Sendai Framework Indicators for Disaster Risk Reduction in Brazil: Initial Conditions, Feasibility Analysis and Understanding the Risk

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ABSTRACT

In December of 2016, the United Nations General Assembly accepted the Report (1) from the Open-Ended Intergovernmental Working Group on Indicators and Terminology Related to Disaster Risk Reduction, which defines how to monitor the progress towards the Global Targets of the Sendai Framework. This research aims to test the methodology developed and the use of the seven proposed sets of Indicators in Brazil, calculating the initial conditions with the available data and identifying the necessary steps to collect the data and adopt the Indicators not yet available. All the Indicators are feasible in the country, and for the five sets with data readily available, the use was tested in different spatial distributions. As more than 85% of the human damages in Brazil are caused by water related disasters, those were combined with Climate Change data from CMIP5 project, to identify the river basins that require attention from the government, based on expected changes on annual precipitation.

Keywords: Sendai Framework, Global Targets, Disaster Data, Indicators, Climate Change

INTRODUCTION

With the adoption of the Sendai Framework by the United Nations (UN) Member States, an Open-Ended Intergovernmental Working Group on Indicators and Terminology Related to Disaster Risk Reduction (OEIWG) was created, with the goal of defining a "*set of possible indicators to measure global progress in the implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030*" (2). Accepted in December of 2016, the set of indicators created was named from A to G, corresponding to each of the global targets, and sub-divided by sequential numbers (ex. A-1).

This research is the first test of the methodology in the country, and is composed by three steps: *I) Initial Condition and Feasibility Analysis – Applicability of the Indicators; II) Spatial Analysis – Distribution of the damages in the country;* and *III) Climate Change – expected scenarios and disasters trend*.

Using data collected from Brazilian institutions, the initial condition of the indicators is calculated for the whole country, allowing the feasibility analysis of the proposed methodology, the assessment of quality and availability of data in the country, and the identification of the necessary steps for adoption of the Indicators with data unavailable.

The next step is the test application of the methodology on finer political divisions such as States and Cities, or physical divisions, like first and second order river basins, to test how those indicators can be used as a tool for better understanding the distribution of the risk inside the country.

Finally, considering that the majority of the human damages by disasters in the country are caused by water related disasters, the results of the indicators on sub river basin level is combined with precipitation data extracted from the CMIP5 project, with the objective of identifying the areas that will need more attention in the future, allowing the Brazilian Government to have a reference for actively work on DRR measures, considering climate change future scenarios.

This study is also useful to further develop the use of the indicators as a resource for government decisions, and can be applied, on similar way, in all the counties adopting the Sendai Framework.

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THEORY AND METHODOLOGY

Based on the methodology developed by the OEIWG on the Report (1) that proposed indicators for Global Targets of the Sendai Framework (Table 1), the required data was requested to the Brazilian institutions in charge of collecting and storing each of the datasets required for the indicators.

Table 1: Global Targets of the Sendai Framework and indicators proposed by the OEIWG (1).

Target	Number	Description of the Indicator
Global Target A: Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015		
A	1 (comp.)	Number of deaths and missing persons attributed to disasters, per 100,000 population
	2	Number of deaths attributed to disasters, per 100,000 population
	3	Number of missing persons attributed to disasters, per 100,000 population
Global Target B: Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared with 2005-2015		
B	1 (comp.)	Number of directly affected people attributed to disasters, per 100,000
	2	Number of injured or ill people attributed to disasters, per 100,000
	3	Number of people whose damaged dwelling were attributed to disaster
	4	Number of people whose destroyed dwelling were attributed to disaster
	5	Number of people whose livelihoods were disrupted or destroyed, attributed to disasters
Global Target C: Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030		
C	1 (comp.)	Direct economic loss attributed to disasters in relation to global gross domestic product
	2	Direct agricultural loss attributed to disasters
	3	Direct economic loss to all other damaged or destroyed productive assets attributed to disasters
	4	Direct economic loss in the housing sector attributed to disasters
	5	Direct economic loss resulting from damaged or destroyed critical infrastructure attributed to disasters
	6	Direct economic loss to cultural heritage damaged or destroyed attributed to disasters
Global Target D: Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030		
D	1 (comp.)	Damage to critical infrastructure attributed to disasters
	2	Number of destroyed or damaged health facilities attributed to disasters
	3	Number of destroyed or damaged educational facilities attributed to disasters
	4	Number of other destroyed or damaged critical infrastructure units and facilities attributed to disasters
	5 (comp.)	Number of disruptions to basic services attributed to disasters
	6	Number of disruptions to educational services attributed to disasters
	7	Number of disruptions to health services attributed to disasters
	8	Number of disruptions to other basic services attributed to disasters
Global Target E: Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020		
E	1	Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2013
	2	Percentage of local governments that adopt and implement local disaster risk reduction strategies in line with national strategies
Global Target F: Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030.		
F	1	Total official international support (ODA + OOF), for national disaster risk reduction actions
	2	Total official international support (ODA + OOF), for national disaster risk reduction actions provided by multilateral agencies
	3	Total official international support (ODA + OOF), for national disaster risk reduction actions provided bilaterally
	4	Total official international support (ODA + OOF), for transfer of disaster risk reduction-related technology
	5	Number of International, regional and bilateral programmes and initiatives for the transfer and exchange of science, technology and innovation in disaster risk reduction for developing countries
	6	Total official international support (ODA + OOF) for Disaster Risk Reduction capacity-building
	7	Number of international, regional and bilateral programmes and initiatives for disaster risk reduction-related capacity-building in developing countries
	8	Number of developing countries supported by international, regional and bilateral initiatives to strengthen their disaster risk reduction-related statistical capacity
Global Target G: Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.		
G	1 (c. 2+5)	Number of Countries that have multi-hazard early warning systems
	2	Number of Countries that have multi-hazard monitoring and forecasting systems
	3	Number of people per 100,000 that are covered by early warning information through local governments or through national dissemination mechanisms
	4	Percentage of local governments having a plan to act on early warnings
	5	Number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the population at the national and local levels
	6	Percentage of population exposed to or at risk from disasters protected through pre-emptive evacuation following early warning

The following step was to assemble a single database combining all the data, allowing the aggregation a of data considering all levels of political subdivisions in the country, and also allowing to correlate the data with other special information, such as the boundaries of river basins. In this way, it was possible do identify data gaps and indicators that could not be calculated with the data available, and allowed to calculate the other indicators on Country, State and River basin levels.

To understand the priorities for action for the Brazilian Government, the results of the Sendai Framework Indicators A and B were combined with change on precipitation data from CMIP5 experiment (3). The climate change experiment was made using all the Global Circulation Models (GCM) com CMIP5, with, Historical data available, Representative Concentration Pathways (RCP) 2.6 and 8.5, regular grid and simulation period up to the beginning of the year 2100.

This condition was satisfied by 26 of the models and, and from those, the mean yearly precipitation was calculated on the time interval of 1986 to 2005, as initial condition, and 2080 to 2099, as expected scenario. The average yearly precipitation was calculated for the 76 second order river basins of the country and the rate of change was calculated comparing the results from historical and future scenarios.

DATA

To each set of indicators, a different set of data had to be obtained. The data related to disasters used on the indicators A, B, C, D and E is available on the country's Integrated System of Disaster Information (S2ID)(4). The data about Economic losses, indicator C, was previously processed by CEPED/UFSC on the Disaster Damage Report 1995-2014 (5). The data about damages to critical infrastructure was collected by the institution but not available due to a system failure, and the data about disruption of services was not collected. The data about International Support, indicator F, was provided by Brazilian Cooperation Agency, but the criteria of classification of the data does not match the required by the indicators. The data related to the Early Warning System was provided both by the National Center of Disaster Monitoring and Alert – CEMADEN (6) and S2ID. Census data the political division of the country was obtained from Brazilian institute of Geography and Statistics (IBGE)(7).

RESULTS AND DISCUSSION

I) Initial Condition and Feasibility Analysis – Applicability of the Indicators

Using the available data and applying the methodology of the report, was possible to identify which of the indicators the initial condition could be calculated with the available data, and from those without the required data, this research aimed to identify the necessary steps for the adoption of the indicator.

Table 2: Indicators for Global Target in Brazil – Initial Conditions

Indicator	Global Targets						
	A	B	C	D	E	F	G
1	1.85	2741.42	0.296%	no access	1.00	no data	1.0
2	1.64	328.81	0.198%	no access	0.67	no data	1.0
3	0.21	530.14	0.022%	no access		no data	45315.56
4		1882.47	0.029%	no access		no data	0.79%
5		no data	0.048%	no data		no data	1.0
6			no data	no data		no data	no data
7				no data		no data	
8				no data		no data	

As shown in Table 2, the indicators A and E could be completely calculated, the indicators B, C and G had one missing data each. For the indicators that could not be calculated, the indicator D-1 to D-4 could not be completed because the data was not provided by the institution in charge, and the D-5 to D-8 because the data was not collected. The indicator F requires the classification of each international cooperation into Disaster Risk Reduction (DRR) and related actions, and the ABC, up to the present, uses a different classification, not allowing the correct calculation of this indicator.

II) Spatial Analysis – Distribution of the damages in the country

To better understand the distribution of disaster in the country, the data related to human damages, indicators A, B and C, were analyzed according to the spatial distribution in the country. The data about disasters in the country is detailed up to the city level, and this research tested the use of those indicators on city, state, country levels, and also on first and second order river basins.

Considering that Brazil is the 5th largest country in the world, each of its 26 states is almost the size of a single country, being adequate to calculate the indicators on State level. As more than 85% of the human damages in Brazil are caused by water related disasters, the calculation of indicators by river basin and sub river basin are also of extreme relevance.

In the Figure 1 identifies the spatial distribution on State level, of values of indicator A and B, on the years from 2005 to 2014. It also identifies that the deadliest disasters happen on the south of the country and on the Rio de Janeiro State (RJ), but the highest rate of people affected by disasters can be found on the Amazon State (AM).

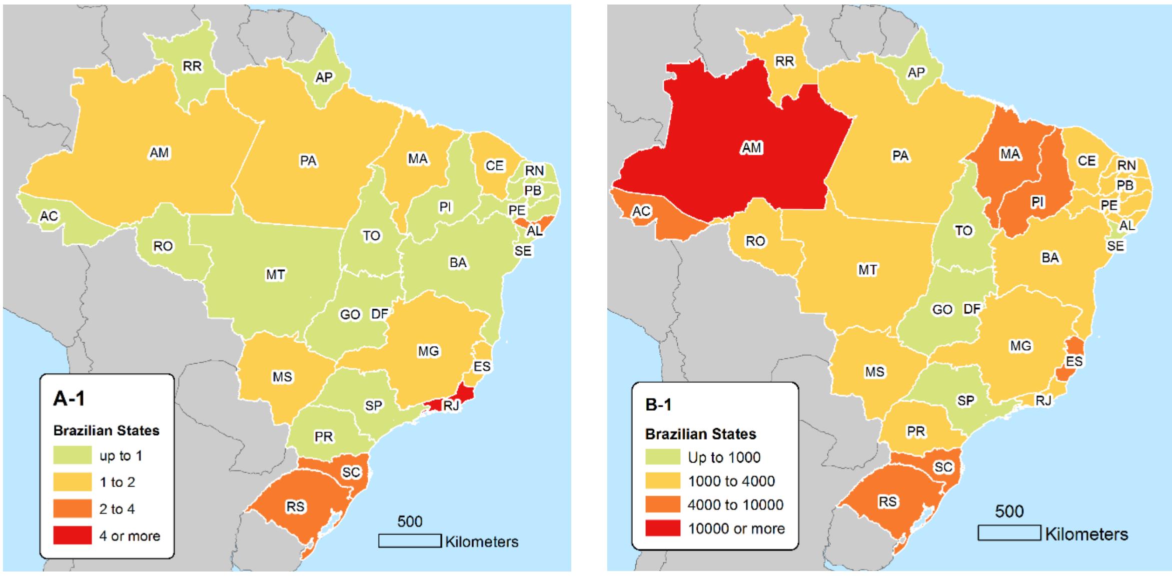

Figure 1: Indicators A-1 and B-1, by Brazilian State

The Figure 2 shows the similar spatial analysis of Figure 1, but using as boundary the sub river basins.

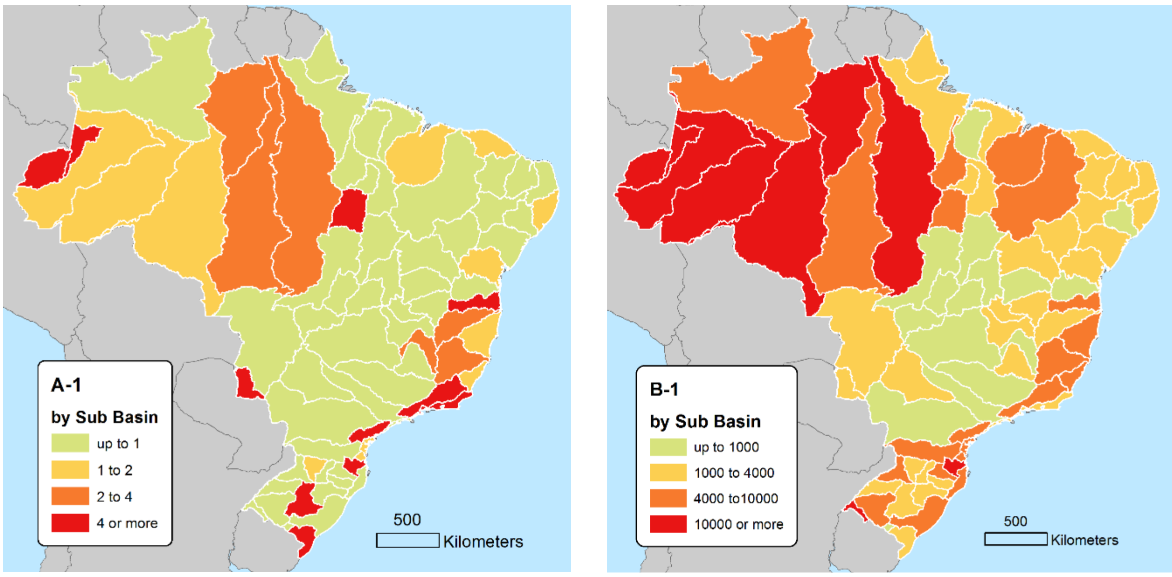

Figure 2: Indicators A-1 and B-1, by Sub River Basin

In this case, the detail is increased and the river basins with higher values for indicators A-1 and B-1 can be found. Comparing the state analysis, the river basin scale shows more precisely the critical areas for human damages, considering the predominance of water related disasters in the country.

III) Climate Change – expected scenarios and disasters trend

With the results obtained on the Indicators for Global Targets of the Sendai Framework, the next step on this research was to calculate the rate of change of average yearly precipitation, considering as initial condition the interval from 1986 to 2005, and as final condition the interval from 2080 to 2099. This rate of change was calculated for each of the sub river basins on the country, for RCP 2.6 and for RCP 8.5. The results for both RCPs are shown below, on Figure 3.

Those results on RCP2.6 shows a small change on precipitation for most of the country, within the range or -5% to +5% on yearly precipitation change ratio. The exceptions are two of the southernmost basins, with expected increase on the range between +5% and +10%.

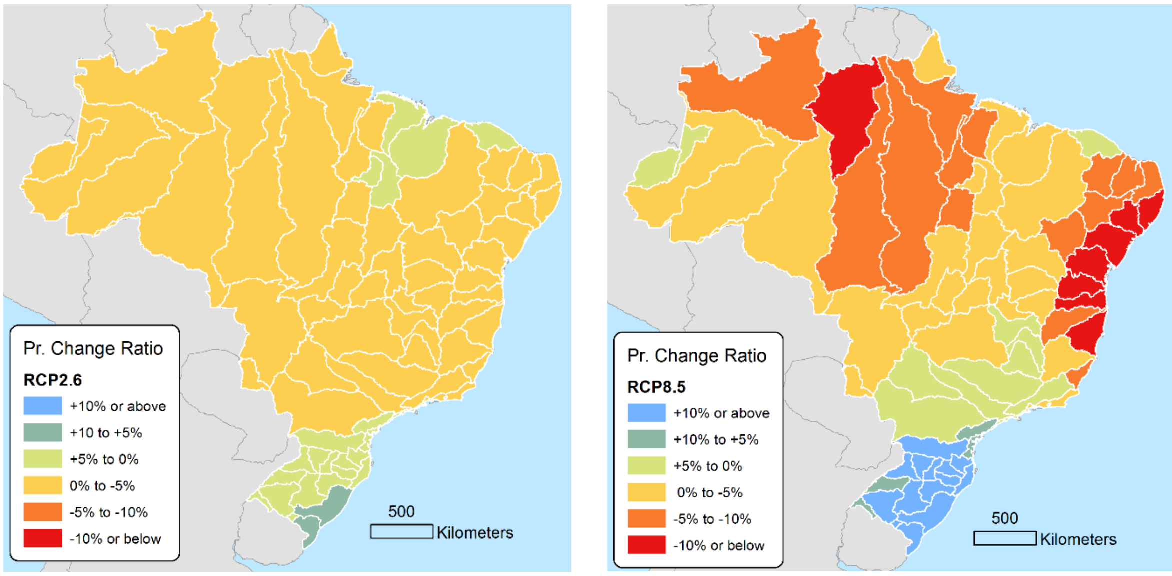

Figure 3: Rate of change on average yearly precipitation.

In the case of the RCP8.5, the expected changes are more extreme, with whole southern area of the country with increase on precipitation exceeding 10%, while part of the north area and part of northeast area with decrease on precipitation beyond -10%.

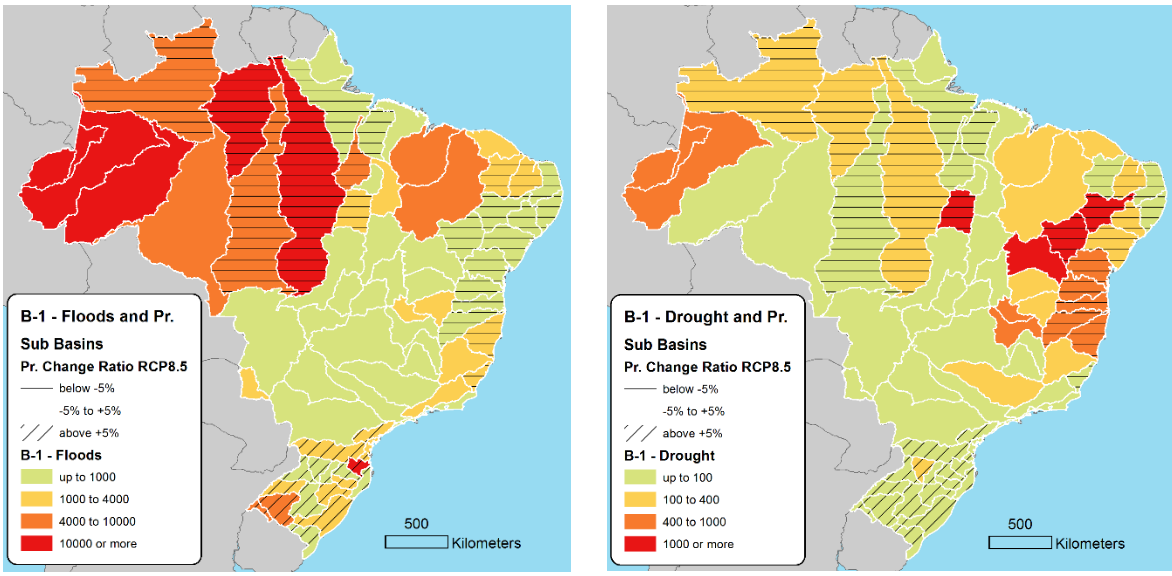

Figure 4: Indicator and B-1 for Floods (left) and Droughts (right), and yearly average precipitation changes on RCP8.5.

The next step was to combine this rate of change on yearly precipitation with the indicators for damages caused by specific disaster types, like floods or droughts. The combination of those results with the indicators A-1 and B-1 can be used for identifying the priorities for action for DRR actions, considering not only the concentration of damages, but also the future scenarios expected for each area.

To this analysis (Figure 4), precipitation change of the RCP8.5 was used, and combined with the indicator B-1 for floods and droughts.

The results on the Figure 4 (left) analysis shows that areas with more people affected by floods, on the northern area of the country, are expected to keep the actual yearly precipitation or decrease more than

10%. While this result may appear interesting considering the reduction of floods, this area is partially covered by Amazon Forest and heavily affected by forest fires on dry years. Another point that requires attention is the Itajaí basin on the southern area, with indicator B-1 for floods higher than 10,000.

The figure on the left shows that the areas most affected by droughts, on the northeast region, are expected to become even dryer on the RCP8.5 scenario, heavily aggravation an already critical situation.

CONCLUSIONS AND RECOMMENDATION

Based on the results of this research, it's possible to understand that the adoption of the Indicators on State and River Basin level can be used for a better understanding of the situation of the country regarding disasters. As this set of indicators is officially the international standard, they should also be officially adopted by the disaster management system in Brazil.

As the country is already developing the S2ID and most of the information necessary to calculate the indicators is already available in this system, with further development the system can also be prepared to calculate dynamically the indicator, providing important data for decision making.

The use of the climate change experiments allows a better understanding of the future scenarios and allows the country to take active role on preparing for the disasters, and should be used as a tool for decisions, policy making and other DRR actions.

Combining the Sendai Framework indicators with expected climate change scenarios can give insight about potentially critical areas, allowing the government to prioritize DRR using, on a reality of limited resources, using objective parameters instead of solely political or by convenience decisions.

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