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RISK CATEGORY CLASSIFICATION CRITERIA ESTABLISHED BY THE BRAZILIAN DAM SAFETY REGULATIONS APPLIED ON SMALL WATER STORAGE DAMS

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Abstract. *In Brazil, the National Policy of Dam Safety has been recently established by the Federal Law nº 12.334/2010. One effect was the implementation of the Brazilian Water Resources Council's (CNRH) Normative Resolution nº 143/2012, which set out general criteria for classification of water storage dams on risk and potential hazard categories, associating the reservoir volume. The objective is a dam safety preliminary analysis, an identification of potential deficiencies that may affect the structures stability and a hierarchical portfolio of dams. This paper presents a study based on field safety inspections and on application of CNRH's classification criteria to 45 small water storage dams located in the Brazilian northeast. The results showed that the CNRH's classification criteria presented some misconceptions when applied to small dams with the profile characteristics sampled.*

1 INTRODUCTION

The dam classification criteria for risk and potential hazard, established by the Brazilian Water Resources Council's (CNRH) Normative Resolution nº 143/2012, consists of a qualitative method for preliminary analysis of risk aiming to establish the priorization in a dam portfolio, based on the potential deficiencies that compromises the structures safety. Among the main benefits of this act, is to promote the government, dam owners and entrepreneurs risk management by the increase of rational planning and orderly prevention measures, risk control and mitigation, according a given classification order. The classification systems also aims to a rational planning of the inspection procedures for dam safety and the monitoring programs to ensure the safety of the venture. A real examples of this fact is the publication of the Resolutions nº 742/2011 and nº 91/2012, by the Brazilian Water Agency, whose content establishes, depending on the obtained classification, the periodicity and the minimum and mandatory content of the regular safety inspections or special inspections, in later, if deeper researches were necessary for safety problems to be identified. Depending on the obtained classification, it may also be required by the inspection agents, to elaborate of an Emergency Action Plan for the dam. Two years after the publication of the proposed classification criteria by the CNRH, some studies were measuring the Brazilian methodology performance for dam classification for risk and potential hazard associated. An example is the Carim et al.

Studies[1], where there were proposed some modifications on the classification criteria defined by the CNRH based on a critical analysis for each one of the descriptors established. However, it was not evaluated in an in-depth manner the performance of the proposed methodology for small water dam classification located at northeast Brazilian region, in which peculiar aspects demands a careful by analysis of the classificatory obtained results, considering the socioeconomic and hydrological peculiarities of the region. Thus, this paper presents a study based on field safety inspections and on application of CNRH's classification criteria in 45 small water storage dams located in the Brazilian northeast.

2 THE CNRH'S RISK CATEGORY CLASSIFICATION CRITERIA

The classification system in risk categories and potential hazard associated, posed by the Brazilian legislation, is based on risk indications and classification matrices, in the same way as the other qualitative methods for a risk preliminary analysis, as: Global Risk Index[2], Modified Global Risk Index[3], Lafitte Index[3]. Such methods are specially applied for a preliminary risk evaluation and when was verified a serious deficiency, a posterior phase may be performed for evaluation, using individual analysis methods for dam risk evaluation as: Causes and Fault Indicators, Failure Mode and Effects Analysis (FMEA), Event Tree Analysis and Fault Tree Analysis (FTA). The risk categories classification as proposed by the CNRH uses three classification matrices[4]. The classification is obtained according to a determined punctuation for each matrix. Table 1 summarize the respective classificatory matrices which define the risk class. Each classification matrix groups in a class set descriptors identified from (a) to (r) that expresses the related aspects for technical characteristics, physical status and operational conditions of the dams and features related to risk management measures applied to the dam. For each descriptor is assigned a value range for scoring, what aims to express the diverse possibilities located between the best scenario (lower scored) and the worst scenario (higher scored) for dam safety. The value range definition for scoring values is obtained as a relative relevance for each descriptor for the class it is associated. Such partial weights define the final score for each matrix and thereafter the final classification of the dam for the risk category[5]. After obtaining the score for each risk matrix, the total score for risk category classification is obtained by Equation 1.

$$RC = TCM + DPM + SPM \tag{1}$$

Where, RC = Total score for risk category classification; TCM = Score for Technical Characteristics matrix; DPM = Score for Dam Preservation matrix; and SPM = Score for Dam Safety Plan matrix. As RC is obtained, the dam classification may proceed for the risk category according Table 2.

The Normative Resolution n° 143/2012 of CNRH establishes in separate the dam classification for risk category (RC) and for potential hazard associated (PHA). The classic definition of risk as the failure probability and its respective consequences, is not used in the normative resolution of the CNRH. However, the risk evaluation according its classics precepts may be performed based on the assumption that the two factors (RC and PHA), involved in the normative resolution, translate the value pair: likelihood and consequence[4]. Thereafter, we may assume that: a) the Risk Category coefficient (RC) represents the failure probability; b) the Potential Hazard Associated coefficient (PHA) represents the resulting consequences. Thus, the Risk value (R), according its classical concept should be estimated by the Equation 2.

$$R = RC.PHA \tag{2}$$

Where, R = Risk; RC = Risk Category; and PHA = Potential Hazard Associated. This paper is limited to the study of the constituted methodology for dam classification in risk categories. This approach does not cover the methodology for dam classification for potential hazard associated.

Technical Characteristics Matrix (TCM) Descriptors	**Score range**
Height (a)	0 to 3
Lenght (b)	2 to 3
Type of construction material (c)	1 to 3
Type of foundation (d)	1 to 5
Age (e)	1 to 4
Design flow conditions (f)	3 to 10
TCM = ∑ (a to f)	8 to 28
Dam Preservation Matrix (DPM) Descriptors	**Score range**
Confiability of spillway structures (g)	0 to 10
Confiability of outlet structures (h)	0 to 6
Seepage (i)	0 to 8
Strains and Settlement (j)	0 to 8
Slopes or faces deterioration (l)	0 to 7
Navigation Lock (m)	0 to 4
DPM = ∑ (g to m)	0 to 43
Dam Safety Plan Matrix (SPM) Descriptors	**Score range**
Existence of project documentation (n)	0 to 10
Organizational structure and technical qualification of dam's safety staff (o)	0 to 6
Procedures and routines of dam safety inspections and monitoring (p)	0 to 8
Operating rules for outlet hydraulic structures (q)	0 to 8
Dam safety reports with analisys and interpretation (r)	0 to 7
SPM = ∑ (n to r):	0 to 39

Table 1: Risk Assessment Matrices and their descriptors and score range

Classification Range	**Risk Category**	**RC**
	High	>= 60 or DPM >=8 (*)
	Medium	35 a 60
	Low	<= 35

Note (*): Score greater or equal to 8 in any column of Dam Preservation Matrix (DPM) automatically imply High Risk Category and immediate steps by dam owner

Table 2: Risk category classification

3 METHODS AND PROCEDURES

3.1 Registered data, topographic survey and dam safety inspections

This current paper methodology involved three steps, starting from surveying the registered data of the dams. In these surveys where performed information search for registered data of the dams in public organs technical collections related to: (1) identification; (2) localization; (3) adopted design criterion; and (4) technical and operational characteristics of the dams. Next step, were performed topographic surveys for each one of the evaluated dam confirming its geometric characteristics and reservoir estimated volume. The last step was the safety inspection for all the focused dams. These inspections were performed in a way to obtain the necessary information for fulfilling the classificatory matrices regarding the risk categories provided by the Normative Resolution nº 143/2012 of the CNRH[5]. The safety inspections were standardized, aiming to minimize the subjectivism on the identification and on the observed anomalies analysis. The main safety parameters evaluated during inspection were: (1) integrity, stability and functionality conditions of the spillway; (2) integrity, stability and tightness conditions of the dam's massive; (3) integrity and functionality of outlet structures and hydromechanics equipment; (4) operational aspects and socio-environmental impacts; (5) presence of design documentation; (6) identification of organizational structure and dam safety staff qualification; (7) presence of guiding proceeding for dam safety and monitoring; (8) presence of safety reports with analysis and interpretation; (9) potential human losses; (10) downstream existing infrastructure.

3.2 Dams classification by risk classification

After obtaining information by the three described surveying steps, the dam risk classification was performed, according to the CNRH's methodology.

4 RESULTS AND DISCUSSION

4.1 Dams general characteristics

The evaluated general dam characteristics were presented and discussed in this point. The 45 evaluated dams where located at semiarid region of northeast Brazilian region, mainly located at Piranhas-Açu river basin. All dams were built as homogeneous earthfill structures over alluvial soil, and many of them rests over originally intermittent rivers. Table 3 shows the main characteritics of the surveyed dams. According to the reservoir volume classification system provided by CNRH's Normative Resolution[5], all evaluated dams were classified as small dams, in fact all them presented reservoirs volumes smaller than 5,000,000 m^3. The average height for the surveyed dams is nearly 8.9 m, what characterizes that dams as small sized ones. These dams where located in rivers that their hydrographic characteristics where adverse for navigation, feature that makes navigation lock structures unfeasible. In general, if we consider only the 24 dams where was possible to identify their built dates, the average age of the dams is around 43 years, what points to the occurrence of ageing process on these structures. It's important to note that at the time of the field inspections, the water level in the reservoir was low.

Over the entire XX Century, the Brazilian Department for Works Against Droughts (DNOCS), promoted intense construction of dams in semiarid northeast Brazilian region and in that period, adopted and disseminated for these designs an empiric criterion for hydrological dimensioning of reservoirs[6] that was elaborated in 1943 by Aguiar[7]. Such method is based on observations about hydrologic behavior of two hydrographic basins of the region ranged between 1911 and 1930. The described method is based on design flows estimated for a recurrence period of 100 years, what contradicts the safety expectations, according to score range established for design flow conditions from risk assessment matrices of the CNRH's Normative Resolution[4]. The spillways of most of these surveyed dams where dimensioned in accordance to these criteria.

Identification number (ID)	Dam	Type	Coordinates (°)		Height (m)	Reservoir volume (m^3)	Year of Construction	Owner
			Latitude	Longitude				
1	Pinga	Homogeneous Earth Fill	-6.016233	-36.281014	18.09	3,952,610.00	1983	DNOCS[1]
2	Tororo	Homogeneous Earth Fill	-6.202424	-36.564980	10.71	3,941,300.00	1933	DNOCS[1]
3	Currais Novos	Homogeneous Earth Fill	-6.269009	-36.526448	8.96	3,815,000.00	Not identified	DNOCS[1]
4	Pituassú	Homogeneous Earth Fill	-6.423358	-35.797728	18.94	3,623,800.00	1980	SEMARH/RN[2]
5	Joaquim Bezerra Cavalcante	Homogeneous Earth Fill	-6.380487	-36.036002	13.83	3,277,600.00	1983	SEMARH/RN[2]
6	Ursula Medeiros	Homogeneous Earth Fill	-6.252501	-36.379973	11.15	2,682,000.00	1984	Particular
7	Barra do Catunda	Homogeneous Earth Fill	-6.151451	-36.421068	11.55	2,242,700.00	1984	SEMARH/RN[2]
8	Barra do Tapuia	Homogeneous Earth Fill	-6.105878	-35.915066	13.53	2,115,917.00	Not identified	Not identified
9	Santa Terezinha	Homogeneous Earth Fill	-5.927414	-36.637301	6.24	2,040,705.66	Not identified	Particular
10	Vale da Sela	Homogeneous Earth Fill	-6.860821	-37.297881	10.81	1,826,356.27	1959	Particular
11	Garrote	Homogeneous Earth Fill	-6.804849	-37.436599	8.73	1,793,384.85	1973	Particular
12	Mulungu Velho I	Homogeneous Earth Fill	-6.578823	-37.550172	12.79	1,649,529.29	Not identified	Particular
13	Francisco Cardoso	Homogeneous Earth Fill	-6.237008	-36.297084	11.47	1,617,649.00	1980	DNOCS[1]
14	Flores	Homogeneous Earth Fill	-6.844265	-37.389786	6.00	1,484,487.74	Not identified	Particular
15	Aristofane Fernandes	Homogeneous Earth Fill	-5.905753	-36.638503	7.78	1,480,624.93	1950	Particular
16	Trapia III	Homogeneous Earth Fill	-5.984518	-36.792379	8.44	1,315,600.00	1985	SEMARH/RN[2]
17	Pracaba	Homogeneous Earth Fill	-5.824320	-36.709853	9.10	1,170,421.55	2005	Particular
18	Riacho da Cachoeira	Homogeneous Earth Fill	-6.145687	-36.114010	11.39	1,128,150.00	1953	Not identified
19	Oriente	Homogeneous Earth Fill	-6.417817	-37.515766	8.95	1,073,100.41	1963	Particular
20	Queimadas	Homogeneous Earth Fill	-6.885482	-37.339838	8.88	1,067,646.14	1958	Particular
21	Rosario	Homogeneous Earth Fill	-5.982707	-36.757690	8.65	1,050,144.45	Not identified	Particular
22	Natalia	Homogeneous Earth Fill	-6.923622	-37.683706	10.87	956,954.00	Not identified	INCRA[4]
23	Cachoeira	Homogeneous Earth Fill	-6.617289	-37.576930	8.58	846,177.89	1953	Particular
24	Timbauba	Homogeneous Earth Fill	-6.583543	-37.516130	8.54	843,526.00	Not identified	Particular
25	São Rafael	Homogeneous Earth Fill	-6.169555	-36.303003	8.88	825,303.79	Not identified	Particular
26	Saraiva	Homogeneous Earth Fill	-6.428007	-37.457138	5.17	817,367.53	1955	Particular
27	Serra do Gado	Homogeneous Earth Fill	-5.912423	-36.530291	7.42	707,859.30	Not identified	Particular
28	Virgulino	Homogeneous Earth Fill	-5.782907	-36.542727	6.16	675,992.26	Not identified	Particular
29	Pitomba	Homogeneous Earth Fill	-6.691283	-37.298503	7.69	625,366.53	1964	Particular
30	Antonio da Volta	Homogeneous Earth Fill	-5.853553	-36.593540	6.08	617,299.41	2000	Particular
31	Castelo	Homogeneous Earth Fill	-6.793916	-37.535045	8.59	560,330.20	Not identified	Particular
32	Santa Rita	Homogeneous Earth Fill	-6.460148	-37.556724	7.67	518,308.59	Not identified	Particular
33	Cachoeirinha	Homogeneous Earth Fill	-5.929388	-36.683106	8.33	511,233.35	Not identified	Particular
34	Fazenda Limao	Homogeneous Earth Fill	-6.943397	-37.628237	8.45	503,121.60	1930	Particular
35	Elisio Galvao	Homogeneous Earth Fill	-5.978538	-36.599842	7.24	489,340.39	Not identified	Not identified
36	Jacobina	Homogeneous Earth Fill	-6.924024	-37.388124	7.73	481,266.17	1980	INCRA[4]
37	Palestina	Homogeneous Earth Fill	-5.948765	-36.763474	5.93	470,029.92	Not identified	Not identified
38	Terra Nova	Homogeneous Earth Fill	-6.416268	-37.474955	4.34	291,696.00	1960	Particular
39	Macapa	Homogeneous Earth Fill	-6.937634	-37.513112	5.10	288,556.11	Not identified	Particular
40	Arapua	Homogeneous Earth Fill	-5.951915	-36.771154	5.68	275,860.29	1999	INCRA[4]
41	Bom Jesus	Homogeneous Earth Fill	-5.865905	-36.622343	7.96	225,464.22	Not identified	Not identified
42	Mulungu	Homogeneous Earth Fill	-5.936674	-36.827841	7.06	220,096.32	Not identified	Not identified
43	Carnaúbas	Homogeneous Earth Fill	-5.881243	-36.401260	10.95	119,432.00	1980	Particular
44	Boa Sorte	Homogeneous Earth Fill	-5.895600	-35.632100	4.75	25,800.25	Not identified	DER/RN[3]
45	Dos Fieis	Homogeneous Earth Fill	-5.896112	-35.640459	5.71	13,870.08	Not identified	Not identified

Note: (1) DNOCS = Brazilian Department for Works Against Droughts; (2) SEMARH/RN = Rio Grande do Norte State Environment and Water Resources Secretariat; (3) DER/RN = Rio Grande do Norte State Department of Highways; and (4) INCRA = Brazilian Institute of Colonization and Agrarian Reform.

Table 3: Dams general characteristics

The present economic activities in the region that these surveyed dams where built are mainly characterized by subsistence ones. By this way, the majority of these dams were built for meet needs for small rural human settlements. Many of them where built by the settled people by themselves, using their own empiric knowledge.

4.2 Risk category classification

In sequence will be presented and discussed the obtained results by the employment of the CNRH's methodology for classification according to risk category for the surveyed dams. The representative percentage of the obtained classifications for the evaluated dams on the risk categories was: 97.78% of the dams were classified at high risk category and 2.22% at medium risk category. None of the dams were classified at low risk category. Therefore, it may declare that, and based only on the final results for risk category, it was not possible to base a clear prioritization scale to implement a risk management on the evaluated dams, considering that almost all dams were classified as high risk. So, to obtain a dam portfolio with the dams with a better defined prioritization scale, it was necessary to go deeper on the scored risk analysis results. The obtained scores for each dam on the three provided matrices by the CNRH's methodology are present on Figure 1. On this figure each dam is presented according its identification number (ID), provided by Table 3. It can be observed that, for most of the evaluated dams, the obtained scores on the DPM matrix are substantially lower than the scores obtained for the other matrices. This observation is also based on the fact that the average value for scores obtained in TCM and SPM matrices is equivalent to 73% of the average value of total score obtained in all dams. Such values represent on average 85% of score required for classifying dams as high risk. Despite the final classification eventually suggests in fact very adverse conditions for almost all evaluated dams, many of them may present satisfactory physical and operational conditions relative to failure probability, as a function of the score values obtained by the DPM matrix. This finding may bring up analysis fails, at the time of establish the actions priorities for risk management. Therefore, it was considered that the dams should not be penalized only by exhibiting some isolated defined technical characteristics, but mainly when problems or anomalies where present that, associated with some appointed technical characteristics, may represent actual failure risk. As an example, it was cited the occurrence of strains/settlements events (matching the (j) descriptor, on DPM matrix) that, depending on the building material (matching the (c) descriptor, on the TCM matrix) may be considered a higher or lesser critical event with respect to failure risk.

Figure 2 presents on areas the score fractions obtained for each one of the three CNRH matrices form dam, according to its identification number (ID). The sum of the fractions corresponds to the accumulated total score obtained for the dam classification according its risk category. Aiming to view the framing for each dam regarding to risk categories present on Table 2, it were inserted two horizontal lines representing the score border (35 and 60 points) defining the low, medium or high risk categories. According to Figure 2, the ID 11 dam was alone the only dams that obtained the matching score with medium risk category, whose score is located between the two horizontal lines. The other ones were classified as high risk category, for their scores are located above the interface line between the medium and high risk categories. It may be observed that the obtained values on TCM and SPM matrices are very uniform and similar for all the evaluated dams, when compared with DPM matrix values. It should emphasize that the observed variation on the final score is due in almost part to score accumulation effect of the DPM matrix obtained score, fact that may be verified by the present similar geometric shapes among the top of the areas of the DPM and SPM matrices.

The Figure 3 shows in area shapes, the obtained score portions for each dam, according to each one of the descriptors that compose the TCM matrix. For a better view of the intensity of the variation of the total score values obtained, it was inserted a horizontal line that represents the average total score for all dams, obtained from the TCM matrix. It can be observed that the total scores obtained for each dam were located slightly near of the average value, not representing great variations around this value. The less contribution portions on total scores are related to the height descriptor (a), in which most the dams were not scored, due to small heights estimated in field for these dams (see Table 3). The obtained scores on the other descriptors also varies only a little bit, being the age descriptor (e) that what presented the larger variation, reflecting more intensely on the total score variation than the other descriptors. In a general way, this express that the dams endows similar technical characteristics according to the evaluated descriptors by the TCM matrix.

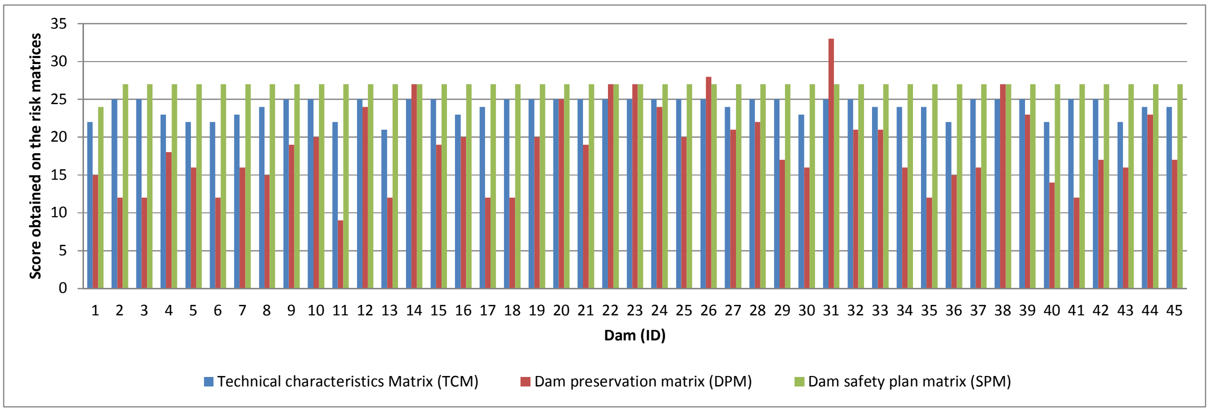

Figure 1: Obtained score on the TCM, DPM and SPM matrices versus Dam (ID).

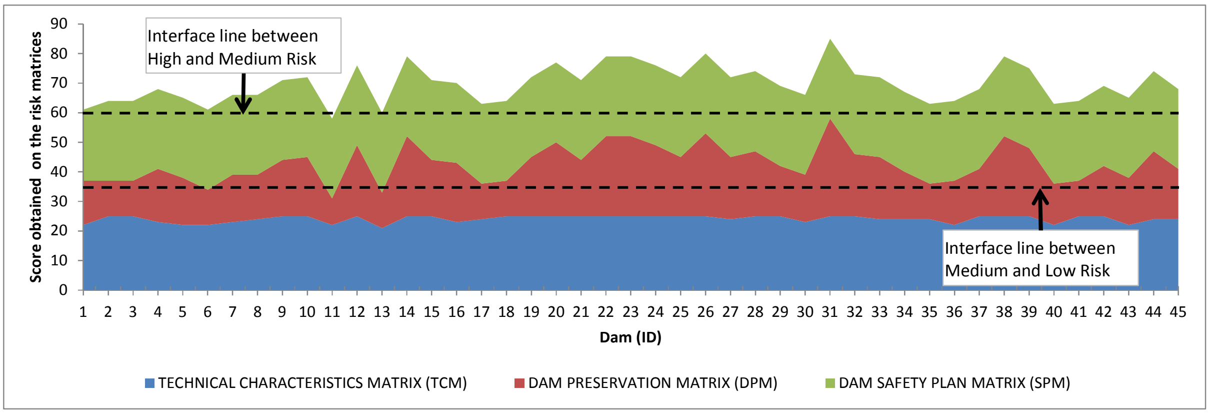

Figure 2: Obtained score on the risk matrices versus Dam (ID).

On Figure 3, it may be noted that the higher impact contribution portion on the final scores are due to the design flow descriptor (f). This fact is related to the adoption of empirical methods for hydrological dimensioning of a considerable number of reservoirs located at the existing intermittent rivers located on the semiarid region of the north-east Brazilian region, as Aguiar method[7], what bases the estimation for design flow on the recurrence period of 100 years. It is also due to the high relevance assigned to this descriptor by the TCM matrix. Regional particularities, as the short flow permanencies, low precipitation rates, time and space irregularities on precipitations and lower than the evaporation index may, in thesis, justify the empiric methods use on design flow estimations over stochastic methods, in dams located on semiarid northeast region.

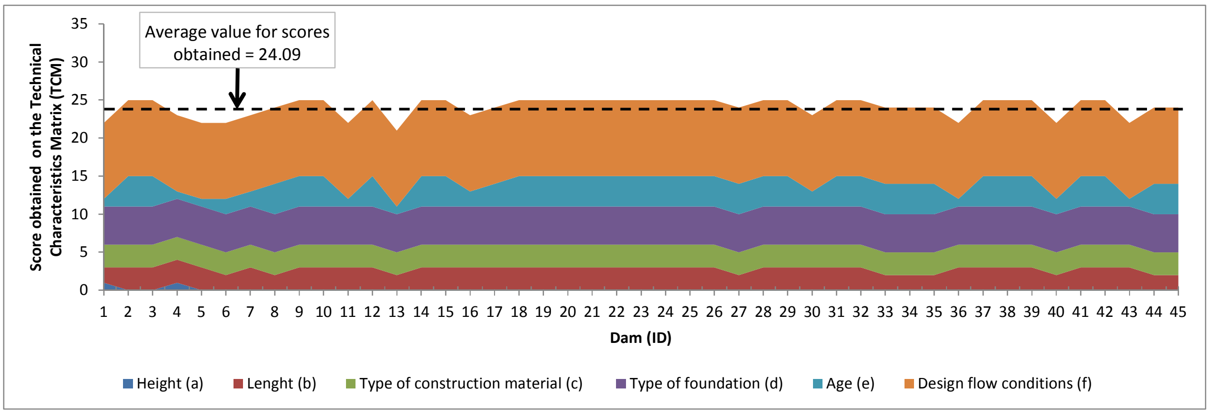

Figure 3: Obtained Score on the Technical Characteristics Matrix versus Dam (ID).

Statistical data may also justify, in thesis, the use of empirical methods for hydrological dimensioning of reservoirs, specifically on semiarid region. According studies carried out[8], in an accident and incident evaluation occurred among 1917 and 2001 on Ceará State, 28 failure cases were registered in at universe of near 30,000 dams, wherein only 7 of these cases may be related to spillway dimensioning problems. Most of the identified failures may be directly associated to constructions in disagreement to correct soil compaction techniques and by not obtaining the optimal moisture content[9], due to inappropriate equipment and water scarcity on the region. This fact is reflected on the work presented[8], as about 71% of the rupture cases were due to problems like seepage, cracks, internal erosion, slope failure and other erosion types not associated to overtopping. However, despite of these considerations, it is known that the stochastic nature of the hydrologic magnitude must be considered, even for semiarid regions. In the other hand, it’s also known that the specific regional features and historic data concerning failures may not be left out.

Figure 4 shows in areas, the scoring portions obtained for each dam, according each one of the descriptors that compose the DPM matrix. It may be observed that the ID 11 dam was better evaluated concerning its physical state and operational conditions. The resulting scores of the DPM matrix were the ones that presented higher variability around the horizontal line that represents the overall mean scoring, allowing to determine a preliminary indicative of dam prioritization aiming the adoption of risk management procedures. As viewed on the figure, the spillway structures reliability descriptor (g) and outlet structures reliability descriptor (h) were the most striking ones on the obtained score on the DPM matrix. This behavior is due to the free-crest spillways of these dams, built on unlined excavated channels, what increases regressive erosions possibility on these structures. By the other side, the water intake and outlet structures, including hydromechanics equipments, has strong lack of maintenance recording, what reduces the reliability of these structures, at the time of the safety inspections. The (l) descriptor, concerning slope deterioration also impacts significantly on the total score obtained through the DPM matrix. This is due most for the reason of inadequate use of vegetal covering as slope protection, that not survive due to long drought periods that the regions is submitted, allowing erosive processes. The lack of slope and surface drainage channels maintenance also aggravates this problem. It may note that seepage problems related to (i) descriptor affected approximately 44% of the evaluated dams. The (j) descriptor strains and settlements were of low on no impact on scoring the evaluated dams. It may note that no navigation lock scoring (m) was performed, because it does not fits to the pattern of evaluated dams.

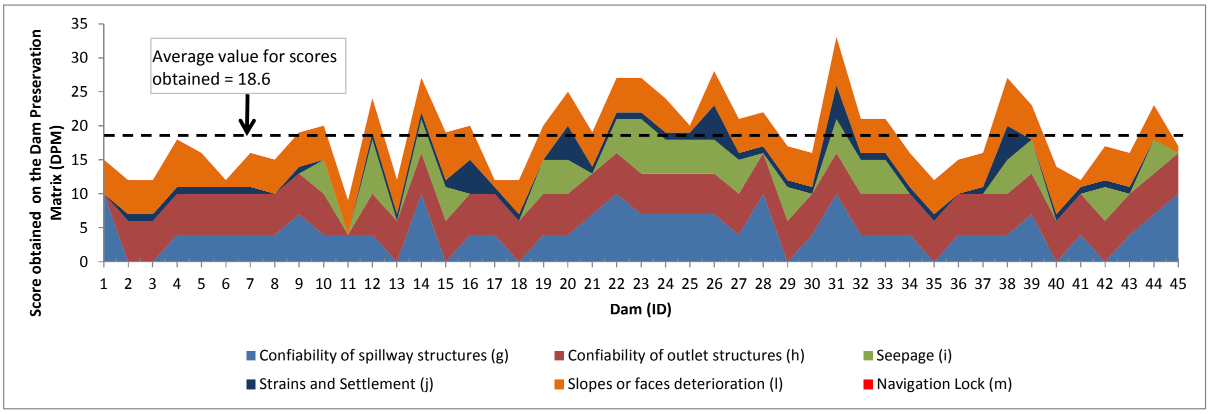

Figure 4: Score obtained on the Dam Preservation Matrix versus Dam (ID).

Figure 5 shows in areas, the obtained score portions for each dam, according each one of the descriptors that composes the SPM matrix. It may be observed that all evaluated dams presented problems related to safety requisite. The absence of project documentation, inspection and monitoring procedures and routines, safety reports, organizational structure and safety technical staff were recurrent on evaluated dams, even at public ownership dams. Thus, maximum scoring was obtained on (n), (o), (p) and (r) descriptors, except for the ID 1 dam, that on descriptor (p) obtained a lower score. Scores were not obtained in the (q) descriptor, because all dams evaluated presented free-crest spillways[5]. Despite the high contribution from the obtained scores by means of SPM matrix and definition of high risk category for most the evaluated dams, we may consider that these dams should be approached with an differentiated scoring range criteria than that currently presented at the SPM matrix, such as weighting and incorporating the socioeconomic features of familiar small properties peasants that exert subsistence agriculture. These people cannot fund a dam safety at the foreseen level of the SPM matrix descriptors. Depending on the economic situation of the ownership, it should be unfeasible to perform practical actions aiming the score reduction of the dam obtained by the SPM matrix, what needs substantial funds and a lot of time to operationalize.

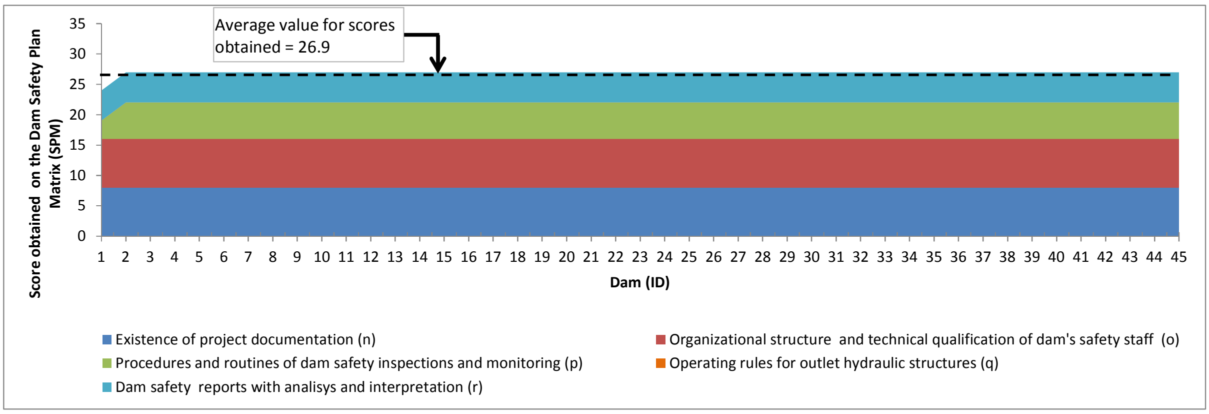

Figure 5: Score obtained on the Dam Safety Plan Matrix versus Dam (ID).

5 CONCLUSIONS

This paper presented a study based on safety inspections and using CNRH's criteria classification for risk categories of 45 small dams located on north-east Brazillian region. The main conclusions are summarized hereafter. The CNRH's matrices don't resulted on a satisfatory hierarchization level in respect to the risk classification for the evaluated dams, insofar as 97.78% of the dams were classified at high risk category, 2.22% at medium risk category and none at low risk category. The obtained score at DPM matrix are significantly lower than that were obtained on the TCM and SPM matrices. This fact indicates that, despite the final classification eventually suggests the presence of very unfavorable conditions for almost all the evaluated dams, many of them may meet satisfactory physical and operational conditions relating failure probability, what may point analysis fails, on adopting priorities for risk management. Considering the high scoring obtained by TCM and SPM matrices, the fact that the dams were penalized only by presenting some isolated technical characteristics was shown a detrimental factor for a risk analysis. It is also considered that the absence of documentation and operating procedures and safety management in the evaluated dams not implies directly high probability of immediate failure. Considering also the high costs of studies for the establishment of inspection and monitoring programs that legally subject the owners, in the case of small dams with the profile of the evaluated ones on the present work, it’s likely that weighing and incorporation at the CNRH’s risk assessment matrices, of regional hydrological peculiarities, reported dam failures occurred on north-east semiarid macro-region, and owners socioeconomic profile, may be beneficial to risk management, for inspection enforcement and for regularization of the irregular dams passive located on this region. Therefore, we suggest a reevaluation of the criteria established by CNRH in order to obtain a more realistic and less conservative approach in assessing the risk on these dam types.

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