)

MAGRE's water analysis showed that the macro zone 1, in the current situation, has a deficit in any activity that demands water in the basin. The human supply, for example, presents a deficit of 44% in the demand, considering a recurrence of 10 years. The activities of irrigation and industry present a deficit of 100% in the demand for the same return period. The control of these demands through the reservoirs allows great improve to the balance. The deficit disappears completely for irrigation in UA1 and changes from 100% to 67% in UA2. However, the activity of human supply presents a worsening on its deficit, changing to 67% in the UA1 and 73% in Una river basin.

Until the horizon of 2025, the situation improves considerably with the arrival of water from San Francisco river, totally eliminating the deficits relative to human demand for the totality of the UA1 and the demand of Una river basin. Likewise, the industrial and irrigation deficits in the UA1 and UA2 are eliminated.

In the macro zone 2, the activity of human supply doesn't present deficit until the horizon of 2025, considering or not São Francisco river's supply. The industry and irrigation demands in the UA3 present a deficit of 9%, with recurrence of 10 years in the current situation, rising to 12% at the horizon of 2025. By controlling the the reservoirs, these deficits would not be annulled. Regarding the connection with São Francisco river, this would present a significant improvement as regards the activity of irrigation for the same UA.

In the macro zone 3, the irrigation and industry demands in the UA4 don't present any deficit in the current situation to a ten-year return period, but in 2025 situation the deficit becomes equal to 4%. Regarding the human supply of the downstream municipalities (Ipojuca and Escada), it was not presented deficit neither for the current situation nor for the horizon of 2025.

With the largest population contingent, the macro zone 2 also has the highest population growth rates throughout the entire basin, with an average annual growth rate around 1.4%. The macro zone 3 increases its population at an average annual rate of about 1.1% and the macro zone 1 with the lowest growth rate around 0.9% per year. Despite the population growth rates are below average of other regions, impacts on social demands will still happening.

Sustainable Scenario - Water Analysis (MAGRE)

Regarding water resources, the sustainable scenario analyzed the attendance of the industrial and agriculture (irrigation) demands using water from the reservoirs. Those who have human supply as primary goal should keep a volume of water to meet these other types of demand. The proposed regulation can be implemented in the UA1 and UA2 by the existence of larger reservoirs. In the UA3 and UA4, it has the same form as the demand regulation in human supply.

In the upper area of the basin there will be deficits, whatever the type of demand in the current and future situation. In the medians and lower parts of the basin it is not presented any deficit related to the human demand. The existing and planned infrastructure (Engenho Maranhão pipelines and dam) allow to compensate the demand growth, whether internal or external to the basin (such as Porto de Galinhas and Suape).

Considering the potential of regularization of the dams and the use of all planned infrastructure and the adoption of measures to improve the match between the irrigation and industrial demands, the deficits would be attended even during drought years, whatever the nature of demand.

Investment Plans

Capibaribe and Ipojuca River Basins

The Investment Plans were formulated as responses to the different problems and potentials identified in the Hydro Environmental Diagnostic of the basins, which provided the basis for the establishment of the trend and sustainable scenarios for 2015 and 2025, and pointed the interventions and reformulations required for the sustainable development of the basins. These plans were developed focusing in three mains themes: socio-environmental, water resources management and water infrastructure.

Seven Investment Plans were presented regarding the social-environmental theme; they were focused on the recovery of the periurban and rural impacted areas and on the restoring of the environmental balance in several municipalities of the basins, covering the macro zones defined by the hydrological modeling (Model MAGRE).

The theme "water resources management" contains thirteen Investment Plans focused on the execution of management tools that allow the Water Resources State System to exercise its role with regard to users, granting, charging, flood control, besides the implementation of representative basins, to establish behavior models of the soil-water-plant relation and its bouncing on water resources.

The goal of the theme "water infrastructure" was to expand the universalization of services to communities diffused do the state, adopting alternative technical solutions for water supply and sanitation in the most critical passages.

The proposed investment should be implemented throughout the next 15 years, so that the constructed scenarios can be achieved in a sustainable manner or adjusted over time to achieve goals and objectives compatible with the changes that occur during the period considered.

Having as a presupposition the importance of ensuring the supply of water to meet human supply and promote socioeconomic development, the implementation of the proposed actions should follow a logical sequence that ensures synergy to the system considering other programs under development by the state government and

municipal governments, optimizing social-environmental responses in the geographic area of the basin.

The total obtained for all proposed Investment Plans for the Capibaribe PHA is R\$ 247,294,238.72 and for Ipojuca PHA is R\$ 172,669,412.26.

The proposed Investment Plans for Capibaribe (Table 5) and Ipojuca (Table 6) PCAs are briefly presented below.

Table 5 – Synthesis of Investments Plans on Capibaribe river basin.

	Investment Plan	General Aim	Implantation Period ¹	Costs (R\$)
SOCIO-ENVIRONMENTAL AXIS	Municipal Urban Parks implantation in Capibaribe river basin. “Janelas para o Rio”.	Implant green areas in Capibaribe and Tapacurá rivers and in Bica, Caçatuba and Gameleira streams	3 years.	12,786,978.38
	Elaboration of Conservation and Use of Surroundings and Reservoir Plan on Capibaribe river basin.	Regularize, map and elaborate the plan of reservoir control and monitoring.	1 year.	2,671,571.24
	Support for the conservation units creation on Capibaribe river basin.	Categorize two ecological reserves in the Metropolitan Region of Recife as UCs and conserve areas of natural vegetation on Alto Capibaribe.	2 years.	3,326,029.48
	Incentive Program for creation of Natural Patrimony Private Reserves on Capibaribe river basin “RPPN amiga da água”.	Encourage the creation and implantation of Natural Patrimony Private Reserves on Capibaribe river basin.	From the first edict (1 year).	200,000.00
	Water Producer Program on Capibaribe river (Recovery of areas degraded by deforestation, mining and erosion; Restoration of riparian forest).	Encourage practices of vegetal cover and soil conservation and the recovery of degraded areas.	10 years.	7,000,000.00
	Recovery of areas degraded by landfills on rivers banks and on strategic areas of the Capibaribe river.	Recover areas degraded by landfills on river banks and on strategic areas of the Capibaribe river and propose actions for solid waste treatment and final destination.	8 years.	41,942,541.55
	Plan for the historical, cultural and sentimental rescue of the Capibaribe river.	Increase historical and cultural knowledge about the Capibaribe river.	3 years.	2,131,163.97

¹ After the implantation, some projects will be monitored, accompanied and continued, on Hydro Environmental Plan analysis period (until 2025).

Table 5 – Synthesis of Investments Plans on Capibaribe river basin.

	Investment Plan	General Aim	Implantation Period ²	Costs (R\$)
WATER INFRASTRUCTURE AXIS	The use of simplified alternatives for the Capibaribe river population supply.	Universalize the basic sanitation customer service for the basin rural area population and provide quality water permanently.	15 years.	83,990,320.00
	The use of simplified alternatives for waste water system to the Capibaribe river population.	Universalize the basic sanitation customer service for the basin rural area population, with investment for waste water system implantation for individual use (families) and associative use(community).	8 years.	74,383,080.00
	Recovery of critical sections of Capibaribe river channel for flood attenuation.	Minimize the risk of floods on the basin and improve channel conditions.	1 year.	1,110,288.01
	Implementation of “representative basins” on Capibaribe river basin physiographic areas.	Define the representative basins water behavior on physiographic areas and extrapolate the knowledge obtained on representative basin for homogeneous zones.	3 years.	952,321.35
	Implementation of monitoring system in real time on Capibaribe river basin overflows areas.	Minimize the risk of floods on the basin and implant flood warning system in real time.	1 year and a half.	1,407,870.44
	Flood contingency plan on Capibaribe river basin.	Elaborate the Flood contingency plan of Capibaribe river basin and fortify institutionally the municipal and state system of Civil Defence.	1 year.	835,210.66

² After the implantation, some projects will be monitored, accompanied and continued, on Hydro Environmental Plan analysis period (until 2025).

Table 5 – Synthesis of Investments Plans on Capibaribe river basin.

	Investment Plan	General Aim	Implantation Period ²	Costs (R\$)
MANAGEMENT OF HYDRAULIC RESOURCES AXIS	Hydro Environmental monitoring plan of Capibaribe river.	Restructure the system of monitoring the quality of Capibaribe river surface water and structure the system of monitoring Capibaribe river groundwater.	1 year and a half.	1,271,656.87
	Elaboration of register of the Capibaribe river water resources users and database systematization.	Elaborate the register of water resources users and make available database informations compatible with – CNARH.	1 year.	965,128.67
	Studies for the water resources using collection.	Subsidize the implementation of collection for the Capibaribe river basin water resources using in waters that are Pernambuco State dominion.	1 year and a half.	1,044,949.63
	Implementation of reference proposal for water bodies framing.	Basin Committee approval for the water bodies framing proposal and steps definition for the framing implementation.	1 year.	839,503.38
	Computerised System for Capibaribe river grants control and follow-up.	Development and implementation of the system for consultation of water use grant process and make available informations about issued grants via web.	1 year.	980,630.21
	Program of rational water use in formal and informal industries on Capibaribe river basin.	Structure a rational water use in formal and informal industries (including flour houses, slaughterhouses and tanneries) aiming a drinking water consumption reduction and encouraging the reuse of water.	1 year.	742,391.48

Table 5 – Synthesis of Investments Plans on Capibaribe river basin.

	Investment Plan	General Aim	Implantation Period ²	Costs (R\$)
MANAGEMENT OF HYDRAULIC RESOURCES AXIS	Strengthening of Capibaribe river basin Committee.	The Capibaribe basin Committee doing its lawful duties and follow-up the implementation of Capibaribe Hydro Environmental Plan.	3 years.	824,438.09
	Monitoring of basic sanitation investments impact of Jucazinho, Tapacurá and Carpina reservoirs.	Study the basic sanitation investments impact of Jucazinho, Tapacurá and Carpina reservoirs.	1 year.	721,192.18
	Support program of Hydro Environmental management for Capibaribe river basin municipalities.	Search and update syntonies of municipal lawful framework referring to Hydro Environmental matter; implant or fortify the infrastructure for Hydro Environmental management; improve legal instruments for resources distribution of socio-environmental ICMS; and stimulate the creation of COBHs state network and Environment Councils.	3 years.	2,040,749.95
	Reuse of household treated wastewater for hydroagriculture exploitation of Capibaribe river.	Increase availability of water supply on Capibaribe river basin rural area, with investments for implantation of household treated wastewater reuse system for hydroagriculture.	According to area and municipal soil availability.	5,126,223.20

TOTAL COST* R\$ 247,294,238.72

* The total cost can be higher than the indicated value, in view that some investments plans cannot be budgeted because they depend of Special Projects that will be contracted.

Table 6 – Synthesis of Investment Plans on Ipojuca river basin.

	Investment Plan	General Aim	Implantation Period ³	Costs (R\$)
SOCIO-ENVIRONMENTAL AXIS	Municipal Urban Parks implantation in Ipojuca river basin "janelas para o rio".	Implant green areas in Ipojuca river.	1 year and a half (2011-2013).	4,324,063.40
	Elaboration of Conservation and Use of Surroundings and Reservoir Plan on Ipojuca river basin.	Regularize, map and elaborate the plan of reservoir control and monitoring.	1 year (2011).	1,495,885.57
	Define priority areas for the creation of conservation units on headwaters areas of Ipojuca river.	Indicate strategic areas for conservation units creation, integrating priority areas for the hydraulic resources protection.	2 years (2011-2012).	1,898,556.99
	Incentive Program for creation of Natural Patrimony Private Reserves "RPPN Amiga da Água".	Encourage the creation and implantation of Natural Patrimony Private Reserves on Ipojuca river basin.	1 year prediction (2011) for implementation of each Natural Patrimony Private Reserves.	305,087.49
	Water Producer Program on Ipojuca river.	Encourage practices of vegetal cover and soil conservation and the recovery of degraded areas.	10 years (2011-2020).	7,000,000.00
	Recovery of areas degraded by landfills on rivers banks and on strategic areas of Ipojuca river basin.	Recover areas degraded by landfills on river banks and on strategic areas of the Ipojuca river and propose actions for solid waste treatment and final destination.	4 years (2011-2014).	16,418,717.48

³ After the implantation, some projects will be monitored, accompanied and continued, on Hydro Environmental Plan analysis period (until 2025).

Table 6 – Synthesis of Investment Plans on Ipojuca river basin.

	Investment Plan	General Aim	Implantation Period ³	Costs (R\$)
WATER INFRASTRUCTURE AXIS	The use of simplified alternatives for the Ipojuca river population supply.	Universalize the basic sanitation customer service for the basin rural area population with adoption of compatible alternatives.	15 years (2011-2025).	69,138,608.00
	The use of simplified alternatives for waste water system to the Ipojuca river population.	Universalize the basic sanitation customer service for the basin rural area population, with investment for waste water system implantation for individual use (families) and associative use (community).	15 years (2011-2025).	61,629,777.00
	Recovery of critical sections of Ipojuca river channel for flood attenuation.	Minimize the risk of floods on the basin and improve channel conditions.	1 year (2012).	1,483,845.20
MANAGEMENT OF HYDRAULIC RESOURCES AXIS	“Representative basin” reactivation of Patachoca river on Ipojuca river basin.	Define the representative basins water behavior on Patachoca river physiographic areas and extrapolate the knowledge obtained on representative basin for homogeneous zones.	3 years (2011-2013).	595,217.59
	Implementation of monitoring system in real time on Ipojuca river basin overflows areas.	Minimize the risk of floods on the basin and implant flood warning system in real time.	1 year and a half (2013-2014).	860,045.84
	Flood contingency plan on Capibaribe river basin.	Elaborate the Flood contingency plan of Capibaribe river basin and fortify institutionally the municipal and state system of Civil Defence.	1 year (2011).	660,332.43
	Hydro Environmental monitoring plan of Ipojuca river.	Restructure the system of monitoring the quality of Ipojuca river surface water and structure the system of monitoring Capibaribe river groundwater.	1 year and a half (2012-2013)	777,106.33

Table 6 – Synthesis of Investment Plans on Ipojuca river basin.

	Investment Plan	General Aim	Implantation Period ³	Costs (R\$)
MANAGEMENT OF WATER RESOURCES AXIS	Elaboration of register of the Capibaribe river water resources users and database systematization.	Elaborate the register of water resources users and make available database informations compatible with – CNARH.	1 year (2011)	576,246.62
	Strengthening of Ipojuca river basin Committee and of Reservoir Management Councils.	The Ipojuca basin Committee doing its lawful duties and follow-up the implementation of Ipojuca Hydro Environmental Plan.	3 years.	824,438.09
	Studies for the water resources using collection.	Subsidize the implementation of collection for the Ipojuca river basin water resources using, in waters that are Pernambuco State dominion.	1 year and a half (2013-2014)	1,044,949.63
	Implementation of reference proposal for water bodies framing.	Basin Committee approval for the water bodies framing proposal and steps definition for the framing implementation.	1 year (2015-2016).	720,892.26
	Computerised System for Capibaribe river grants control and follow-up.	Development and implementation of the system for consultation of water use grant process and make available informations about issued grants via web.	1 year (2012).	636,985.40
	Program of rational water use in formal and informal industries on Capibaribe river basin.	Structure a rational water use in formal and informal industries (including flour houses, slaughterhouses and tanneries) aiming a drinking water consumption reduction and encouraging the reuse of water.	1 year (2013).	556,838.13
	Support program of Hydro Environmental management for Ipojuca river basin municipalities.	Search and update syntonies of municipal lawful framework referring to Hydro Environmental matter; implant or fortify the infrastructure for Hydro Environmental management; improve legal instruments for resources distribution of socio-environmental ICMS; and stimulate the creation of COBHs state network and Environment Councils.	3 years (2011-2013).	1,721,818.80
TOTAL COST* R\$ 172,669,412.26				

* The total cost can be higher than the indicated value, in view that some investments plans cannot be budgeted because they depend of Special Projects that will be contracted.

CONCLUSION

The Hydro Environmental Plans are one of the management instruments of far-reaching elaborated for Capibaribe and Ipojuca Rivers basins, not just because it covers the entire basins areas, but also for the explanation of investments and actions to be applied for concret results of environmental, hydric and socioeconomic aspects.

After the Investments Plans, the Pernambuco Government starts to available consistents proposals that together with the actions and investments may return to Capibaribe and Ipojuca Rivers basins its great potencial of social and economic development on environmentally sustained areas.

However, plans on this scale demand a management structure able to follow-up each plan process, analyze the results and optimize interative process of the set of plans. There is a big challenge in this complexity involved in simultaneous operation of several investments plans: coordinate synchronous actions, expressed in individual plans, that may result in a significant economy of scale.

It is important to highlight that each investment plan establish its social and monitoring constraints with specific indicators and goals to be reached, in such a way that the follow-up of realization and results is already included in the plan context. Thus, the management involves links between various entities and bodies, process preparation for plan licensing, bid for equipments purchase, documents elaboration, technical visits, financial monitoring and plans technical supervision.

Finally, it is significant to say that the Pernambucana climate and water agency is responsible for the management of Hydro Environmental Plans, since the agency creation was with the purposes of water resources management, including the organization, the planning and appropriate tool management. On this management the COBH Capibaribe and the COBH Ipojuca have crucial role in this process, since were involved to the plans ideas and are participating in the realization of it.

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