*Periódico Eletrônico*
**Fórum Ambiental da Alta Paulista**
ISSN 1980-0827 – Volume 19, número 2, 2023

# Mobile Devices in Microdrainage Systems in the City of Recife-PE

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*Periódico Eletrônico*
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ISSN 1980-0827 – Volume 19, número 2, 2023

**SUMMARY**

The catch basins have paramount importance for an urban drainage system, since its main functionality is to capture and control the volume of transported water from the ground to the existing network, until its arrival in rivers and seas. With disorderly urbanization, the volume of produced garbage grows and drainage systems are impaired. In this way, the present work presents some devices created and implanted in the microdrainage group in the city of Recife. Three eco-basket models were installed inside the collection boxes. The initial version, made of cast iron, did not present a good viability due to its mass, with approximately 30 kg. A second HDPE version was then created, showing positive results, however interactions with some external agents (mainly rodents) reduced its useful life. Finally, the third model was built in fiberglass, meeting expectations satisfactorily. The results obtained proved to be convincing, since that after the implantation of a minimum amount of devices, more than a ton of debris were removed, which would obstruct the microdrainage system, and thus, would potentiate the effects of flooding, still associated with diseases of water transmission and the pollution of urban waters.

**KEYWORDS:** Rainwater. Flooding. Ecobasket.

## 1 INTRODUCTION

The disorderly population growth has produced great disturbances in the infrastructure of water resources. One of the main losers has been the urban drainage system, so that the life span of these systems has decreased, generating an increase in the constancy and magnitude of floods. Currently, one of the relevant factors in metropolitan centers is the destination given to the solid residues produced by the population that tends to concentrate more and more in the cities. Thus, it is becoming increasingly common the concern that public agencies have to manage such problems resulting from population densification.

Over ten years ago Hoffmann; Miguel and Pedroso (2011) discussed the importance of urban planning and environmental management, putting on the agenda one of the biggest challenges in the administrations of cities, which is the uncontrolled advance within the metropolises, which has been increasingly intense. Modifying the original qualities of cities and in this way creating a difference with the master plan, making the process of improvement and transformation of well-being increasingly difficult.

The increase in population housing in non-building areas interferes with the elements of the hydrological cycle, altering the characteristics of infiltration, runoff, and evaporation of rainwater, causing major disruption on days of heavy precipitation (Holland; Soares, 2019). To determine which methodologies are used worldwide to mitigate flooding, Wang et al. (2021) conducted a systematic review. They found that techniques vary according to the development of each country, mainly due to the costs involved in the necessary interventions. For China, the paper points out that the best alternative to reduce downstream pollution would result in improved performance and efficiency of the stormwater drainage system.

One of the consequences of uncontrolled population growth is the increased production of solid waste, which is often improperly disposed of. These wastes interfere with the entry of stormwater into the urban drainage system. Alam et al. (2017) evaluated waste in the drainage system in Gosnells, Western Australia. They developed and applied structures to remove pollutants from stormwater and obtained quite significant results, with large volumes retained in the catchment devices. They noted that for greater efficiency, these materials should be captured early in the system, before they penetrate and damage the drainage channels.

It is worth noting that accumulated materials in urban basins are not only aesthetically unpleasant, but also cause environmentally threatening effects to the natural balance, and impede the hydraulic performance of the urban drainage system (Noor et al. 2016).

Nichols and Luck (2016) evaluated the effectiveness of a type of device that retains waste and aids in primary stormwater treatment (Gross Pollutant Trap -GPT), which has been widely used in urban catchments. The research was carried out over a period of one year in Queensland, Australia. They confirmed good efficiency in both retention and removal of pollutants after treatment by the device.

In order to verify the type of material that are discarded irregularly in the microdrainage networks, Daltoé et al (2016), conducted a survey in the City of Pelotas-RS. They performed inspections in 11 different spots of the city and observed the presence of type 1 plastic material in all of them. Thus, it is essential to adopt management measures that minimize the disposal and/or the entry of these materials in the urban drainage system, since they can cause inconvenience to the residents of the city, especially on rainy days, causing flooding and thus interfering with people's life quality.

Silva Junior; Silva and Alcoforado (2016) evaluated Recife's microdrainage system and proposed as mitigating measures the identification of clogged sections of the drainage network, the cleaning of streets and sidewalks, the encouragement of the use of grids with systematic maintenance to replace conventional manholes, and the use of micro-detention reservoirs at the lot level. Moura and Silva (2015) proposed the use of rain gardens and permeable sidewalk techniques as possible alternatives to minimize the constant flooding in the City of Recife. In both studies, the conclusions were obtained through computer simulations.

The microdrainage of the City of Recife implemented in the mid-twentieth century was executed with ceramic, concrete and concrete materials. Over time, these materials deteriorate mainly due to the characteristic of high degree of sewage discharge connected to the drainage pipes, decreasing their lifetime (OLIVEIRA; HOLANDA E SOARES, 2021). Currently the replacement/implantation of these pipes is in High Density Polyethylene (HDPE) pipes, having as the main advantages: durability, lightness, fast installation and mobility (SILVA, 2019; SANTOS, 2019).

In this context, this paper aims to present devices made and used in the micro drainage system of the City of Recife, in order to retain urban waste, providing a better flow of urban stormwater, and providing an appropriate destination for the captured material.

## 2 METHODOLOGY

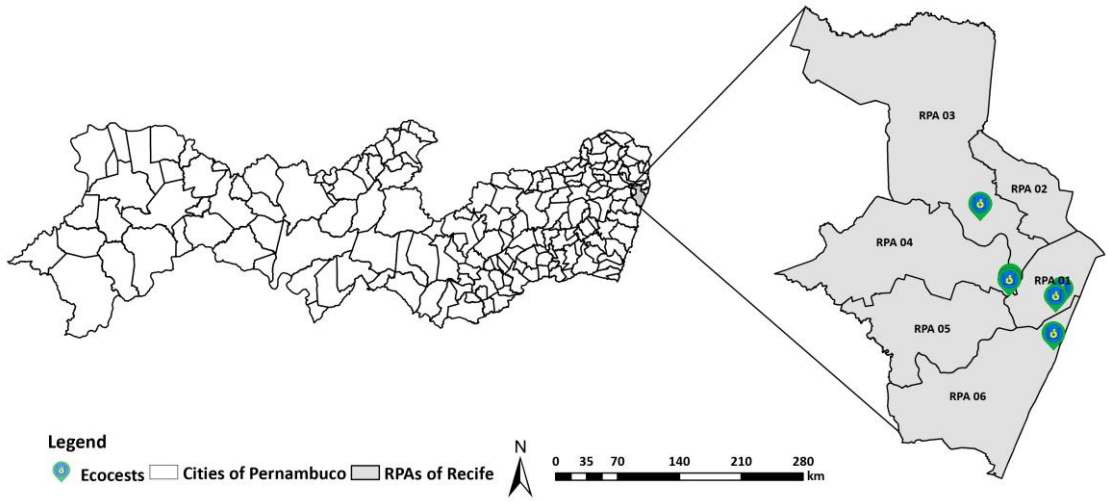
The study site and the types of devices created will be presented, based on existing structures, adapted to the reality of the urbanization of the studied sites in the City of Recife. The implementation points were defined together with the Secretary of Infrastructure and Urban Services, through the Autarchy of Maintenance and Urban Cleaning (EMLURB), of the City of Recife.

### 2.1 Characterization of the Study Area

The study was conducted in the city of Recife, capital of the state of Pernambuco, cut by five main rivers (Capibaribe, Beberibe, Tejipió, Paratibe and Jaboatão) and has about 130 km of canals, the microdrainage system has about 1,500 km of galleries and channels, being part of its registration the drainage elements, such as manholes and catch basins more than 75 thousand units. Located at coordinates: latitude 8º 04' 03'' S and longitude 34º 55' 00'' W, altitude: 4m. The coastal city covers a land area of 218.50 km2, with 1,537,704 inhabitants and a demographic density of 7,037.61 hab/km² (IBGE, 2010).

The regions where the devices were deployed are located in several districts of the City of Recife, according to the distribution that can be seen in Figure 1, in view of the amount of waste on the road and the recurrence in the cleaning of these elements.

Figure 1 - Map of the city of Recife, highlighting the locations where the ecocest were installed.




Source: Prepared by the author.

**2.2 Ecobaskets**

The Ecobasket is a system that retains the solid waste that enters the collection bins. They were conceived based on existing structures, adapted to the reality of the urbanization of the places studied in the City of Recife.

Its first projection was created in cast iron, because it is a material resistant to aggressive environments, it also has a long life span, minimizing maintenance costs. Its format is rectangular and is composed by a structure in cast iron angles, coupled to a protection net in polyester, the chosen steel alloy corresponds to a material whose potentialities are countless, and its durability and resistance to traction can be highlighted.

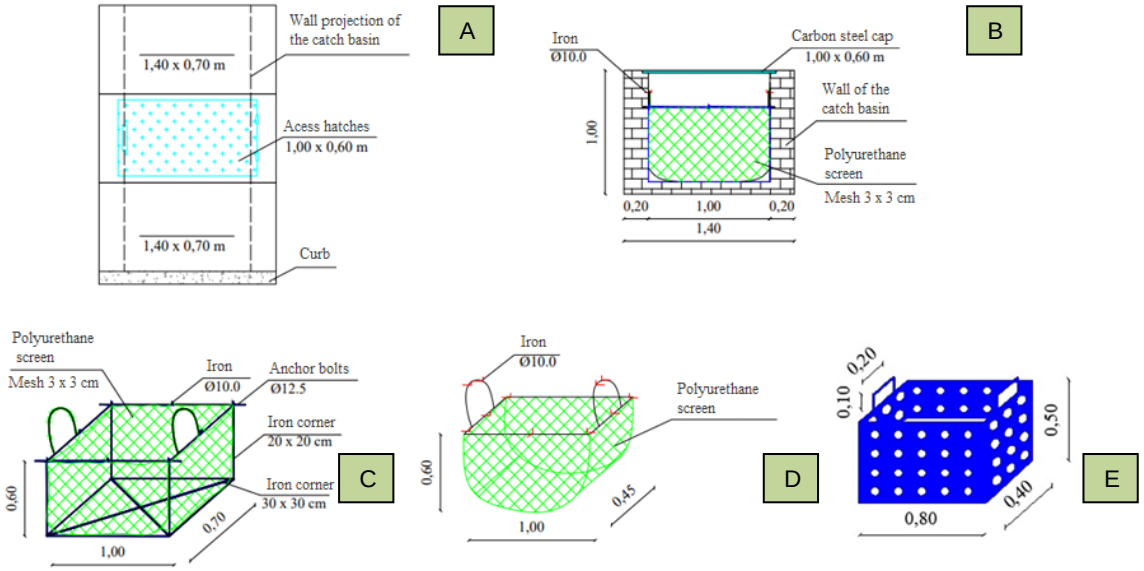
A second version of the device was created in canvas, builting of a 5-meter, six-millimeter rope made of High Density Polyethylene (HDPE). This device is not welded, has knots, and supports up to 500 kg/m2. The mesh offers flexibility, being able to fit all the dimensions found in drainage elements.

A third model of device was also designed, in fiberglass, with the same proposal of a

practical alternative for cleaning and preventing the circulation of these residues in the drainage systems. With an estimated mass of 4 kg, the material presents good resistance against the biological agents existing in the installed environment.

Figure 2 shows the detailing of the manholes, the ecocest slots seen in section, and the respective cast iron, HDPE, and fiber devices.

Figure 2 - Detail of the collecting boxes, with the access cover for cleaning (A), fitting of the ecbaskets seen in section, the internal part of the drainage element (B) and the ecbaskets in cast iron (C), in HDPE (D) and finally in fiber (E).




Source: Prepared by the author.

## 2.3 Ecobaskets Removals, comparative analysis and operational costs

The removal of the material captured by the ecobaskets was done manually, being executed twice a month on average. On days with heavy rainfall the team has to be attentive to perform the removals. In addition, it is important to report that the people who perform such services did not need to get inside the collection box. The operation lasts an average of 5 minutes and is performed with a maximum of two people (Figure 3), the collected waste is disposed of properly to the CTR-Candeias.

Figure 3 - Removal of the ecobaskets after solid waste capture.

Source: Prepared by the author.

After the implementation of the three types of devices, comparative analyses of the performance of each structure were carried out, verifying which one best suited the functional conditions in the City of Recife, thus providing the appropriate drainage in the flow of rainwater, retaining the debris. Analyses were also carried out, through photographic records, at the locations that received such devices, in order to observe how the performance went on days of heavy rainfall.

Before the implementation of the devices, the cleaning activity of the microdrainage galleries in the City of Recife was performed annually, where it was necessary a standard team, composed of 10 assistants and a foreman, to clean the microdrainage networks and with an estimated duration for this intervention, of at least 15 days. After the implantation of the ecocestos baskets, with a maximum of two people, the removal of the captured residues was carried out fortnightly and sent to the accredited landfill.

## 3 RESULTS

There are several locations in the City of Recife, where there is a recurrence of flooding points, which are worrying places, due to factors such as: under-dimensioning of the system for the current times, or poor execution of the same, leaving it clogged with garbage that is thrown incorrectly. Based on the waste factor, the locations for the implementation of the devices under study were chosen.

### 3.1 Preparations of the ecobasket receiving locations

The pilot project for the implementation of the Ecobasket was installed at Avenida Dantas Barreto/Recife, #719, in the month of October/2021, as located in Figure 4, the location has abundant commerce and peddlers, which naturally produces a high amount of waste. In the highlight of the Figure below the collection box is completely filled with irregularly discarded material, obstructing the water circulation, also causing flooding points.

Figure 4 - Location map where the ecobasket was deployed.


Source: Prepared by the author from Google Maps image (2022).

A manual cleaning was performed in the drawer-type collection box in order to remove all solids (such as PET bottles, papers, plastic bags, leaves, and other materials), which are irregularly discarded on the road, affecting directly on the proper functioning of the microdrainage system. Next, hydroblasting was performed, which is a service that uses a suction jet whose purpose is to clean or unclog the drainage network. The high speed of the water generates enough pressure to displace objects or substances that may be impeding the flow inside a pipeline without damaging it, thus preventing dirt from contaminating rivers and seas. After cleaning, the drainage element also receives maintenance, such as improvements in the internal lining of the box and, finally, the implementation of the ecobasket.

In order to increase the agility of waste removal, in the drainage elements that received the ecocest, Carbon Steel lids were installed with an estimated weight of 15 kg, to facilitate the opening of the collection box, with dimensions of 1.00 x 0.60m. Normally, a pre-molded cover in reinforced concrete is used to close this type of box, but this cannot be adopted in the case in discussion, as it would make the opening for periodic maintenance unfeasible, due to the mass of the material, which is approximately 300 kg.

After the implantation of the new device, a painting was also done in order to communicate with the passers-by that circulate through the city streets, inhibiting even more the action of irregular disposal on public roads.

### 3.2 Cast iron Ecobasket

The first prototype designed in cast iron can be seen in Figure 5. As its mass was very large, approximately 30 kg, it made the continuity of the project unfeasible, due to issues involving the safety and health of workers. The idea of producing the devices in cast iron was discarded, as it was impractical to maintain, not to mention the fact that the device would still receive the contribution of solid waste.

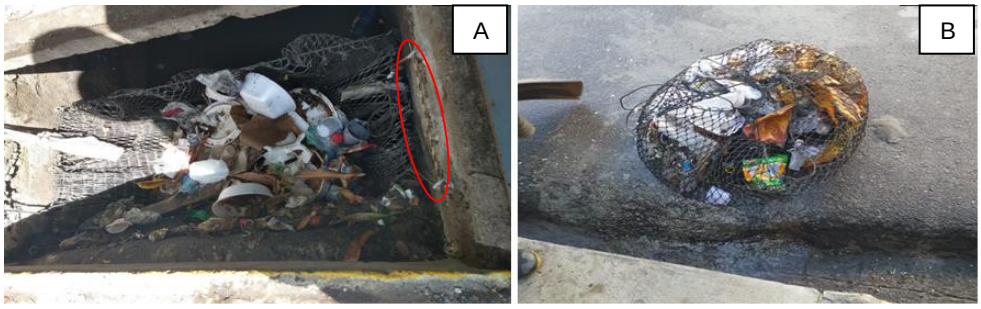
Figure 5 - Model of the cast iron ecobasket.

Source: Prepared by the author.

### 3.3 HDPE Ecobasket

The ecocest composed of a HDPE material, in the shape of a basket, was fixed using handles of the same material on steel bars, anchored to the wall of the collection box. This ecocest has a mass of 0.5kg (Figure 6).

Figure 6 - Model of the HDPE ecobasket, the circled area shows the detail of the anchoring with ϕ10 mm, installed at Abelardo Baltar Square (A) and the capture of the waste that was retained on the screen (B), both in the City of Recife.




Source: Prepared by the author.

For this ecobasket model, it was observed the need to collect the garbage retained twice a month and to destine them to the appropriate place. The places that received these devices were foreseen to be adopted, i.e., someone who would be available to make the necessary removals in the agreed time interval. The initial six months were monitored by the technical team of the Maintenance and Urban Cleaning Autarchy (EMLURB). The data related to the collections can be seen in Figure 7, after which the responsibility was passed on to the adopter of the ecobasket.

Figure 7 - Masses of the removals no ecocesto in the ecobasket at Av. Dantas Barreto/Recife.

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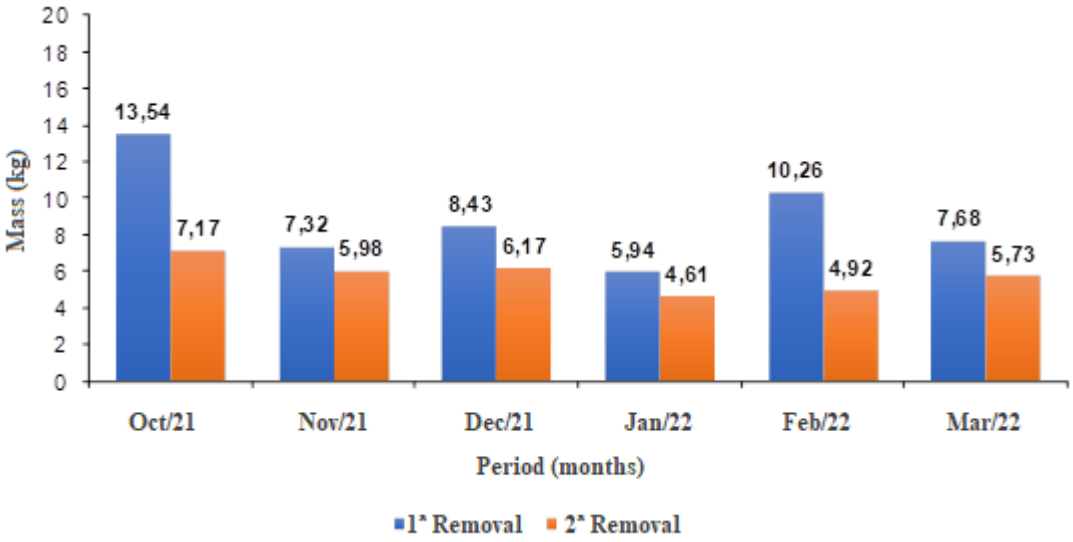


Source: Prepared by the author.

After 06 months of its implementation, 87.75kg of garbage were removed, discarded irregularly by the society on the street in question in the City of Recife, which act as agents causing problems for the drainage system and, above all, for the ecosystem. It was also noted that rodents were assiduously visiting the HDPE ecocestos bins, damaging the ropes that hold such waste, thus decreasing their useful life span.

The second removals always presented lower masses in relation to the first, considering that, the consumption of products is higher in the first 15 days of the month, due to the payment of the payroll, when it is assumed that the waste disposal increases.

Considering that the result of the installation of the device was very positive, in view of the low cost of installation, compared to the gain in benefits, another 05 HDPE ecobaskets were installed on the roads with the highest garbage demand, according to table 1.

Table 1 - Removals of HDPE ecobaskets

| Location | *RPA | Quantity (Units) | Implementation date | Date of last removal | Weight removed (kg) |
|---|---|---|---|---|---|
| Dantas Barreto Avenue, nº719 - São José | 01 | 01 | 01/10/2022 | 29/04/2022 | 87,75 |
| Dantas Barreto Avenue in front of Bradesco Bank - São José | 01 | 01 | 28/04/2022 | 19/07/2022 | 38,90 |
| Abelardo Baltar Square - Pina | 06 | 02 | 07/02/2022 | 20/07/2022 | 92,70 |
| Padre Lemos Street in front of Visconde de Taunay Street - Casa Amarela | 03 | 01 | 22/04/2022 | 13/07/2022 | 36,75 |
| Rua Padre Lemos in front of the Caixa Econômica Federal - Casa Amarela | 03 | 01 | 22/04/2022 | 13/07/2022 | 40,20 |
| **Total** | | | | | **296,30** |

*RPA – Political Administrative Region.

Source: Prepared by the author.

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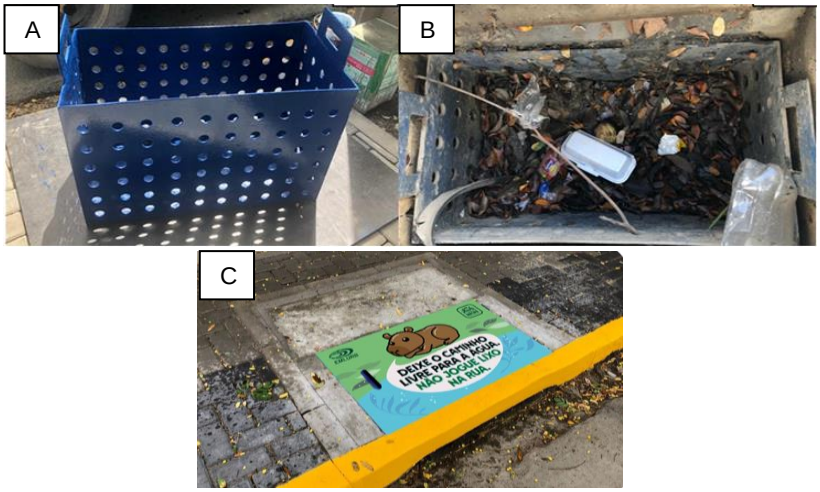
### 3.4 Fiber Ecobasket

With a more structural format, the fiber devices were first installed on Rua Professor Benedito Monteiro in the city of Recife (Figure 8). In all, there were 20 units that besides being light, weighing approximately 4 kg, are functional and resistant, and present an aesthetically pleasing format.

Figure 8 - Model of the fiber ecocest (A), with material from irregular disposal (B), and the signage implemented in May/2022 on Rua Professor Benedito Monteiro (C), in the city of Recife.




Source: Prepared by the author.

The mechanics of the ecocesto is simple and the advantages are countless. While normal collection bins clog, overflow, contaminate and proliferate insects and rodents, the eco-baskets are functional devices to improve the drainage of the water circulating through these galleries are made of a material that is safe and easy to maintain. In addition, the water infiltrated by these clogged elements causes asphalt erosion, subsidence, potholes, accidents, dirt, and consequently more problems. Removals are performed every 15 days according to Table 2.

Table 2 - Removals of the fiberglass ecobaskets.

| Localização | *RPA | Quantity (Units) | Implementation date | Date of last removal | Weight removed (kg) |
|---|---|---|---|---|---|
| Professor Benedito Monteiro Street .Madalena/Recife | 04 | 20 | Maio/2022 | Maio/2022 | 181,00 |
| Professor Benedito Monteiro Street, Madalena/Recife | 04 | 20 | Maio/2022 | Junho/2022 | 80,20 |
| Professor Benedito Monteiro Street, Madalena/Recife | 04 | 20 | Maio/2022 | Julho/2022 | 120,60 |
| Professor Benedito Monteiro Street, Madalena/Recife | 04 | 20 | Maio/2022 | Agosto/2022 | 197,60 |
| Professor Benedito Monteiro Street, Madalena/Recife | 04 | 20 | Maio/2022 | Setembro/2022 | 244,80 |
| **Total** | | | | | **824,20** |

*RPA – Political Administrative Region

Source: Prepared by the author.

In the 48 hours between August 2 and 3, 2022, 122.22 millimeters of rainfall were recorded by the National Center for Monitoring and Alerts of Natural Disasters (CEMADEN, 2022). Normally, this volume of contribution would generate disturbances in the circulation of vehicles and people on this road. However, this road had its normal vehicular and people traffic activities, without any damage to the institutions located there, as can be seen in Figures 9A and 9B. However, on Benfica Street, which borders the street used in the study, flooding points can be seen in Figures 9C and 9D.

Figure 9 - Professor Benedito Monteiro Street, with normal flow of cars and pedestrians (A and B) and Benfica Street in front of the club, presenting vehicle retention due to water accumulation on the road (C and D), in the City of Recife.


Source: Prepared by the author.

## 4 CONCLUSION

The present work analyzed the construction and use of three types of mobile devices as a flood mitigation technique, preventing solid waste from obstructing the urban stormwater passage. In general, the mobile devices deployed in the City of Recife proved to be quite satisfactory in retaining the debris that circulates arbitrarily, preventing these materials from causing nuisance and advancing into rivers and seas.

The first device was made of cast iron, and due to its high mass, about 30 kg, the continuity of the project became unfeasible, in order to improve the operational quality of the removals.

The second model of device, made of HDPE material, reaped positive results as the total of approximately 300 kg of irregular discarded waste were retained in the equipment after nine months experiment, what facilitated the circulation of rainwater within the drainage gallery. The main disadvantage of this model was the fragility regarding the interaction with rodents.

The third model, created in fiberglass, met the expectations adequately, considering that the roads where the devices were applied used to flood with small precipitations, before their implementation. After the application of the ecobasket, the streets did not suffer flooding for rainfall events greater than 100 mm.

## ACKNOWLEDGEMENTS

This work was carried out with the support of the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES) - Brazil - Funding Code 001.

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