KfW Development Bank

Ex-post evaluation, Paraopeba, Brazil

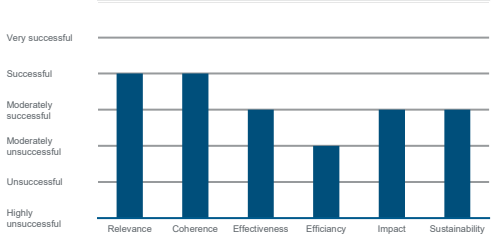
Title	Protection of the Rio Paraopeba watershed		
Sector and CRS code	Water supply, sanitation and wastewater management – large systems (CRS code 14020)		
Project number	BMZ No. 2009 66 929		
Client	Federal Ministry for Economic Cooperation and Development (BMZ)		
Recipient / Project executing agency	Companhia de Saneamento de Minas Gerais (COPASA MG)		
Project volume / financing instrument	EUR 100 million / FC development loan		
Project duration	2011 (loan agreement) to 2020 (final inspection)		
Reporting year	2025	**Year of random sample**	2022

Project objectives and implementation

The outcome-level objective underlying the EPE was the efficient, proper, environmentally and socially compatible collection, treatment and disposal of wastewater at the programme locations, as well as the disposal of the resulting sludge and residual materials. The EPE's overarching development policy impact objective is to improve the environmental situation and living conditions of the population and to protect surface waters and springs in the Rio Paraopeba catchment area.

A total of 336 km of sewage networks and collectors, three sewage treatment plants and a treatment plant for sludge from drinking water production were built in several cities.

Overall assessment:
moderately successful



Key findings

The project achieved its intended development policy impact, but fell short of expectations and is therefore rated as "moderately successful":

- In line with Brazilian priorities, the project conceptually addressed a key bottleneck with the right measures.
- During implementation, it became apparent that, due to the poor quality of existing data and planning documents, the scope of the project had been significantly overestimated in the concept with regard to the measures that could be implemented with the funds available.
- As a result, significantly fewer sewage networks and treatment plants were built than intended. The target values for properly treated wastewater and sewer connections are therefore not being achieved at the project sites. However, the sewage treatment plants and the treatment plant for sludge from drinking water treatment that were implemented comply with the specified discharge and performance values, and any residual materials are disposed of properly.
- In the vicinity of the respective locations, the measures contributed to the intended overarching development policy effects. However, as less was built than planned, these effects are less than envisaged.
- The positive contribution to water quality is limited to the receiving waters in the immediate vicinity of the sewage treatment plants. In view of the relatively small scope of the measures implemented and the large number of inputs into the waters of the catchment area that cannot be influenced by the project, no significant positive effects of the project on the Rio Paraopeba catchment area are to be expected. Any potential effects on the Rio Paraopeba are negated by the mining accident in Brumadinho (2019) and the contamination of the river over hundreds of kilometres.
- Despite the weaknesses identified in some areas of operational management and maintenance, the solid position of the project sponsor and its expertise suggest that the project will have a sustainable impact overall.

Conclusions

- Even for large and experienced institutions, it is essential during the concept development/review phase, it is essential to thoroughly analyse and critically examine the quality of the inventory data and planning documents and their internal quality control, as well as the project planning and implementation processes.
- A systematic review of (externally) prepared planning documents is essential prior to tendering in order to prevent cost increases, a reduction in the scope of measures and delays in implementation.
- When planning sewage networks and collectors, it is essential to check whether, due to the topography, settlement structure or other local conditions, alternative technical concepts for sewage collection are also necessary locally in addition to the construction of conventional sewage collection systems.

Ex-post evaluation – assessment according to OECD DAC criteria

Overview of sub-evaluations:

Relevance	2
Coherence	2
Effectiveness	3
Efficiency	4
Overarching development policy impacts	3
Sustainability	3
Overall assessment:	**3**

List of abbreviations:

AK	Final inspection
BMZ	Federal Ministry for Economic Cooperation and Development
COPASA	Companhia de Saneamento de Minas Gerais (Water supply and wastewater disposal company of Minas Gerais)
DAC	Development Assistance Committee
EUR	Euro
ETE	Estação de tratamento de águas residuais (wastewater treatment plant)
FC	Financial cooperation
FC E	FZ Evaluation
IGAM	Instituto Mineiro de Gestão das Águas (Institute for Water Management of the State of Minas Gerais)
PLANSAB	Plano Nacional de Saneamento Básico (National Basic Sanitation Plan)
PA	Programme appraisal
PAR	Programme review report
PPP	Public-private partnership
TC	Technical cooperation
UGP	Unidade de gerenciamento de programa (Programme Implementation Unit)
UTR	Usina de Tratamento de resíduos (treatment plant for sludge from drinking water treatment)

General conditions and classification of the project

The state of Minas Gerais is relatively rich in water and important for water resource management throughout Brazil. Numerous rivers and watersheds that are of great importance for the water supply of the population, irrigation, industry and the preservation of ecosystems in other parts of the country originate in Minas Gerais. The Rio São Francisco, considered one of the most important waterways in the country, has its source in Minas Gerais.

The Rio Paraopeba catchment area (project programme area) is, alongside the Rio das Velhas catchment area, the sub-catchment area of the Rio São Francisco in the state of Minas Gerais with the greatest potential for pollution in terms of its population and economic structure.

The Rio Paraopeba catchment area can be divided into three regions: (1) Alto Paraopeba (upper course) with intensive mining activity, (2) the densely populated region of Médio Paraopeba (middle course) bordering the Belo Horizonte metropolitan area, and (3) the sparsely populated region of Baixo Paraopeba (lower course), which is mainly used for agriculture. The two most important economic sectors, mining and steel, are mainly located in the upper and middle reaches of the river. In addition to its importance as a major economic region, the Belo Horizonte metropolitan area is also important for drinking water production.

As mentioned above, the Paraopeba catchment area has a high degree of urbanisation due to its proximity to the Belo Horizonte metropolitan area. At the time of the project review, the largest cities were Betim with 415,000 inhabitants, Conselheiro Lafaiete with 122,000, Ibirité with 160,000, Congonhas with 47,000 and Igarapé with 37,000.

Brief description of the project

In order to improve the environmental situation and living conditions of the population and to protect surface waters and springs in the Rio Paraopeba catchment area, the project involved the collection, treatment and disposal of wastewater and the disposal of sludge and residual materials, the expansion of sewage networks and collectors, the construction of sewage treatment plants in the cities of Betim, Conselheiro Lafaiete, Ibirité, Congonhas, Igarapé, Mario Campos, Mateus Leme and São Joaquim de Bicas, and the construction of sludge treatment plants for the drinking water treatment plants in Vargem das Flores (Betim) and Serra Azul (Juatuba). The project also included surface water and spring protection measures in spring areas of central importance for drinking water supply. The project was carried out by the water supply and wastewater disposal company Companhia de Saneamento de Minas Gerais (COPASA).

Ultimately, only (and at a significantly lower level than planned) were built at the Ibirité, Congonhas and Mateus Leme, São Joaquim de Bicas sewage networks and collectors. Furthermore, sewage treatment plants were only built at the Conselheiro Lafaiete, Ibirité and Mateus Leme sites, and only the sludge water treatment plant for the Serra Azul drinking water treatment plant (Juatuba) was built. The sites in Mario Campos (due to lack of a concession), Betim (other funding) and Igarapé (tender not compatible with the FC) were excluded from the project. With regard to surface water and spring protection measures, a large number of small-scale measures were implemented by the project promoter.

The direct target group of the project was the population at the programme locations, who benefited directly from the improvement of environmental and living conditions and the protection of surface waters and springs in the catchment area.

Breakdown of total costs

In EUR million	Inv. (plan)	Inv. (Actual)
Total costs	**150**	**123.15**
Own contribution	50*	23.15**
External funding	100	100
of which BMZ funds	*100*	*100*

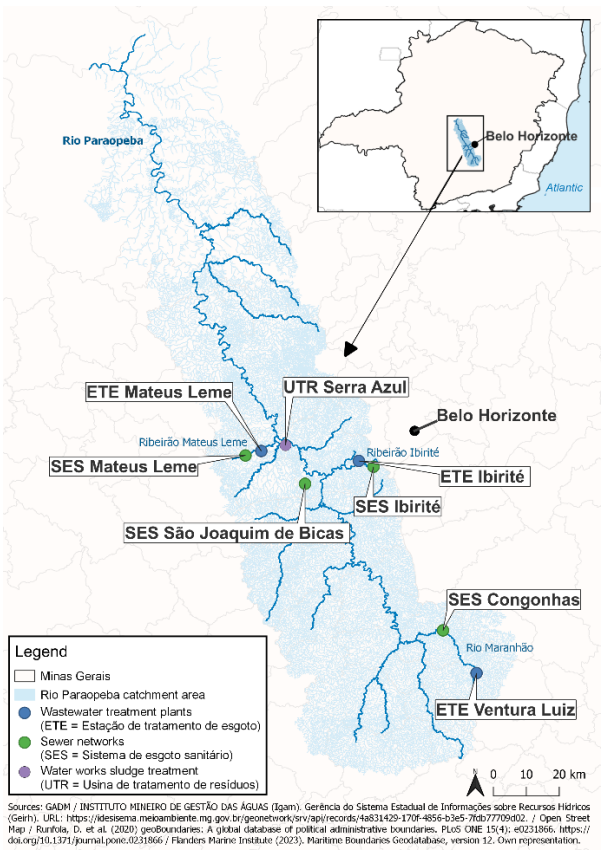
* EUR 44 million (COPASA) + EUR 6 million (target group for in-house connections, work performed in the context of the source protection component)

** Own contribution of target group not included (not quantifiable according to final inspection)

Map of the project country including project locations

Figure 1 – Map of the project region

Figure 2 – Map of the Rio Paraopeba catchment area and implemented locations



Assessment according to OECD DAC criteria

Relevance

1. Alignment with policies and priorities

At the time the project was reviewed (2009/2010), the water, wastewater and waste sector was one of the Brazilian government's key areas of action in the field of public infrastructure due to its fundamental importance for people's living conditions and the protection of water resources.

The project's objectives were in line with the Brazilian environmental policy priorities at the time regarding the protection of water catchment areas of central importance to humans and the preservation of ecosystems. By improving the water quality of the Paraopeba tributary, the project addressed Brazil's priority of revitalising the Rio São Francisco catchment area, one of the country's most important waterways, and was guided by the principles of Brazilian water resource policy, which takes an integrated approach to water resources. From today's perspective, the project is also in line with the priorities of the Brazilian Basic Sanitation Plan (Plano Nacional de Saneamento Básico, PLANSAB) and the state and municipal water and sanitation plans of Minas Gerais. The main objective of these plans is to provide access to water and sanitation for all (Universalização do Saneamento Básico).

The project was also in line with Germany's development policy objectives. Although it did not directly fit into the focus of German development cooperation with Brazil, it was linked to the general objective of German development cooperation in Brazil ( ) to make a sustainable contribution to environmental and climate protection. The field of municipal environmental protection with the aim of sustainable water resource management is directly related to environmental and climate protection.

In the years prior to the project review, the sectoral framework was fundamentally revised and modern, transparent framework legislation was created, which had to be implemented gradually. As in the rest of Brazil, municipal environmental and resource protection had become a political focus in Minas Gerais due to increasing environmental problems. In view of the considerable environmental pollution caused by inadequate wastewater collection and treatment, the State Environmental Council (Conselho Estadual de Política Ambiental, COPAM) adopted binding requirements for municipalities with regard to wastewater collection and treatment in 2006 (Deliberacão Normativa No. 96). These requirements stipulate that municipalities must significantly increase their wastewater collection and treatment rates within specified time frames, graded according to the number of inhabitants.

2. Alignment with the needs and capacities of stakeholders and beneficiaries

Like other regions of Brazil, the state of Minas Gerais was confronted with severe pollution of its water resources, particularly in urban centres. At the time the project was reviewed, the environmental situation and sanitation in the Rio Paraopeba catchment area were precarious in many places. At many measuring stations, the water quality in the rivers did not meet the limits for the respective water quality class. The most polluted regions were located in the lower reaches of the large urban settlements and were sub-catchment areas/tributaries of the Rio Paraopeba: Rio Betim (pollution from the city of Betim), Rio Ibirité (pollution from the cities of Ibirité and Mario Campos), Rio Maranhão (cities of Congonhas and Conselheiro Lafaiete), Ribeirão São Joaquim (cities of Igarapé and São Joaquim de Bicas) and sections of the Rio Paraopeba. As a result, ecosystems were endangered and the living conditions and health of the population were impaired by inadequate sanitation and pollution of surface waters.

The main causes of environmental and water resource pollution were inadequate or non-existent collection and treatment of domestic, commercial and industrial wastewater, improper use and settlement of land, soil and springs, and the extraction and processing of minerals. Agriculture and livestock farming posed an additional challenge in the surface waters and spring areas used for drinking water extraction.

The core problem was correctly identified and still persists today. Consequently, the project addressed measures to eliminate a significant part of the main causes of pollution and had the potential to contribute to solving the core problem in terms of the threat to humans and the environment and the deterioration of living conditions for the population at the locations of the individual measures. This is considered appropriate from both a contemporary and a retrospective perspective. However, in retrospect, the programme's potential contribution to the desired

effects of protecting the Três Marias reservoir and revitalising the São Francisco River in terms of integrated water resource management is considered to be minor and insignificant. This is due, on the one hand, to the scope of the programme's planned measures in relation to the size of the water catchment area and, on the other hand, to other influencing factors outside the programme (e.g. agriculture, industry, mining).

The entire population of the municipalities is affected by the heavily polluted streams and rivers in the settlement areas, which not only pose significant health risks but also cause odour nuisance. The project was not specifically designed to connect low-income residential areas or particularly disadvantaged or vulnerable groups, nor was it gender-specific. Sewage systems benefit men and women equally. Nevertheless, it stands to reason that women and children in particular will derive the greatest benefit from the improvement in hygienic conditions in their immediate living environment, as the improved environmental situation is expected to reduce health risks and the burden of caring for sick children, which is primarily assumed by women.

The main criteria for selecting the locations were the degree of pollution of the watercourses and the existence and/or coverage of sewage collection, disposal and treatment systems, as well as the existence of basic projects or planning studies. The planned locations included the largest cities in the metropolitan region (see *framework conditions and classification of the project*). The expansion of networks and collectors also included plans to connect poorer urban areas and informal settlements. In retrospect, however, connecting informal settlements proved to be very difficult due to the topography and irregular settlement structure. It became apparent that classic wastewater collection, especially at the level of house connections, is not possible from the perspective of a conventional collection system in public spaces and that adapted technical concepts for wastewater collection are required. These include, for example, concepts for rear connections to houses and the routing of rainwater and sewage through already built-up properties.

Due to the social tariff for low-income households and the selective subsidisation of internal connections, it was expected at the time of the review that the additional financial burden on the (poor) population would be within reasonable limits.

3. Appropriateness of design

The decision to rely on COPASA as the implementing agency is understandable. At the time of the audit, COPASA was a water supply and wastewater disposal company with the state of Minas Gerais as its majority shareholder, responsible for supplying drinking water to 63% of the population of Minas Gerais and for wastewater disposal for 36% of the population of Minas Gerais. At the time of the audit, both the supply and disposal rates and the quality of services in COPASA's concession areas were well above the national and state averages. COPASA stood out for its high technical and solid financial performance in a national comparison and, at the time of the audit, was considered one of Brazil's best-performing utilities and suitable for planning, implementing and operating the challenging project.

At the time of the audit, wastewater treatment was still a relatively new field for COPASA, as it was for most utility companies in Brazil. Conceptually, it was therefore logical to provide the agency with support in selected areas by a consultant with specific expertise. Similarly, due to the large number and complexity of the measures, it was planned that COPASA would establish a programme management unit (, UGP) for overall internal and external coordination and staff it appropriately. The planning, implementation and monitoring of specific individual investments and consulting services was to remain the responsibility of the relevant operational departments of the company.

In the course of programme implementation, it became apparent that COPASA had little or inconsistent information on existing networks and actual sewer connections to existing networks (customer register) and, as a result, the actual situation at the time was not sufficiently known prior to implementation. Furthermore, it became apparent that the planning documents (Projeto Básico and Projeto Executivo, roughly comparable to draft and implementation planning) were often inadequate and not adapted to local conditions (see section 2. *Alignment with the needs and capacities of stakeholders and affected parties)*. It is considered critical that it was COPASA's standard practice at the time to initiate the necessary procedures relating to land issues and environmental permits only after the construction contract had been signed.

In retrospect, the analysis and critical examination of the database on existing house connections and sewage networks, as well as COPASA's project planning and implementation processes, are assessed as inadequate and conceptually weak. Within the framework of the ex-post evaluation, it is not possible to conclusively assess to what extent a more in-depth analysis and critical examination of the database on existing house connections and

sewage networks and collectors, as well as COPASA's project planning and implementation processes, would have revealed the extent of the above-mentioned weaknesses at the time of the audit and whether targeted measures could have been taken to counteract them.

The following replicated impact logic formed the basis of the project: Project financing (input)→ Expansion or construction of sewage networks and collectors, construction of sewage treatment plants, construction of sludge treatment plants for drinking water treatment, and surface water and spring protection measures (output)→ Proper collection, treatment and disposal of sewage, and proper disposal of sludge and residual materials (Outcome)→ Reduction of surface water and environmental pollution→ Improvement of the environmental situation/sanitation and living conditions of the population (overarching development policy impacts).

The chain of effects outlined above and its assumptions were fundamentally plausible at the time of the audit and the ex-post evaluation. However, the audit report does not continue the chain of effects with regard to the impact target formulation postulated therein. The original objective at the impact level was to contribute to the protection of the Três Marias reservoir and the Rio São Francisco. No indicators were defined for this at the impact level during the audit. From the perspective of the ex-post evaluation, the programme's potential contribution to the desired effects of protecting the Três Marias reservoir and revitalising the Rio São Francisco is considered to be low due to the scope of the measures planned within the project and other influencing factors outside the project (e.g. agriculture, industry, mining). Its contribution to improving surface waters and the environment in the vicinity of the sites is undisputed. However, even at the time of the audit, it was unrealistic and overly ambitious to expect that parameters such as dissolved oxygen over a length of 500 km and the concentration of coliform bacteria over a length of 300 km (original outcome indicators) could be significantly influenced by the project.

Overall, it should be noted that, as previously stated in the review report, there is a significant gap in the allocation at the impact level. The original outcome target (improvement of the environmental situation and living conditions of the population in the Paraopeba river basin through the protection of surface waters and springs from pollution) is typically located at the impact level in this sector and is also more appropriate for the project. The wording of the results (outputs), such as "hygienic and ecologically safe collection, discharge and treatment of collected wastewater", "proper sludge treatment and disposal", and the original output indicators are also located at the outcome level, as is customary in the sector. Overall, the original target formulations, their indicators and their value assignment were only partially appropriate.

During the implementation of the project, the above-mentioned original outcome indicators were sensibly revised and related to available metrics, but they were still left at the outcome level, even though they should be attributed to the impact level. Similarly, the output indicators were partially adjusted but remained at the output level, even though, as mentioned above, they should be attributed to the outcome level.

Due to the significant gap in classification with regard to the impact-level objective and the unusual formulation and classification of output and outcome as well as their indicators, the target system was comprehensively adjusted as part of the ex-post evaluation (see *Appendix: Target System and Indicators*).

In retrospect, the scope of the measures and the connection rate achievable with the financial resources were significantly overestimated in the design phase of the programme, as COPASA's target figures were too optimistic and, as mentioned above, the planning documents did not take sufficient account of local conditions. In the course of programme implementation, it also became apparent, as mentioned above, that the information provided by COPASA on existing networks and the actual connection rate to existing networks was inconsistent and that the actual situation was therefore different than expected. The conceptual overestimation of the feasible scope of measures is underlined by the fact that the actual specific costs of the project are in line with comparable projects implemented at national and state level (see section *11. Production efficiency)*.

From the perspective of the ex-post evaluation, the four-year duration envisaged for the programme (from the signing of the loan agreement to the final inspection) was an unrealistically tight timeframe for a project of this size and with so many locations – even though some planning documents were available or in preparation at the time of the project review and individual tenders had already been launched.

In principle, the project pursued a holistic approach to sustainable development. The project primarily aimed at ecological and economic sustainability, as at the time of the audit there was no sensible ecological and macroeconomic alternative for improving the environmental situation and sanitation (see *Efficiency – Allocation Efficiency)*. Ultimately, the project also has a socio-economic impact by reducing health risks, as it reduces disease and thus creates an important prerequisite for reliable employment.

4. *Adaptability – response to change*

The project was adjusted several times during implementation. However, this was not due to changes in the framework conditions (risks and potential), but rather to the weaknesses mentioned under *3. Appropriateness of the concept* (inconsistent data on customers and existing networks, inadequate planning documents that were not adapted to local conditions, and COPASA's project planning and implementation processes), which necessitated adjustments to the scope and consequently led to significantly fewer measures being implemented within the framework of the project ( ) (see *Effectiveness – Contribution to the achievement of objectives)*.

Rating summary

The assessment of relevance presents a mixed picture. On the one hand, the core problem was correctly identified and the project conceptually addressed a central bottleneck with the right measures. Furthermore, it was in line with the policies and priorities of both the Brazilian and German governments. On the other hand, in retrospect it became apparent that COPASA's customer and network data, planning documents, project planning and implementation processes were inadequate and had probably not been sufficiently analysed and critically examined during the design phase. As a result, the actual situation was not sufficiently known in advance and the scope of possible measures was significantly overestimated in the design. The impact logic underlying the project was fundamentally sound, but the level of ambition was unrealistic or excessive. Overall, the relevance is considered successful. The decisive factor for the still successful assessment is that, despite the aforementioned conceptual weaknesses, the core problem was correctly identified and addressed with the right measures, and that Brazilian and German priorities and policies were fully complied with.

Relevance: 2

Coherence

5. *Internal coherence*

The project tied in with the general objective of German development cooperation in Brazil to make a sustainable contribution to environmental and climate protection. However, it was not directly aligned with the focus of German development cooperation with Brazil at the time, which was geared towards renewable energies and energy efficiency as well as the protection and sustainable management of tropical forests. However, the field of municipal environmental protection with the aim of sustainable water resource management is directly related to environmental and climate protection. Furthermore, the intended effects of the project are in line with the objectives of the Climate and Environmental Protection Initiative under which it was funded.

There are direct synergies between the project and the follow-up project "Municipal Environmental Protection". The lessons learned from the evaluated project were taken into account in the design of the follow-up project.

At the time of the review, there were potential synergies with the PPP project of the Technical Cooperation (TC) in the area of "Energy use of biogas and energy efficiency at municipal sewage treatment plants". The PPP measure was implemented as part of the development cooperation priority "Energy (energy efficiency and renewable energies)". The extent to which the results of the PPP measure were incorporated into the programme could not be clarified retrospectively. Nor was it possible to clarify retrospectively what consulting services were provided to COPASA on the use of biogas.

The project was consistent with the MDGs at the time, specifically MDG 7 (sustainable use of natural resources), MDG 4 (reduction of child and maternal mortality) and MDG 6 (reduction of water-induced diseases). At the time of the audit, Brazil was relatively far from achieving the development goal of "halving the proportion of people without adequate sanitation", part of MDG 7. It was also consistent with the SDGs of the current Agenda 2030 and the Paris Climate Agreement (see *contributions to Agenda 2030)*.

6. *External coherence*

The project was consistent with Brazil's efforts under the programme to revitalise the São Francisco River basin. The Brazilian government provided substantial funding for the revitalisation programme. Most of these funds were earmarked for urban wastewater and waste management. The programme to combat pollution in the Rio Paraopeba basin thus directly complemented the measures taken by the Brazilian government.

By working with COPASA, the central player in the field of water supply and wastewater disposal, the project drew on existing national structures. COPASA is responsible for monitoring inflow and effluent values. The water quality of the state is monitored at defined measuring points by the Institute for Water Management (*Instituto Mineiro de Gestão das Águas – IGAM)*, which is responsible for monitoring the state of Minas Gerais.

At the time the project was reviewed, the most important donors in the field of environmental protection and municipal resources in Brazil were the Inter-American Development Bank (IDB) and the World Bank. They supported the Brazilian government in financing and implementing large-scale projects and improving the sector structure. At that time, there was no specific cooperation or coordination between German financial cooperation and national and multilateral financial institutions in the field of municipal environmental and resource protection.

Beyond the FC follow-up project, COPASA continues to invest in the expansion and extension of water and wastewater networks and collectors, as well as the construction of wastewater treatment plants in the concession area, with national and international financing from the Agence Française de Développement (AfD) and the European Investment Bank (EIB).

Rating summary

The project was linked to the general objective of German development cooperation in Brazil to make a sustainable contribution to environmental and climate protection and was implemented outside the scope of the focus on Brazil at the time. Against this background, there was no explicit division of labour with technical cooperation. Potential synergy effects with a PPP project of technical cooperation could not be conclusively clarified.

The project was consistent with the Millennium Development Goals (MDGs), the Sustainable Development Goals (SDGs) of Agenda 2030 and the Paris Climate Agreement. It also complemented and supported Brazil's own efforts, drawing on existing national structures. Overall, coherence is assessed as successful.

Coherence: 2

Effectiveness

7. Achievement of (intended) objectives

The outcome-level objective underlying the EPE was the efficient, proper, environmentally and socially compatible collection, treatment and disposal of domestic wastewater at the programme sites, as well as the disposal of the resulting sludge and residual materials.

The achievement of the target at outcome level can be summarised as follows for the components of wastewater collection, sewage treatment plants and sludge treatment or disposal, and source protection measures. It should be noted that the **actual values of the project completion report (PCR) for the indicators relating to the expansion of sewage networks and collectors as well as surface/source protection measures represent the actual status after completion of the project.** As the expansion of sewage networks and collectors and surface/source protection measures is an ongoing activity of COPASA, the actual values at the time of the ex-post evaluation go beyond the contribution of the project.

Table Target achievement Outcome:

Indicator	Status PA (baseline 12/2008)	Target value at PA/EPE	Actual value at PCR (2018/2019)	Actual value for EPE
(1) Properly collected domestic wastewater at the project sites	64 %	<75 % (PP)	78 % 76 % [1)] **Met**	84 80 %[1)]
(2) Proportion of domestic wastewater properly collected at the project sites with wastewater	0 %	90 % (PP)	65 % [2)] **Not met**	80 % [2)] 65 % [3)]

treatment plants (wastewater volume)				
(3) Actual increase in sewer connections at the project sites	-	17,700 (2012)	15,806 **Not met**	48,663
(4) Effluent values from sewage treatment plants comply with the statutory minimum standards (DN CO-PAM/CERH-MG No. 1/2008)	-	90 % (PA) 100 % (EPE)	83 % **Not met**	100 %
(5) Properly disposed sewage sludge	-	<80% (PA) 100% (EPE)	100% [4)] **Compliant**	100 %
(6) Properly collected and flared sewage gases	-	Capture: Yes Flaring: yes (EPE)	Collection: Yes Flare: Partially **Partially fulfilled**	Version: partially [5)] Flaring: partially[5)]
(7) Energy use of biogas	-	Yes (EPE)	Yes **Fulfilled**	Yes
(8) Purified process water from drinking water treatment complies with legal requirements (DN CO-PAM/CERH-MG No. 1/2008).	-	90 % (PA) 100 % (EPE)	No continuous operation [6)] **Not fulfilled**	100 % [6)]
(9) Properly disposed sludge from sludge treatment in the drinking water treatment plant	-	90% (PP)	-	100 %
(10) House connections that can be connected to the sewage network as a result of the project (identification/mobilisation campaign)	-	33,757 (2012)	22,841 [7)] **Not fulfilled**	-
(11) Protective measures for surface waters and springs	-	30 sub-catchment areas and 900 km² area (PA)	30 sub-catchment areas and 400 km² area **Compliant**	30 sub-catchment areas and ~1,400 km² area[8)]

1) Excluding São Joaquim de Bicas, as contrary to the original plan, the sewage treatment plant was not implemented and no house connections were made despite the expansion of the network and collectors. The sewage treatment plant will be implemented in the follow-up project "Municipal Environmental Protection".

2) Only applies to project locations with sewage treatment plants (Mateus Leme, Conselheiro Lafaiete, Ibirité).

3) Including the locations Congonhas and S.J. de Bicas, where networks and collectors were expanded but no sewage treatment plants were built.

4) Refers only to the sewage treatment plants in Mateus Leme and Ibirité, as no data was available from the Ventura Luiz sewage treatment plant (Conselheiro Lafaite).

5) Biogas flaring at the Ventura Luiz sewage treatment plant (Conselheiro Lafaite) is not continuous due to operational and/or construction problems. Comparable plants operate continuously.

6) According to operating personnel, sludge treatment has only been in continuous operation since 2024. This means that until 2024, the backwash water from the filter (sludge from drinking water treatment) was discharged untreated into the receiving watercourse. Currently, the sludge treatment plant at the Serra Azul drinking water treatment plant can only treat about 70% of the filter backwash water. The rest flows untreated into the receiving watercourse.

7) Results of social mobilisation (identified house connections) in the categories "immediate income/connectable", "feasible with high connection costs" and "feasible with low connection costs". Information does not include data from the Mateus Leme and São Joaquim de Bicas sites (not available).

8) Information refers exclusively to the "Pró-Mananciais" programme launched in 2017.

8. Contribution to achieving the objectives

Of the 336 km of planned sewage network and collectors (2009-2012), only 185 km (AK) were extended at four locations. Furthermore, only three of six sewage treatment plants were built. Of the two sludge treatment plants originally planned for drinking water treatment, only one of two plants was implemented. In this case, only half of the capacity was implemented with a modified process (see *18. Sustainability of effects over time)*.

The changes to the scope of the measures implemented are primarily due to the partially inadequate planning documents, insufficient knowledge of the actual situation on site and inconsistent data on the existing network and customers, partly difficult topography, underestimated costs, price increases and the project management practices common at the time, as well as insufficient (personnel) capacities at COPASA (see section *9. Quality of implementation)*. With regard to the sludge treatment plants for drinking water treatment, COPASA's focus had changed in view of the extreme drought and the resulting water crisis (2014-2016). As a result of the drought, the volume of process water to be treated for drinking water production had decreased dramatically and COPASA's (investment) focus had shifted to ensuring basic drinking water supply, particularly in the Belo Horizonte metropolitan area (see Section *11. Production efficiency)*.

With regard to the achievement of indicator targets (see *table: Target achievement outcome***)**, the picture is very mixed. The target value for properly collected domestic wastewater (indicator 1) is being achieved at the project sites. However, connecting informal settlements proved to be very challenging due to the topography and irregular settlement structure. Alternative development concepts for wastewater collection are needed there (see Section 2*. Alignment with the needs and capacities of stakeholders and affected parties)*.

The target value for properly treated wastewater at the project sites with sewage treatment plants (indicator 2) was not achieved after completion of the project and has not been achieved to date. The legally prescribed discharge values (indicator 4) were not achieved after completion of implementation but are being complied with at the time of the EPE. The sewage sludge from the plants has been and continues to be disposed of properly at licensed landfills (indicator 5). The collection and flaring of sewage gases is only partially fulfilled (indicator 6). At the sewage treatment plants, sewage gases are properly collected and flared at two of the three plants. At the Ventura Luiz sewage treatment plant in Conselheiro Lafaiete, biogas flaring is not continuous. This is due to operational and/or structural problems with the piping, which affect the flaring of biogas. At the Ibirité sewage treatment plant, biogas is used for energy as intended (indicator 7). The biogas is used to generate electricity and for the sludge drying and incineration plant. The use of biogas for energy is carried out on a pilot (small) scale.

Against the backdrop of reduced network and collector expansion, the expected increase in sewer connections (indicator 3) will not be achieved after implementation is complete. However, this is also related to insufficient knowledge of the actual situation on the ground with regard to existing networks and actual and potential house connections, as well as inconsistent data in the customer register (see 3*. Adequacy of the design)* and is also reflected in the failure to achieve the number of connections that can be connected to the sewerage network (indicator 10). These were collected as part of a mobilisation and diagnostic campaign and were one third below the number of connectable connections assumed in 2012. It stands to reason that the number of connections to the sewage network that could potentially be achieved was overestimated in the planning phase. This illustrates the unreliability of COPASA's existing data at the time.

According to operating personnel, the sludge treatment plant at the Serra Azul drinking water treatment plant has only been in continuous operation since 2024. As the drinking water is treated from surface water, a significant amount of chemical-containing sludge is produced in the individual stages of the water treatment process, which was discharged untreated into the receiving watercourse until 2024. At the time of the ex-post evaluation, the sludge treatment plant at the Serra Azul drinking water treatment plant can treat around 70% of the backwash water from the filter. The rest flows untreated into the receiving watercourse. At the time of the ex-post evaluation, the treated sludge water complies with legal requirements (indicator 8). The sludge is also disposed of properly in licensed landfills (indicator 9).

The (small-scale) protective measures for surface waters and springs implemented by COPASA itself were carried out and the target values were achieved (indicator 11).

9. *Quality of implementation*

The implementation revealed weaknesses in COPASA's project planning and implementation processes. In addition to inconsistent information on the existing network and customers, it was common practice at COPASA to initiate the necessary procedures relating to land issues and environmental permits only after the construction contract had been signed. There was no systematic, detailed review of the (externally) prepared planning documents. The aforementioned aspects, as well as insufficient personnel capacity in the COPASA departments responsible for implementation and in the coordinating project management unit, led to additional costs and massive delays. The planned duration of four years was significantly exceeded, with the project ultimately taking eight years to complete. However, the planned duration of four years was too short for a project of this magnitude (see 3. *Appropriateness of design)*.

10. *Unintended effects (positive or negative)*

The ex-post evaluation did not identify any negative unintended effects of the project on people or the environment, either during the construction or the operational phase. COPASA obtained environmental permits for construction and operation in accordance with legal requirements.

Rating summary

The achievement of the indicator targets presents a very mixed picture. The target values for properly treated wastewater and sewer connections have not been met. This is related to the insufficient knowledge of the initial situation that came to light during the implementation phase, partly inadequate planning documents and weaknesses in COPASA's project planning and implementation processes. In addition to underestimated costs, there were also price increases. As a result, significantly fewer wastewater networks, collectors and treatment plants were implemented than planned. On the other hand, the indicators relating to the effluent values of the treatment plants and the sludge treatment plant at the Serra Azul drinking water treatment plant are being met and residual materials are being disposed of properly. At one of three sewage treatment plants, only some of the sewage gases are flared. Experience is being gained on a pilot scale with the use of biogas at one plant. Furthermore, the targets for surface water and spring protection measures have been achieved.

The achievement of objectives is below expectations. However, as the positive results outweigh the negative ones, the overall effectiveness of the project is still considered to be moderately successful.

Effectiveness: 3

Efficiency

11. *Production efficiency*

At the time of the project review (2009/2010), the total cost was estimated at just under EUR 150 million (BRL 396 million). Financing was to be provided by an FC development loan of EUR 100 million (BRL 265 million) and an own contribution of around EUR 49 million (BRL 131 million), of which around EUR 44 million (BRL 116 million) was to come from COPASA. The remaining portion of the own funds was to be financed by the prefectures and customers in the amount of just under EUR 6 million (BRL 15 million).[1]

The total cost of the programme amounted to BRL 414 million (AK), of which BRL 336 million was financed by the FC development loan and BRL 77 million by COPASA's own contribution. The total cost in EUR amounts to EUR 123 million, of which EUR 100 million was financed by German Financial Cooperation and EUR 23 million by COPASA.[2] According to the final review, the target group's own contribution could not be quantified. COPASA's own contribution mentioned above is lower than planned and, according to the final review, amounts to approximately 19% instead of the planned 29%. According to the final review, this is due, among other things, to the fact that several planned construction measures could no longer be implemented within the framework of the project due to slow project preparation. In addition, according to the final review, the extreme drought of 2024-2016 led to a shift in COPASA's investment priorities. As a result of the drought, COPASA made considerable financial efforts to ensure the basic supply of drinking water to its customers. In view of this exceptional situation, the AK

[1] Exchange rate 1 EUR = 2.65 BRL – rounded amounts
[2] Exchange rate 1 EUR = 3.37 BRL – average term (calculated on the basis of the respective daily rates at the time of payment)

concluded that the reduced own contribution was acceptable. From the perspective of the ex-post evaluation, this is fundamentally understandable. It remains unclear what proportion of the reduced own contribution can be attributed to weaknesses in the planning and implementation processes and what proportion of the reduction is due to the drought.

At the time of the audit (2010), based on the information and documents provided by COPASA, it was estimated that these funds would enable the construction of 650 km of sewage network and collectors as well as eight sewage treatment plants. Before the measures were implemented (2012), it was assumed, based on the design and implementation plans available at that time, that the available funds would be sufficient to implement 336 km of sewage network and collectors, six sewage treatment plants and two treatment plants for waterworks sludge for drinking water treatment plants.

During the implementation of the project, there were significant cost increases, particularly in the expansion of the sewage network and collectors. These cost increases could not be offset by the sharp devaluation of the Brazilian real (BRL). Ultimately, only 185 km of sewage network and collectors were completed, and three sewage treatment plants and a sludge treatment plant for drinking water treatment were built.

On the one hand, the construction costs were significantly underestimated in advance – both in the design phase and in the project planning phase up to 2012 – which was partly due to insufficient consideration of local conditions such as steep slopes and informal settlement structures. On the other hand, the weaknesses outlined in section *8, Contribution to the achievement of objectives*, regarding knowledge of the initial situation, planning documents and COPASA's planning and implementation processes led to additional costs. Further cost increases are attributable to the fact that a significant proportion of the measures were contracted during the economic boom years (2011–2014), when the general price level in the construction sector in Brazil was very high.

Against this background, it is surprising that the specific costs for sewage networks and collectors as well as for the wastewater treatment plants are in line with comparable projects at national and state level. However, this does not mean that the project's production efficiency was adequate. Without the weaknesses outlined above, it is certain that (significantly) more measures could have been implemented. Production efficiency is therefore considered to be rather unsuccessful.

12. Allocation efficiency

The large-scale construction of sewerage systems and sewage treatment plants was essential and unavoidable for the intended improvement of the environmental situation and living conditions of the population as well as the protection of surface waters and springs, even if alternative concepts to conventional wastewater construction would have been necessary at some individual locations (see section *2. Alignment with the needs and capacities of stakeholders and affected parties*).

No profitability calculations were carried out for the individual locations. COPASA operates on a full cost recovery basis, with all investment and operating costs covered by tariff revenues. In addition to full cost recovery, COPASA has also been able to generate profits in recent years. The financial burden on poor sections of the target group was taken into account through subsidised financing for the internal piping to be installed by the customers themselves and through social tariffs. The proportion of customers with social tariffs has been between 9 and 15% in recent years (2012: 11.44%, 2018: 15.43% and 2023: 9.32%). For all (domestic) customers, connection at the external connection point is free of charge.

Rating summary

Although the large-scale construction of sewerage systems and sewage treatment plants is essential and there is no alternative (allocation efficiency), production efficiency, which is significantly below expectations and possibilities, considerably impairs the potential positive effects at the macroeconomic level. Overall, efficiency is therefore assessed as rather unsuccessful.

Efficiency: 4

Overarching development policy effects

13. Overarching (intended) developmental changes

The objective underlying the EPE at the level of overarching development policy impacts is to improve the environmental situation and living conditions of the population and to protect surface waters and springs in the Rio Paraopeba catchment area.

As part of the ex-post evaluation, the formulation of the objective at the level of overarching development policy impacts was adjusted and the water quality indicators adjusted during the implementation phase were moved from the outcome level to the level of overarching development policy impacts (see Section *3. Appropriateness of the design*).

Thanks to COPASA's ongoing activities to expand sewage networks and collectors, construct and expand sewage treatment plants, and protect surface waters and springs, the environmental situation, living conditions of the population, and protection of surface waters and springs are expected to improve in COPASA's area of operation, or at least in the immediate vicinity of the respective locations. the living conditions of the population and the protection of surface waters and springs. This is suggested by the data available for the project locations at the time of the ex-post evaluation (see *table Target achievement outcome).*

The achievement of the objective at the impact level can be summarised as follows.

Table: Impact target achievement:

Indicator	Status at PA	Target value at EPE	Actual value at PCR	Actual value at EPE
(1) The discharge values of the sewage treatment plants comply with the requirements of the respective environmental licence and enable compliance with the water quality class in the water body.	-	**Compliant**	**Compliant**	**Fulfilled**

14. Contribution to overarching (intended) developmental changes

The effluent values of the three wastewater treatment plants constructed as part of the project met the requirements of the respective environmental permit both after completion of the project (AK) and at the time of the ex-post evaluation and correspond to the water quality class of the water body. In conjunction with the effects of the project measures outlined in Section 8. *Contribution to the achievement of objectives*, it can be assumed that the project contributes to the protection of the environment and surface waters, with corresponding positive effects on the living conditions of the population. Health data at the project sites show a decline in water-induced diseases and diseases related to poor sanitation. It is obvious that the project measures contributed to this.

The project was not specifically aimed at connecting low-income residential areas. However, due to the topography and irregular settlement structure, particularly in Ibirité, it was not always possible to connect all poor residents. In the next phase of the project, alternative concepts for connecting these urban areas will be investigated.

However, due to the fact that, as a result of the identified planning and implementation weaknesses, significantly fewer kilometres of sewage network and collectors were built and, consequently, fewer people were connected and fewer sewage treatment plants were built than originally planned, the project's contribution is lower than expected and than would have been possible (see Section *8. Contribution to the achievement of objectives, 9. Quality of implementation* and Section *11. Production efficiency)*.

Positive effects are also expected from measures to protect water sources. However, it is not possible to estimate the extent of the impact on water quality.

However, with regard to the Rio Paraopeba catchment area, the intended effects will not be achieved despite the wastewater treatment plants complying with the discharge values. On the one hand, it was not realistic (even with the originally planned scope of measures) to make a significant contribution and influence the water quality of the Rio Paraopeba over a length of several hundred kilometres due to many other inputs that could not be influenced by the project (see section 3*. Appropriateness of the design)*. On the other hand, the Rio Paraopeba was

contaminated by the Brumadinho mining accident (2019). In the accident, the dam of a tailings pond at an iron ore mine broke and the contaminated mudslide flowed into the Rio Paraopeba. As a result of this environmental disaster, the extraction and use of water and the production of drinking water from the Rio Paraopeba are still prohibited today.

The biogas pilot plant (Ibirité wastewater treatment plant) is in operation and helps to reduce the external electricity consumption of the wastewater treatment plant. The plant for sludge drying and incineration with biogas is only operated temporarily when the amount of biogas is sufficient. The available amount of biogas does not allow for continuous operation. The use of biogas is for demonstration purposes, but COPASA has not pursued the use of biogas for sludge drying and incineration in the construction or renovation of sewage treatment plants and did not intend to do so at the time of the ex-post evaluation.

As part of its core and ongoing remit, COPASA continued to expand and develop sewage networks, collectors and sewage treatment plants, financed in part by external sources such as the follow-up project funded by the FC and with financing from the EIB and AFD.

The following aspects will be taken into account in the subsequent phase based on the weaknesses identified in the project: The Projeto Básico and the Projeto Executivo (comparable to the draft and implementation plans) will be analysed and conceptual and specific recommendations will be developed. In addition, fundamental inventories will be carried out prior to the design planning and a detailed construction schedule with binding milestones for the contractor will be drawn up, which will be contractually anchored in the subsequent construction contracts. Consultants will be called in for specific issues such as construction supervision, legal advice and clarification of land issues. However, these aspects are not applied in other implementations (outside the follow-up project). The analysis and/or revision of design and implementation plans is a desired process, but one that has not yet been formalised internally at COPASA. This also applies to the specifications for the contractor regarding the order of implementation in the construction schedule.

Since 2021, COPASA has been revising its internal project management processes to improve quality and efficiency in the project cycle. The Project Management Office (PMO) methodology is to be applied on a pilot basis to selected projects (>10 million BRL) during a test phase. With regard to inventory data, a general review of the customer register in the Belo Horizonte metropolitan area is scheduled to begin in the first quarter of 2025. This will then be extended to all concessions.

15. Contribution to overarching (unintended) developmental changes

The ex-post evaluation did not identify any negative unintended effects of the project on people or the environment.

Rating summary

In the vicinity of the respective locations, the project measures contributed to improving the environmental situation and living conditions of the population, as well as protecting surface waters and springs. However, the positive effects are less than intended, as fewer measures than planned were implemented. The positive contribution to water quality is limited to the receiving waters in the immediate vicinity of the sewage treatment plants. Given the relatively small scope of the measures implemented and the large number of inputs that cannot be influenced by the project, no significant positive effects of the project on the Rio Paraopeba catchment area are to be expected. With regard to the Rio Paraopeba, any potential effects are negated by the mining accident in Brumandinho (2019) and the contamination of the river over several hundred kilometres.

The decisive factor for the still limited success of the overall development policy impacts is the plausible direct contribution of the project to improving the environmental situation, the living conditions of the population and the protection of surface waters and springs in the vicinity of the respective sites.

Overall developmental impact: 3

Sustainability

16. Capacities of stakeholders and beneficiaries

COPASA is on a sound footing in terms of its finances, personnel and organisation. Its employees are highly educated. COPASA's self-image and conduct are characterised by motivation and ownership.

COPASA has good resilience to respond adequately to technical problems. There is potential for optimisation with regard to COPASA's project planning and implementation processes, including comprehensive inventories and their ongoing updating prior to draft planning; systematic detailed analysis and/or revision of (externally) prepared planning documents, and the application of detailed construction schedules (see 9. *Quality of implementation; 14. Contribution to overarching (intended) development policy changes)*.

The expected increase in heavy rainfall events will pose major challenges for COPASA in the planning and operation of sewage networks (especially sewage collectors), e.g. flooding, soil erosion in riparian areas where collectors are laid.

17. Contribution to supporting sustainable capacities

Extensive training and further education measures were not planned as part of the project. However, COPASA was supported by a consultant. The consulting services covered the following key areas: i) support for the programme implementation unit (UGP) in planning, coordinating and monitoring the components and effects of the overall project, ii) advising the technical departments on the planning, tendering and monitoring of the investment components, iii) advising in the form of short-term assignments in specific subject areas (e.g. biogas utilisation, advanced treatment, mobilisation, awareness-raising and hygiene education of the population, etc.). In addition, the consultant gave various technical presentations.

Thanks to the close cooperation with the consultant, it can be assumed that at least the capacities of the COPASA employees involved in the project have been strengthened.

18. Durability of impacts over time

Ventura Luiz, Ibirité and Mateus Leme wastewater treatment plants:

All three sewage treatment plants were visited as part of the ex-post evaluation. The condition of the plants in terms of the structures is considered to be good to satisfactory. The condition of the electrical and mechanical equipment corresponds to the age of the plants. In some cases, parts of the plants have already been replaced. However, this is due to poor operating experience with the originally installed equipment. At the Ibirité wastewater treatment plant, for example, the fine screens of the rotary filter drums were replaced by mechanically cleaned step screens. The biofilm carrier material used in the aeration tanks (MBBR) was removed due to operational problems and, contrary to the original plan, the wastewater treatment plant is now operated as a conventional activated sludge plant. Overall, the design of the Ibirité wastewater treatment plant appears to be more complex than necessary for the process.

The operating logs are structured transparently and the data is continuously updated and fed into the central IT system. The data satisfies the monitoring requirements specified in the operating licence. There is no evidence that the data is subjected to targeted analysis for the purpose of optimising plant operation.

The plants were largely operated in a professional manner. However, significant deficiencies were identified at the Ventura Luiz wastewater treatment plant. For example, the collected biogas is only flared during a limited period each day, despite continuous biogas production (see *8. Contribution to achieving the objectives*). The collected odour-laden exhaust air is pressed into a biofilter. The surface of this filter is almost impermeable, which prevents the exhaust air from passing through the filter body. Accordingly, the effectiveness of the biofilter is questionable. The operating personnel do not appear to be addressing these shortcomings. The rotary sprinkler of the trickling filter for post-treatment of the UASB reactor effluent is out of operation, with the result that this treatment stage is inefficient due to the lack of uniform feeding of the entire trickling filter volume. The operating data and visual impression suggest that the trickling filter has not been in operation for several months. It is to be expected that the selective feeding of the trickling filter will require extensive cleaning of the reactor.

With the exception of the Ventura Luiz wastewater treatment plant (Municipio Conseilheiro Lafaiete), the operating and working instructions for the wastewater treatment plants were not available in paper form. According to COPASA, these can be accessed via COPASA's central IT portal. Discussions with the operating personnel gave the impression that the specified work processes and operating configurations are mainly determined iteratively on the basis of experience and observations on site.

No complete documentation of the implementation planning or installed units could be presented for any of the plants, either on site or in the IT system. Only at the Ventura Luiz wastewater treatment plant was the Projeto Básico (design planning) presented in paper form. However, this did not indicate whether the document corresponded to the "as-built" status.

The deficiencies identified during the final inspection were only corrected in isolated cases. The main deficiencies at the Ventura Luiz sewage treatment plant remain, such as the accumulation of sand material in the mechanical pre-treatment (rake and sand trap system). These are being addressed symptomatically with mobile and manual solutions. The above-mentioned deficiencies of the biogas filter also remain unchanged.

Biogas production at the Ibirité sewage treatment plant still does not meet the planning data. As a result, the sludge drying and incineration plant is only operated sporadically. The available biogas is primarily used to generate electricity and to cover electricity demand, especially during high-price hours.

Depending on the process technology selected, gas capture at sewage treatment plants is only feasible to a certain extent, i.e. complete elimination of the gases is not possible. Furthermore, according to operating personnel, the efficiency of the gas flares is 30-40%. At selected sewage treatment plants (including the Mateus Leme sewage treatment plant), COPASA is currently replacing the gas flares with more efficient flaring systems.

In 2022, a binding limit value for ammonium nitrogen was introduced. As a result, all sewage treatment plants must be retrofitted to comply with the requirements. To this end, COPASA has commissioned a national team of experts to design the plant modifications.

With an average service life of 30 years for the structures and 10-15 years for the equipment, based on the visits to the wastewater treatment plants carried out as part of the ex-post evaluation and the operating modes observed during these visits, it can be assumed that the wastewater treatment plants will achieve the above-mentioned service lives.

Sludge treatment plant Serra Azul (Juatuba) drinking water treatment plant

Due to the water crisis in 2015, the sludge treatment plant at the Serra Azul drinking water treatment plant was only implemented at half capacity (one process line). During the on-site visit, the condition of the facilities in terms of the structures and the electrical and mechanical equipment made a good to very good impression.

The originally planned mechanical sludge dewatering system was replaced by a more cost-effective variant with filter bags. Plans are currently being drawn up to expand the plant, converting it from the current sludge dewatering system to the original design with mechanical sludge dewatering.

The sludge treatment plant is fully automated and integrated into the central system of the Serra Azul drinking water treatment plant. The digital operating log, including laboratory data, is transparently structured. The data is continuously updated and fed into COPASA's central IT system.

However, according to operating personnel, sludge treatment has only been in continuous operation since 2024. Until 2024, filter backwash water was discharged untreated into the receiving watercourse. Currently, the plant is able to treat about 70% of the filter backwash water. The rest runs untreated into the receiving watercourse via the overflow.

Based on the condition and mode of operation of the plants, it can be assumed that the sludge treatment stage of the Serra Azul drinking water treatment plant can be operated over the expected service life of such plants (50 years for structures, 15-25 years for pipelines and electrical and mechanical equipment).

Sewage networks and collectors

As part of the ex-post evaluation, sewage collectors, sewage networks and house connections were inspected in Conselheiro Lafaiete, Congonhas, Ibirité and Mateus Leme. COPASA was unable to provide complete documentation of the sewage networks and collectors, either in paper form on site or in the computer system.

In some places, the soil material around the upper part of the manhole rings indicated poor compaction. This leads to subsidence of the manhole covers and increased infiltration into the sewage system. In residential areas with roads that have been asphalted by the local authorities, the manhole covers are often covered with asphalt, making the manholes impossible to locate or inaccessible. The theft of manhole covers is also a common problem.

In Mateus Leme, concrete manholes in sections with high groundwater levels are already being replaced with prefabricated PE components. The original concrete design led to high levels of infiltration into the sewage network at the manholes. This was also evident from the sewage treatment plant inflow data. The high sand load in the sewage treatment plant inflow (especially at the Ventura Luiz sewage treatment plant) also indicates a high degree of misconnections in the rainwater system (especially in private homes) and infiltration into the sewage system.

The laid sewage collectors generally follow the natural course of streams and rivers. Sewage collectors in irregularly developed riparian zones are particularly difficult to access, with buildings sometimes extending right up to the edge of streams or rivers. The dense vegetation and topography of the terrain make access for operation and maintenance difficult. In addition, operation and maintenance are restricted seasonally (rainy season). The inspected sewage networks and collectors do not indicate regular preventive inspection. However, regular inspection of the sewage networks and collectors is essential, especially in vulnerable areas.

Faulty implementation planning required subsequent planning changes during the construction phase with protective measures using gabions, particularly in sections with an increased risk of flooding and erosion. The sewage collectors and manholes laid in the riparian zones continue to be at risk from future flooding and erosion.

The expected service life of sewage pipes is 50–80 years. However, due to the above-mentioned points, there is a risk that this service life will not be achieved, especially for sewage collectors laid in endangered zones.

Overall, despite the generally good quality of the structures and the good operational management of the Ibirité and Mateus Leme sewage treatment plants, sustainability is assessed as only partially successful due to the following points: continuing deficiencies at the Ventura Luiz sewage treatment plant; lack of as-built documentation for the operation and maintenance of sewage treatment plants, the sewage network and collectors; poor compaction of manhole rings in some cases; replacement of existing manholes already necessary; Infiltration into the sewage network; lack of preventive inspections and continuing threat to sewage collectors and manholes in riparian zones from future flooding and erosion.

Rating summary

Despite the weaknesses identified in some areas of operational management and maintenance, the economically, personnel and organisationally sound position of the operator and its expertise suggest that the project will have a sustainable impact overall. Sustainability is therefore rated as moderately successful.

Sustainability: 3

Overall assessment

The project addressed a key bottleneck with an appropriate design in line with Brazilian priorities. It was implemented outside the scope of the focus areas agreed with Brazil at the time but was in line with the general objective of German development cooperation in Brazil to make a sustainable contribution to environmental and climate protection and complemented Brazil's own efforts.

However, during implementation it became apparent that, due to the poor quality of the existing data and planning documents, the scope of the measures that could be carried out with the available funding had been significantly overestimated in the initial concept. In view of the intended effects, however, the large-scale construction of sewage networks, collectors and treatment plants was essential and there was no alternative. Price increases added to the underestimated costs. Against this background, significantly fewer sewage networks and treatment plants were built than planned. As a result, the target values for properly treated sewage and sewer connections will not be achieved at the programme locations. However, the sewage treatment plants and the waterworks sludge treatment plant that have been implemented comply with the specified discharge values and any residual materials are disposed of properly.

In the vicinity of the respective locations, the project measures contributed to improving the environmental situation, the living conditions of the population and the protection of surface waters and springs. However, given the reduced scope of the measures implemented, the positive effects are less than envisaged. The positive contribution to water quality is limited to the receiving waters in the immediate vicinity of the sewage treatment plants. In view of the relatively small scope of the measures implemented and the large number of inputs that cannot be influenced by the project, no significant positive effects of the project on the Rio Paraopeba catchment area are to be expected. With regard to the Rio Paraopeba, any potential effects are negated by the mining accident in Brumandinho (2019) and the contamination of the river over several hundred kilometres.

The solid position of the project proponent and its expertise suggest that the project will have a sustainable impact overall.

Overall rating: 3

Contributions to Agenda 2030

The project is in line with the SDGs of the current Agenda 2030 and the Paris Climate Agreement. Specifically, the project contributes directly to SDG 6 (Clean Water and Sanitation) through the construction of wastewater disposal systems and treatment plants, to SDG 3 (Good Health and Well-being) through the reduction of (water-induced) diseases, to improved urban living conditions and thus to SDG 11 (Sustainable Cities and Communities) and, by reducing greenhouse gas emissions in wastewater/wastewater treatment, to SDG 13 (Climate Action) and the Paris Climate Agreement.

Indirectly, the project contributes to increased productivity and thus to SDG 1 (No Poverty) by improving living conditions and the resulting health effects, to increased school attendance and thus to SDG 4 (Quality Education), and to SDG 5 (Gender Equality) by enabling women and girls to participate.

Project-specific strengths and weaknesses as well as cross-project conclusions and lessons learned

Strengths:

- The project addressed a key problem with appropriate measures. The large-scale construction of sewage systems and treatment plants was essential and without alternative for the intended (large-scale) improvement of sanitation, the environmental situation and the living conditions of the population, as well as the protection of surface waters and springs, even though alternative concepts to the conventional sewage network and collector system would have been necessary in some locations (see weaknesses).

Weaknesses:

- The four-year duration envisaged for the programme (from the signing of the loan agreement to the final inspection) was an unrealistically short timeframe for a project of this size and number of locations – even taking into account the fact that, at the time of the project review, some planning documents were available or in preparation and individual tenders had been launched.
- In the course of programme implementation, it became apparent that COPASA had little or inconsistent information on the existing network and on the actual sewer connections in existing networks (customer register) and, accordingly, the actual situation was not sufficiently known in advance of implementation.
- The planning documents (design and implementation planning) were often inadequate and not adapted to local conditions. These were not subject to any internal quality control prior to tendering.
- Due to inconsistent or insufficient inventory data, the actual situation was different than expected. In combination with the poor quality of the planning documents and their failure to adapt to local conditions, this led to a massive overestimation of the feasible scope of implementation during the design phase.
- Looking back, it seems that during the project's design phase, COPASA's existing customer and network data, planning documents, project planning and implementation processes were not analysed and critically examined to a sufficient degree. As a result, the initial situation was not sufficiently understood, leading to a significant overestimation of the scope of feasible measures.
- Connecting informal settlements proved to be very challenging due to the topography and irregular settlement structure. It became apparent that classic wastewater collection, especially at the level of house connections, was not possible using a conventional collection system and that adapted technical concepts for wastewater collection were required.
- At the time, it was standard practice for COPASA to initiate the necessary procedures relating to land issues and environmental permits only after the construction contract had been signed. Construction contracts did not include detailed construction schedules with specifications regarding the timing of construction phases and corresponding milestones.

Conclusions and lessons learned:

- Even with large and experienced contractors, it is essential during the design/review phase to thoroughly analyse and critically examine the quality of the existing data and planning documents and their internal quality control, as well as the project planning and implementation processes, including the timing of the clarification of land issues and the obtaining of environmental permits.
- A systematic review of (externally) prepared planning documents is generally necessary prior to tendering in order to prevent cost increases, a reduction in the scope of measures and delays in implementation.
- When planning sewage networks and collectors, it is essential to check whether, due to the topography, settlement structure or other local conditions, alternative technical concepts for sewage collection are required to complement the construction of conventional sewage collection systems.

Evaluation approach and methods

Methodology of the ex-post evaluation

The ex-post evaluation follows the methodology of a rapid appraisal, i.e. a data-supported, qualitative contribution analysis, and represents an expert opinion. The project is attributed effects based on plausibility considerations, which are based on a careful analysis of documents, data, facts and impressions. Where possible, this also includes the use of digital data sources and modern techniques (e.g. satellite data, online surveys, geocoding). The causes of any contradictory information are investigated, attempts are made to resolve them, and the assessment is based on statements that are confirmed by several sources of information (triangulation), where possible.

Documents:
internal project documents, context, country and sector analyses, comparable evaluations.

Data sources and analysis tools:
On-site data collection and monitoring data from the partner and IGAM

Interview partners:
Project implementers, target group.

The analysis of impacts is based on assumed impact relationships, documented in the impact matrix developed during the project appraisal and updated during the ex-post evaluation, if necessary. The evaluation report sets out arguments as to why certain influencing factors were identified for the impacts observed and why the project under review probably made a certain contribution (contribution analysis). The context of the development measure is taken into account in terms of its influence on the results. The conclusions are put into relation to the availability and quality of the data basis. An evaluation concept serves as the reference framework for the evaluation.

On average, the method offers a balanced cost-benefit ratio for project evaluations, with the knowledge gained and the evaluation effort being in equilibrium and allows for a systematic assessment of the effectiveness of DFG projects across all project evaluations. Individual ex-post evaluations cannot therefore meet the requirements of a scientific assessment in the sense of a clear causal analysis.

The following aspects limited the evaluation:
None

methodology for assessing success

A six-point scale is used to assess the project according to OECD DAC criteria. The scale values are as follows:

Level 1 Very successful: results significantly above expectations

Level 2 Successful: results fully in line with expectations, without significant shortcomings

Level 3 Moderately success: below expectations, but positive results predominate

Level 4 Moderately unsuccessful: significantly below expectations and negative results dominate despite recognisable positive results

Level 5 Unsuccessful: despite some positive partial results, the negative results clearly dominate

Level 6 Highly unsuccessful: the project is useless or the situation has deteriorated

The overall rating on the six-point scale is based on a project-specific weighting of the six individual criteria. Levels 1–3 of the overall rating indicate a 'successful' project, while levels 4–6 indicate an 'unsuccessful' project. It should be noted that a project can generally only be classified as "successful" in terms of development policy if the achievement of project objectives ("effectiveness") and the effects at the overall objective level ("overarching development policy effects") as well as sustainability are rated at least as "limited success" (level 3).

The annex to this report is available upon request (German only).

Imprint

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