

THE SANDY FEATURES EDGES OF THE SÃO FRANCISCO RIVER IN XIQUE-XIQUE AND BARRA/BA: A REVIEW

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Abstract: The research focused on discussing the dynamics of the origin and current state of the fossil dunes that border the São Francisco River in the stretch between Xique Xique and Barra in the State of Bahia. The fossil dunes or paleodunes of the São Francisco River are important records for understanding the actions of past climates on these areas, as well as on the speed and direction of winds in the remote past, thus being essential to understand the origin and evolution of these features. . In this sense, the objective of this article was to analyze the discussions and scientific records of authors who are dedicated to understanding these paleoenvironments, based on a systematic literature review, motivated by three guiding questions (QNs). The works found established a relationship with the following themes: origin, evolution, current conditions of these features and possible actions to mitigate the impacts, and point to the need for conservation of these paleoenvironments.

Keywords: Fossil dunes; paleodunes; paleodune geosystem.

These dune fields are completely surrounded by the Sertaneja Meridional Depression, the southern diagonal limit being totally defined by the São Francisco River and the southwest part is limited by the Serra do Estreito (BA), with most of the ecoregion being west of the river. San Francisco, with a total area of 36,170 km².

Thus, the research area, according to the Köppen classification, is characterized by the BswH climate and the annual precipitation is around 400-800 mm and occurs mainly from October to March. According to Nimer (1977;1989), the average temperature of the coldest month is above 18° C and the annual averages do not exceed 27° C. The seasonal fluctuations of the winds are linked to the masses, Atlantic Equatorial and Atlantic

Tropical, in winter, and the Continental Equatorial Mass in summer. In this area, there is a predominance of caatinga vegetation due to the sandy soils that are not well developed in the dunes and the semi-arid climate (JACOMINE et al., 1976).

The researched area is located in the peripheral depression of the middle São Francisco River, with altitudes varying between 400 and 800 m, where the features related to aeolian sedimentation were analyzed in terms of sedimentological and morphological characteristics, post-depositional modifications and past paleovent patterns (BARRETO , 1996). Estudos de Barreto points out the predominance of five geomorphological domains: fluvial, sand sheets, dunes with clear morphology, dunes with tenuous and sharp morphology and dissipated dunes.

In this sense, in geomorphological terms it is necessary to consider two aspects, namely: a) morphostructural domain and b) peripheral depression of the middle São Francisco. The morphostructural domain is defined by the grouping of geomorphological facts from broad geological aspects (PACHECO, 2004). According to the IBGE (1977) there are two major morphogenetic factors that explain the modeling of the relief of Northeast Brazil, with a view to structural factors, conditioning the large morphostructural domains and which originate the spatial base of regional relief and, to climatic factors, responsible for the diversification of plant formations and morphogenetic processes acting in different morphoclimatic environments.

Therefore, in the context of the São Francisco basin, there are important urban centers, wide natural landscapes and archaeological sites. Schobbenhaus et al. (1984, p.242) points out that the paleodune fields of the middle São Francisco River are the "only example of dune formations in a quaternary desert environment

in Brazil”, classifying these deposits in the field of “Pleistocene aeolian deposits”. of the San Francisco craton.

In this sense, the geomorphological features are impacted by climatic agents, which conditions a new design to the terrestrial model. As a new model is built, the input and output of energy in a geomorphological system will allow erosion, transport and sedimentation of surface debris to take place (CABRAL, 2014). Weathering, erosion, transport and anthropogenic action end up reworking recent sedimentary deposits, which makes it difficult to have a reliable indicator to punctuate relevant occurrences in the evolutionary framework of terrestrial landscapes, and in particular those that concern the geological-geomorphological and climatic framework (MELO et al., 2005).

MATERIALS AND METHODS

The geographical context of the research is limited to the municipalities of Barra and Xique in the State of Bahia, as shown in figure 1. The sandy features, which this systematic review addresses, are located in the northwest of the State of Bahia, between latitudes 10°00’ and 11°00’ S and longitudes 42°30’ and 43° 20’ Occupying part of the municipalities of Remanso, Pilão Arcado, Xique and Barra, about 700km from the capital, Salvador. Composed of extensive formations of aeolian deposits, whose height can exceed 100 meters, the area has a semi-arid climate, with native vegetation of caatinga (hypoxerophilous), with stretches of very dry caatinga (hyperxerophilic), and small enclaves characteristic of wetter climates as river and interdune depressions.

To discuss the topic in vogue, a systematic literature review was adopted as a methodological strategy, through an exploratory quantitative approach, as it allows the familiarization of the problem by building hypotheses, limiting the recording of observed

facts without interference. In addition, as for the procedures, the research is classified as bibliographical, both in materials already prepared and having its sources as a type of instruments (PRODANOV; FREITAS, 2013).

The systematic review of the literature is a research modality, which follows specific protocols seeking to understand and give meaning to a large corpus of documents, especially, verifying what fits and what does not fit in a given context. It is focused on its reproducibility by other researchers, explicitly presenting the bibliographic databases that were examined, the search strategies used in each database, the selection process of scientific works, the inclusion and exclusion criteria of the same and the process of analysis of each one (GALVÃO; RICARTE, 2020).

Considering the purpose of this article, in analyzing the discussions on the origin and current state of the fossil dunes of Xique Xique and Barra in Bahia, three QNs were launched which motivated the development of the research, namely: QN1: What the studies point out about the origin of the fossil dunes of Xique Xique and Barra? QN2: What is the current state of the tables in terms of anthropogenic actions? QN3: Is there a plan to mitigate the socio-environmental impacts for these areas?

The criterion used to carry out the research was the process of conducting independent searches and the second was the identification of findings to acquire rigor and reliability in the search (YIN, 2010). Based on the agreement of the researchers involved in conducting independent searches, a research protocol was built, even if initially they were studied in a generic way.

In order to obtain the supporting works of this review, the journals portal of the Coordination for the Improvement of Personnel of Higher Education (CAPES), the Scientific Electronic Library Online (SciELO),

and Google Scholar (Google Academic) were adopted as tools. research descriptors: “fossil dunes”, “São Francisco dunes”, “paleodunes”, “paleodune geosystem” and “Paleodunes of Xique Xique”. , dissertations and books and a time frame for decades (1990 to 2020), as they are studies related to climate, being, therefore, relevant to analyze at least 30 years to have a reliable result.

The studies obtained in this search went through other refinement processes, to be included and integrate the discussion of this review. In this sense, the following were included: papers published in journals with at least Qualis B2; those whose research region was Xique Xique and Barra; as for its theme, those that provided results for the Northern Questions (NQs) exposed here and recorded in the research protocol. In addition to these selection processes mentioned, articles/papers that had as methodological strategy the bibliographic review were excluded, thus reaching a plausible number for the systematic study of the theme that evidenced the most important dimensions and their respective classical and updated textualizations.

In addition, the selected data were submitted to a preparation process, in order to detect a priori if the chosen documents were in accordance with the theme to be reviewed, in order to then submit it to the analysis of its content. After this date, the data were submitted to the unitarization process, through exploratory reading of all content and adoption of coding, classification and categorization procedures.

From the accomplishment of this research, it was verified the lack of articles that worked on the theme addressed in the format of a systematic review, thus punctuating the relevance of this work. There was also a scarcity of specific literature on paleodunes, fossil dunes, and dunes of São Francisco, specifically the paleodunas of Xique Xique

and Barra/BA.

RESULTS AND DISCUSSIONS

Chart 1 presents a flowchart of the research with its refinement processes (inclusion and exclusion). In the end, 2,570 studies were found in the search that addressed in general the theme “dunes”. However, after the filtering process, only 12 studies were selected to make up the discussion of this systematic literature review, because they were directly related to the object of study and answered the NQs, as shown in Chart 2.

The flowchart above presents the electronic search process and the databases used, the descriptors inserted in the search, the processes of inclusion and exclusion of the findings (considering qualis, research region, theme addressed and methodological strategy), meeting the protocol elaborated for this review.

For a better understanding of Chart 3, it brings the quantitative of the findings by search engines and by keyword.

It is worth informing that when using all the keywords in the search it was not possible to find any results, having then opted for the search for each descriptor in isolation. For the analysis of the 12 selected papers (01 of capes journal, SciELO, and Google academic), an organization was carried out according to the central theme of its contents, as shown in Table 4. In suma, the analyzed studies focused their research on origin and evolution; main impacts current conditions of the features (risks of mischaracterization of dune fields); mitigation and conservation plans for these areas.

FINDINGS ON THE ORIGIN AND EVOLUTION OF PALEODUNES

Work 1 points out that the São Francisco River and its tributaries are responsible for the construction of the two fossil dunes



FIGURE 1: Search area location

Source: Map adapted from Barreto (1996); Image by Pacheco (2017)

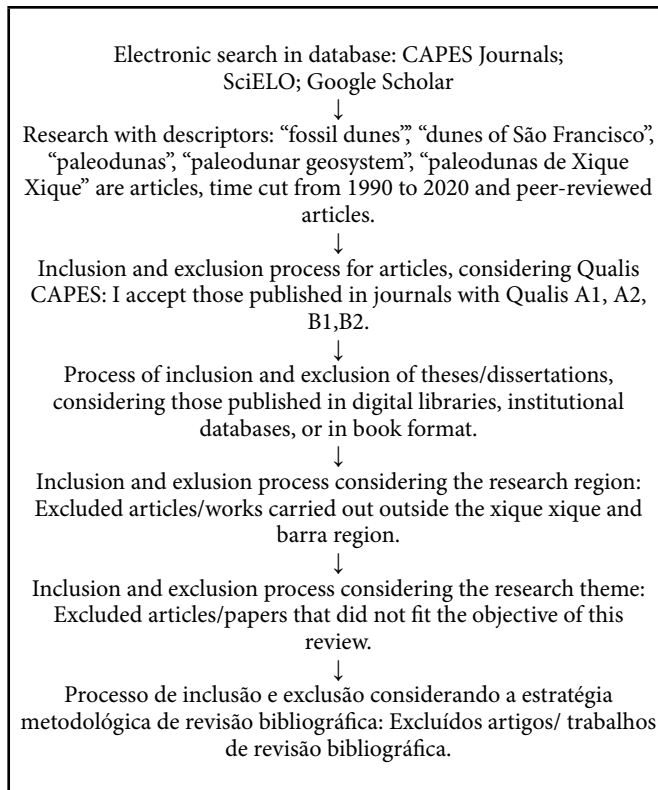


TABLE 1: Search flowchart and refinement process (inclusion/exclusion)

SOURCE: Authors (2021)

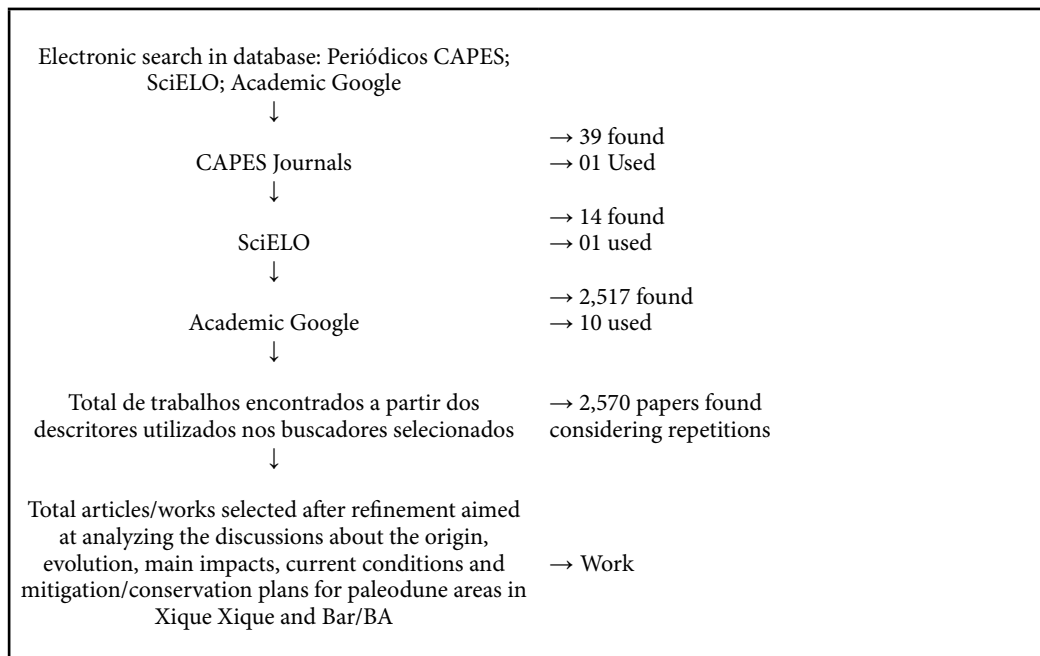


TABLE 2 - Research flowchart by search sources and selection of findings

SOURCE: prepared by the author (2021)

Keywords					
Seekers	Fossil dunes	dunes of São Francisco	paleodunes	Geosystem paleodune	paleodunes of Xique Xique
periodical capes	03	00	36	00	00
SciELO	00	12	02	00	00
Academic Google	260	169	1830	180	78

TABLE 3 - Quantitative findings by search engines and keywords

SOURCE: Authors (2021)

Nº	Title of Work	authors	Year Pub.	Type	Qualis	Thematic
01	Morphological and sedimentological study of the northern portion of the Rio São Francisco sand sea, Bahia	BARRETO	1993	Dissertation	No Qualis	Study morphological and sedimentological of the dunes
02	Paleoenvironmental interpretation of the fixed dune system of the middle São Francisco River, Bahia	BARRETO	1996	Tese	No Qualis	granulometric study, morphoscopic and mining of the dunes
03	The inactive dune field of the middle São Francisco River, Bahia	BARRETO; SUGUIO; DE OLIVEIRA; TATUMI	2002	Article	No Qualis	Different generations of wind dunes and conservation measures

04	The paleodesert of Xique - Xique	AB'SABER	2006	ARTICLE	B1	Origin Evolution Impacts
05	Ecodynamics of the Paleodunar Landscape of the Middle São Francisco River/BA: in defense of the battered borders	PACHECO	2014	Dissertation	Without Qualis	Origem Evolução Impactos e conservação
06	Ecodynamics of the Paleodune Landscape of the Middle São Francisco River/BA	PACHECO; OLIVEIRA	2017	Book	Without Qualis	Origem, Impactos e Planos de conservação
07	Paleocosystems in the course of the São Francisco River/BA and the ecodynamics of landscapes	PACHECO	2020	Book	L1	Current impacts conservation plans
08	The vulnerabilities of the paleodune geosystem of the middle São Francisco River (BA)a conservation proposal	PACHECO; OLIVEIRA	2016	Article	B1	Environmental impacts on paleodunar areas
09	Historical-environmental characterization of the APA dunes and paths of the lower-middle São Francisco (BA)	PACHECO; OLIVEIRA	2016	Article	B1	Physical geographic characterization of paleodunes
10	La degradacion ambiental em paleoambientes de Brasil: análisis ecodinamico de la Ecorregión Dunas de São Francisco	PACHECO; SANTOS COSTA SILVA	2018	Article	A2	Environmental degradation of paleodunes
11	Paleodune Geosystems in the São Francisco River Course	PACHECO; SANTOS; COSTA; ARAUJO; MOREIRA; ARAUJO;	2020	Article	B1	Environmental impacts and current state of paleoenvironments
12	Environmental Conservation proposal(PCA) for the Casa Nova/ BA paleodunar complex: a study with fishermen and riverine people from the São FranciscoRiver	ARAUJO; SANTOS; PACHECO; MOREIRA;	2020	Article	A1	Impacts and Conservation Plans

TABLE 4 - Organization and classification of articles according to their central themes

SOURCE: Authors(2021)

between Xique Xique and Barra, which were the suppliers of areas that, deposited in the sedimentary basin, were reworked by the wind, generating fluvio-eolian deposits. . Currently, due to the probable inversion of relief and/or climate change, the paleodunes are being eroded by the current erosive cycle, called by Barreto (1993) the Paraguaçu Cycle.

Barreto and Suguio (1993) follow the same reasoning that the São Francisco River and its tributaries were the main source of sand that formed the dunes, following the load of sand transported between the areas of the Barra and Xique Xique fields. These researchers found an age of at least 100,000 years necessary for the river to supply the full amount of sand for the formation of dune fields.

Work 2 demonstrates that, using thermoluminescence techniques, it was possible to date the aeolian sediments and, using the radiocarbon technique, to date the wind reworking phases of the fixed dunes of the middle São Francisco River. Among the erosive processes, Barreto (1996) highlights that he found evidence of fluvial and/or pluvial erosive pedogenetic processes in the dunes and sand sheets, due to the influence of human occupation that intensified the remobilization of the dunes. He also verified the variation of the relief, showing changes in the height and density of the dunes, indicating preserved parts and others not, with erosion by the São Francisco River and by human action.

Moreover, the author says that, from the methods used, it came to the inclusion that, at least since 28000 years there were conditions in the area conducive to the development of dunes, characterized by arid or semi-arid climate and relatively strong winds, associated with abundant sand supply available for wind transport. In summary, the author states that the oldest dunes date back 28,000 years and the most recent 900 years.

In work 4, Ab'Saber (2006) since the 1950s, raised some hypotheses regarding the origin of the fields, stating that: 1. Se it is a true erg of a regional intermontano paleodesert, still uncertain, located in the central-eastern part of Brazil. According to him, the large masses of sands deposited there, and reworked by wind processes, were brought upstream (upstream), by a slow process of river sedimentation, in a certain period of the Upper Quaternary (Pleistocene); 2. It can be thought that the high fixed dunes of Xique – Xique were generated in one of the semi-arid phases of the Upper Pleistocene, at times when the general level of the seas was tens and tens of meters lower than the current levels.

In the conception of Ab'Saber (2006, p.306), the xique-xique dune field constitutes “the largest mass of sands existing anywhere in The Brazilian territory. It is an environment endowed with very strong erodibility, when impacted by the erosivity of incompatible anthropic actions.” He draws attention to the need to constitute this area in an area of permanent preservation, however, he already warned that it was indispensable to have a set of “proposals to compensate the poor roceiros of the leakers, as well as the shepherds of goats who are initiating a new activity of very serious consequences for the derruição of the dunes”, aiming to preserve the existence of this physiographic and ecological scenario so delicate and important.

Work 5 highlights that the area of the inactive dune field of the middle São Francisco River represents an important site, testimony to local geological and geomorphological evolutions, largely attributable to paleoclimatic alternation snares of the Brazilian Northeast during the Quaternary. On the other hand, the local faunistic and floristic biodiversity also reflect the dynamic physical and edaphoclimatic scenario (PACHECO, 2016).

FINDINGS ON THE MAIN IMPACTS AND CURRENT CONDITIONS

In work 3, Barreto et al., (2002, p.230), points out that “the susceptibility to erosion of essentially sandy sediments is enormous, so that the human occupation of the area would lead to complete geomorphological disfigurement of the dunes, causing irreversible reflections in hydrology and faunistic and floristic biodiversity”. He adds that there is no doubt that the deepening of local human occupation would exacerbate geological processes, and poor soils that are used by the rarefied local population are used for subsistence crops and, moreover, access difficulties are some of the natural factors that favor preservation.

Based on the findings of his research in the 1950s, Ab’Saber discusses in work 4 that came to the conclusion that anthropic activities at this time already affected the biome in these fields. So he checked out five types of degradations:

Living scars of denuclearization of the dunes to the north of the set; anastomosed trails of dc goats transit through extensive stretches of the eastern part of the old regional dunes; denuclearization of the extreme periphery of the dune field in the eastern piedmont of the north-south ridge of serra do Estreito; exposed sands on the edge of the dunes in front of the larger bed of the São Francisco River; and expansion of devastation in some other valleys once endowed with narrow ebbs by rustic agrarian activities (AB’SABER, 2006, p. 303-304).

Work 6, according to the paleodunes of the middle São Francisco River, is part of the Environmental Preservation Area (APA) Dunes and Path of the Middle São Francisco River and have its natural system of resilience, however, it needs to be in line with its external dynamics, because it does not help the natural system itself to self-redo, if at the same time anthropogenic actions affect it directly and

indirectly, thus diminishing its natural power to restore itself (PACHECO; OLIVEIRA, 2017).

On the other hand, work 7 highlights that the modification by man of a component of this geosystem will imply a change in the system as a whole towards new states of equilibrium, whose functioning may be undesirable and difficult to control. The integral preservation of vegetated dunes, especially the frontal dunes, has proved crucial in protecting this balance (PACHECO, 2020).

Also in the work 8 Pacheco e Oliveira (2016) address that the geographical space being the stage of the dune ecosystem undergoes profound changes due to anthropogenic derivations, that is, different degrees of derivation of natural systems, under human impact, providing often irreversible transformations. Generally, coastal areas, whether sea or river, are in a phase of degradation and fragility in which the pressures exerted on their habitats, require with some urgency the application of integrated management strategies to face increasingly complex problems.

In addition, Pacheco et al., (2018) in the IO work, draws attention to the need for these areas, so sensitive to degradation, to receive attention and effectively adequate supervision from the public authorities and/or the management of the EPA, since these are tourist areas visibly explored anywhere on the planet, of a unique natural beauty and of fabulous relevance for research, since the records are indicators of paleoeras and hold crucial archaeological records for the understanding, at present, of the origin of these paleoenvironments.

In study 11, Pacheco et al., (2020) indicate numerous environmental impacts 3168 in the dune areas that border the San Francisco, i.e. illegal extraction of sands and native species; dumps of solid waste and effluents in natura;

opening of trails under the dunes and sports practices; unsustainable tourism; unlicensed construction under the fields; removal of riparian forest from the edges of the river and dune fields; irrigated agriculture on the banks of the river and contamination of water by the use of pesticides; grazing, predatory hunting and burning; irregular occupation in app area, among others.

Thus, the authors reiterate that currently, all areas of paleodunar fields that border the São Francisco River, can be considered environments with very strong erodibility, impacted by incompatible anthropic actions, and it is therefore important to have a conservation plan for paleodunes, since, as it originates in past eras, they can never be reconstituted with the same intensity in the present (PACHECO, et al., 2020).

FINDINGS ON CONSERVATION PROPOSALS FOR THESE AREAS

Work 9 points out that the paleodunar fields that border the São Francisco River are considered relevant ecosystems because they harbor a unique biological diversity, composed of a flora rich in species and a fauna consisting of insects, reptiles, amphibians, small mammals and some species of birds that use the dunes to build their nests. Due to their importance, environmental conservation areas are considered, so they are protected by law, which obliges the management body to adopt land use and occupation plans and environmental management and conservation (PACHECO, 2016).

The authors also add that among the various factors conditioning the formation of dune environments and paleoenvironments stand out contributing elements of the dune vulnerability process that are associated both with anthropic factors and those related to the dynamics of coastal elements active in the place. They also state that, when it comes to this

dynamic, it is worth emphasizing the presence of vegetation and its state of damage, the presence or absence of wind and/or river sands in dune composition, the speed and direction of winds influencing processes of accretion and dune erosion, the seasonal variation of rainfall, in addition to anthropogenic derivations with the advancement of agricultural practices, traffic of vehicles, buildings on the river line and in the area of accumulation of sands, among others (Ibidem).

In study 3, the authors address that there is no doubt that the deepening of local human occupation would exacerbate geological processes, and for this reason the need for conservation measures for the area is indispensable (BARRETO, et al., 2002).

Study 4 points to the conception of Ab'Saber (2006, p. 304), which says that the xique-xique dune field constitutes "the largest mass of sands in any part of the Brazilian territory. It is an environment endowed with very strong erodibility, when impacted by the erosivity of incompatible anthropic actions." He draws attention to the need to constitute this area in an area of permanent preservation, however, he warned that it was indispensable to have a set of "proposals to compensate the poor roceiros of the ebbs, as well as the shepherds of goats who are initiating a new activity of very serious consequences for the derruição of the dunes" (p. 304), in order to preserve the existence of this physiographic and ecological scenario so delicate and important.

In work II, the authors discuss the relevance of environmental management instruments available for protected areas, it is necessary to plan a management plan for protected areas, aiming at territorial organization and management of land use and occupation. Among these instruments, the Management Plan is essential for the conservation of these environments. In this sense, Pacheco et al., (2020) proposes (in study II), a Conservation

Plan 3169 Paleodunar (PCP), also called the Environmental Conservation Plan (PCA) in other studies by Pacheco, in which it indicates mechanisms for prevention, control and conservation of natural environments. These authors categorized the area according to Tricart's theory, in stable, intergrade and unstable, and for each categorized area presented a conservation plan.

In the proposal of conservation plan the authors divided into three, being: 1. The Environmental Management and Conservation Plan (PMCA) with a view to being applied in areas that still present themselves as stable, with vegetation on the dunes fixing them and avoiding degradation. 2. The Environmental Control Plan (PCA), for areas that are already in the process of degradation (intergrids), aiming to maintain control and containment of wear in areas that are in transition. 3. The Environmental Revitalization and Conservation Plan (PRCA) points to strategies for revitalization and reforestation (with native vegetation of the ecosystem) of areas seen as strongly instable (ARAÚJO, et al., 2020).

In this sense, table 1 is presented below, synthesizing the findings with a view to the answers sought for the pivoting questions.

Thus, in this review, we sought to answer the specific questions raised. The NiQ, which asked about what the studies point to about the origin of the fossil dunes of Xique Xique and Barra, was answered from studies 1, 2, 4 and 5 by Barreto (1993; 1996), Ab'Saber (2006) and Pacheco (2014). On the other hand, The NQ2, which wanted to know their current status regarding anthropogenic actions, was answered through studies 3, 4, 6, 7, 8, 10 and 11 by Barreto et al., (2002), Ab'Saber (2006), Pacheco e Oliveira (2016; 2017), Pacheco (2020), Pacheco et al., (2018; 2020). Finally, The QN3, where it was sought to know if there is any plan to mitigate the

socio-environmental impacts for these areas, was answered by studies 4, 9, 11 and 12 from Pacheco e Oliveira (2016), Pacheco et al., (2020) and Araújo et al., (2020).

FINAL CONSIDERATIONS

The systematic literature review has given an opportunity to understand the origin and evolution of the dunes fields of Xique Xique and Barra, as well as the main impacts found in these areas and their current conditions, considering their process of natural vulnerability.

Thus, the research findings indicate that its origin is linked to the São Francisco River, which at another time in natural history, and under conditions different from the current one, elaborated the sandy deposits, being aided by the work of the wind in the process of transport and modeling of the paleodunar fields. Thus, the studies pointed out the São Francisco River needed at least 100,000,000 years to execute the deposit of sandy sediments, in view of the volume of the fields today.

Furthermore, the fragility of these environments and the amount and natural and anthropic impacts to which they are vulnerable were also pointed out in the studies, considering that the process of settlement of the areas contributes greatly to increase the processes of degradation of these environments.

Therefore, considering the relevance of these environments not only as a source of research in several areas, but also as local tourist potential, it is essential to have a management and conservation plan for these areas. In this sense, the studies also pointed out this need, already existing conservation proposals for this and other paleodunar areas that border the São Francisco River.

QN1-STUDIES 1,2,3,4 E 5 (Origin)	QN2-STUDIES 3,4,6,7,8,10 e11 (Impacts)	QN3-STUDIES 3,4,9,11, e 12 (plans)
AUTHORS:Barreto(1993);1996) Ab'Saber (2006); Pacheco(2014)	AUTHORS: Barreto et al.,Ab'Saber (2006); Pacheco and Oliveira (2016;2017); Pacheco(2020); Pacheco et al,(2018;2020)	AUTHORS:Barreto et al.,(2002); Ab'Saber (2006); Pacheco and Oliveira (2016); Pacheco et al,(2020); Araujo et al.,(2020)
<ul style="list-style-type: none"> • São Francisco River and its tributaries that supplied the sands. • The sands were reworked by the wind, generating aeolian deposits (Barreto, 1993;1996) 	<ul style="list-style-type: none"> • Susceptibility to sediment erosion; • Human occupation of the area leads to the geomorphological disfigurement of the dunes (Barreto, et al., 2002) 	<ul style="list-style-type: none"> • Densification of human occupation exacerbates geological processes; • Indispensable conservation measures (Barreto et al., 2002).
<ul style="list-style-type: none"> • An erg from a regional intermontane paleodesert; • Originated in semi-arid phases of the Late Pleistocene (general sea level was very low) • (Ab'Saber, 2006) 	<ul style="list-style-type: none"> • Destruction of the northern part of the dunes; • Anastomosed trails of goat transits; • Destruction of the extreme periphery of the dune field in the eastern plemonte Serra do Estreito; • Exposed sands on the edge of the dunes; • Expansion of devastation in ebb waters by agrarian activities (Ab'Saber, 2006) 	<ul style="list-style-type: none"> • Need to constitute an area of permanent preservation; • It is essential to have a set of proposals to compensate local residents (Ab'Saber, 2006).
<ul style="list-style-type: none"> • The fields represent a very important site as a witness of local geological and geomorphological evolutions; • Originating from paleoclimatic alternations in the Brazilian Northeast during the Quaternary (Pacheco, 2014) 	<ul style="list-style-type: none"> • Illegal extraction of sand and native species; • Dumps of solid waste and effluents in natura; • Opening of trails under the dunes and sports practices; • unsustainable tourism; • unlicensed constructions under the dunes; • Removal of riparian forest from the edges of the river and dune fields; • Irrigated agriculture along the river and water contamination; • Irregular occupation in APP areas, among others (Pacheco; Oliveira 2016;2017); • Pacheco(2020); • Pacheco et al.,(2018;2020). 	<p>Proposal of conservation plan the authors divided the three, being:</p> <ol style="list-style-type: none"> 1.The Environmental Management and Conservation Plan (PMCA); 2.The Environmental Control Plan (PCA), for areas that have already been in the process of degradation (intergrids); 3. The Plan for Revitalization and Environmental Conservation (PRCA) (Pacheco;Oliveira(2016); Pacheco et al,(2020); Araujo et al;(2020)

TABLE 1 - Answers to NQs from systematic literature review

SOURCE: Authors (2021)

REFERENCES

- AB'SABER, AN. O paleodeserto de Xique -Xique. Estudos Avançados.vol.20 no 56. São Paulo Jan/Abr.2006.<https://www.scielo.br.php?script=arttext&pid=S0103-40142006000100020>. Acesso em 1º, maio, 2021.
- ARAÚJO, I.P.R; SANTOS, R.P; PACHECO, C.S.G.R.; MOREIRA; M.B. Environmental Conservation Proposal (PCA) for the Casa Nova/BA paleodunar complex: a study with fishermen and riverine people from the São Francisco River. International Journal of Advanced Engineering Research and Science. Vol-7, Issue-2, February 2020. Disponível em: <https://ijaers.com/detail/environmental-conservation-proposal-pca-for-the-casa-nova-ba-paleodunar-complex-a-study-with-fishermen-and-riverine-people-from-the-s-o-francisco-river/>. Acesso em: 02 maio, 2021.
- BARRETO, A.M.F. 1993. Estudo morfológico e sedimentológico da porção norte do mar de areia fóssil do médio Rio São Francisco, Bahia. **Inst. de Geociências**, Universidade de São Paulo, São Paulo, Dissertação de Mestrado, 98p. https://teses.usp.br/teses/disponiveis/44/44136/tde-15072015-160307/publico/Barreto_Mestrado.pdf. Acesso em: 1º, maio, 2021.
- BAHIA. **Decreto Estadual nº 6.547 de 18 de Julho de 1997**. Disponível em: <https://www.inema.ba.gov.br/gestao-2/unidades-de-conservacao/apa-dunas-e-veredas-do-baixo-medio-sao-francisco/>. Acesso em 14 de maio de 2021.
- CABRAL, C. J. Caracterização paleoclimática e paleoambiental no campo de dunas de Petrolina em Pernambuco: Um subsídio para reconstituição do submédio São Francisco. (**Dissertação de Mestrado**), Recife: PE, 2014, 152.
- GALVÃO, M.C.B.; RICARTE, I.L.M. Revisão Sistemática da literatura: conceituação, produção e publicação. LOGEION: Filosofia da informação. Rio de Janeiro, v.6 n. 1, p-57-73, set. 2019/fev.2020.
- INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATISTICA (IBGE). **Geografia do Brasil**. Rio de Janeiro: SERGRAF/IBGE, vol.2, 1977.
- JACOMINE, P.K.T.; CAVALCANTE, A.C.; RIBEIRO, M.R.; MONTENEGRO, J.O.; BURGOS, N. 1976. Levantamento Exploratório-Recohecimento de solos da margem esquerda do Rio São Francisco, Estado da Bahia. **Boletim técnico EMBRAPA**
- MELO, R.B. et al. Análise da produção e da exportação de manga no pólo Petrolina/PE-Juazeiro/BA. Disponível: www.ifpi.edu.br/eventos/.../6dd6f664d10c768ef6e27d10608c878c.pdf. Acesso em: 15. Abr. 2021
- NIMER, E. Clima. In: Geografia do Brasil-Região Nordeste. Vol.2. Rio de Janeiro: IBGE, 1977.
- _____, Climatologia do Brasil, Rio de Janeiro: IBGE, 1989, 421 p.
- PACHECO, C.S.G.R. Ecodinâmica da Paisagem Paleodunar do Médio Rio São Francisco/BA: em defesa das fronteiras agredidas. **Dissertação de Mestrado**. Instituto de Tecnologia de Pernambuco (ITEP), Recife/PE, 2014, 153p.
- PACHECO, C.S.G.R.; OLIVEIRA, N.M.G.A.. Caracterização histórico-ambiental da APA dunas e veredas do-baixo-medio São Francisco (BA). **Revista Ibero-Americana de Ciências Ambientais**, v.7n.2, p29-44, 2016. DOI: <https://doi.org/10.6008/SPC2179-6858.2016.002.0003>. Disponível em: <https://sustenere.co/index.php/trica/article/views/SPC21796858.2016.002.0003/729>. Acesso em: 1º, maio, 2021.
- PACHECO, C.S.G.R.; SANTOS, R.P.; COSTA, I.M.G.S.; SILVA, K.J.S.; La degradación ambiental em paleoambientais de Brasil: analisis ecodinamico de lá ecorregión Dunas de São Francisco. **La Técnica: Revista de las agrociências**. Nº.20(2018): Julio-Diciembre. Disponível em: <https://revistas.utm.edu.ec/index.php/fronteras/article/view/3471>. Acesso em: 1º, maio, 2021.
- PACHECO, C.S.G.R. **Paleocossistemas no curso do rio São Francisco/BA e a ecodinâmica das paisagens**. Curitiba/PR. Editora CRV. 2020. DOI: 10.24824/978854443919.7. Disponível em: <https://www.editoracriv.com.br/produtos/detalhes/34490-paleocossistemas-no-curso-do-rio-sao-francisco-ba-e-a-ecodinamica-das-paisagens-br2-edicao>. Acesso em: 02 maio, 2021.
- PRODANOV, C.C., & FREITAS, E.C. **Metodologia do trabalho científico: métodos e técnicas da pesquisa e do trabalho acadêmico**. Novo Hamburgo: Feevale, 2013.

SCHOBENHAUS, C. F.; ALMEIDA CAMPOS, D.; DERZE, G.R.; ASMUS, N. E.; Geologia do Brasil. Texto explicativo do mapa geológico do Brasil e da área oceânica adjacente incluindo depósitos minerais, escala 1:2.500.000. Brasília, MME/DNPM, 1984, 501p.

YIN, R. K. **Estudo de caso: planejamento e métodos**. Porto Alegre: Bookman. 2010.