World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:12, No:5, 2018

Projections of Climate Change in the Rain Regime of the Ibicui River Basin

Claudineia Brazil, Elison Eduardo Bierhals, Francisco Pereira, José Leandro Néris, Matheus Rippel, Luciane Salvi

Abstract**—**The global concern about climate change has been increasing, since the emission of gases from human activities contributes to the greenhouse effect in the atmosphere, indicating significant impacts to the planet in the coming years. The study of precipitation regime is fundamental for the development of research in several areas. Among them are hydrology, agriculture, and electric sector. Using the climatic projections of the models belonging to the CMIP5, the main objective of the paper was to present an analysis of the impacts of climate change without rainfall in the Uruguay River basin. After an analysis of the results, it can be observed that for the future climate, there is a tendency, in relation to the present climate, for larger numbers of dry events, mainly in the winter months, changing the pluviometric regime for wet summers and drier winters. Given this projected framework, it is important to note the importance of adequate management of the existing water sources in the river basin, since the value of rainfall is reduced for the next years, it may compromise the dynamics of the ecosystems in the region. Facing climate change is fundamental issue for regions and cities all around the world. Society must improve its resilience to phenomenon impacts, and spreading the knowledge among decision makers and citizens is also essential. So, these research results can be subsidies for the decision-making in planning and management of mitigation measures and/or adaptation in south Brazil.

Keywords**—**Climate change, hydrological potential, precipitation, mitigation.

I. INTRODUCTION

RECENT studies show that increasing the average temperature of the planet can cause an intensification of the hydrological cycle, which can cause changes in rainfall regimes, greatly altering the water availability of a given region. This study is of paramount importance for various activities, including for a generation of renewable energy sources that are linked to the climatic conditions.

The Intergovernmental Panel on Climate Change (IPCC) was created through an initiative of the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) [2]. The IPCC was established with the mission of evaluating research, interpreting and collecting all relevant technical, scientific, and socioeconomic information, as well as comprehensive, easily understood and accessible by all communities, including decision makers [1].

Rainfall in southern Brazil between 1990 and 2005 can be described as well distributed, with maxima varying from 1200 to 2100 mm/year [3].

As hydroelectric plants are in the first position in the Brazilian energy matrix, they evidence a need to know a distribution of the pluviometric regime of the region. An examination of the trend of the rainfall patterns is one of the hypotheses to infer the occurrence of local climate change, therefore the objective of this work is to present an analysis of the impacts of climate change without rains in the Ibicui river basin.

II. MATERIALS AND METHODS

A. Study Area Description

An evaluation of precipitation projections in the region of the Ibicui River basin is shown in Fig. 1. The Basin extends between geographic coordinates 28° 53 ' and 30° 51' south latitude and 53° 39' and 57° 36' west longitude, covering 30 Cities, draining an area of 35,439 km², counting with a total population of 414,321 in habitants. Its main trainers are the rivers Toropi, Jaguari, Ibicuí Mirim, Ibirapuitã and Santa Maria. Economic activities are detachment which is the cultivation of irrigated rice, production, and mining (extraction of sand for civil construction).

B. Data Description and Climate Model

The scenarios were generated using the models used in the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC-AR5), based on an analysis of the seasonal variability of precipitation and the consequent variation in energy production.

The database used in this research is part of the Phase 5 Intercomparison of Matching Models (CMIP5) and contributed to the preparation of the fifth IPCC-AR5 report. The data were extracted from ACCESS model (The Australian Community Climate and Earth System Simulator).

In AR5, the scenarios are organized according to the RCPs [4]. In this research, RCP 8.5 scenario was used which represents a scenario with a continuous population growth, resulting in high carbon dioxide emissions, with an increase Up to 4 °C. This scenario is considered to be the most pessimistic for the 21st century in terms of greenhouse gas emissions, consistent with no policy change to reduce emissions and strong reliance on fossil fuels [5].

The climatic projections of the precipitation series were divided into three scenarios: Scenario-1 (2026-2050), Scenario-2 (2051-2075) and Scenario-3 (2076-2100), the

Claudineia Brazil is with the environmental and sanitary engineering, College Dom Bosco (phone: 55 51 981326819; e-mail: neiabrazil@gmail.com).

Elison Eduardo Jardim Bierhals and Francisco Pereira are with the Energy Engineering, State University of Rio Grande do Sul, Brazil, (e-mail: bierhalseduardo@gmail.com, kiko.borgesp@gmail.com).

José Leandro Melgar Néris, Matheus Lara Rippel, and Luciane Salvi are with the environmental and sanitary engineering, College Dom Bosco, (e-mail: leandro_melgar@hotmail.com, matheuslrippel@gmail.com, salvi.faculdade@dombosco.net).

seasonal analysis was done for each of these scenarios.

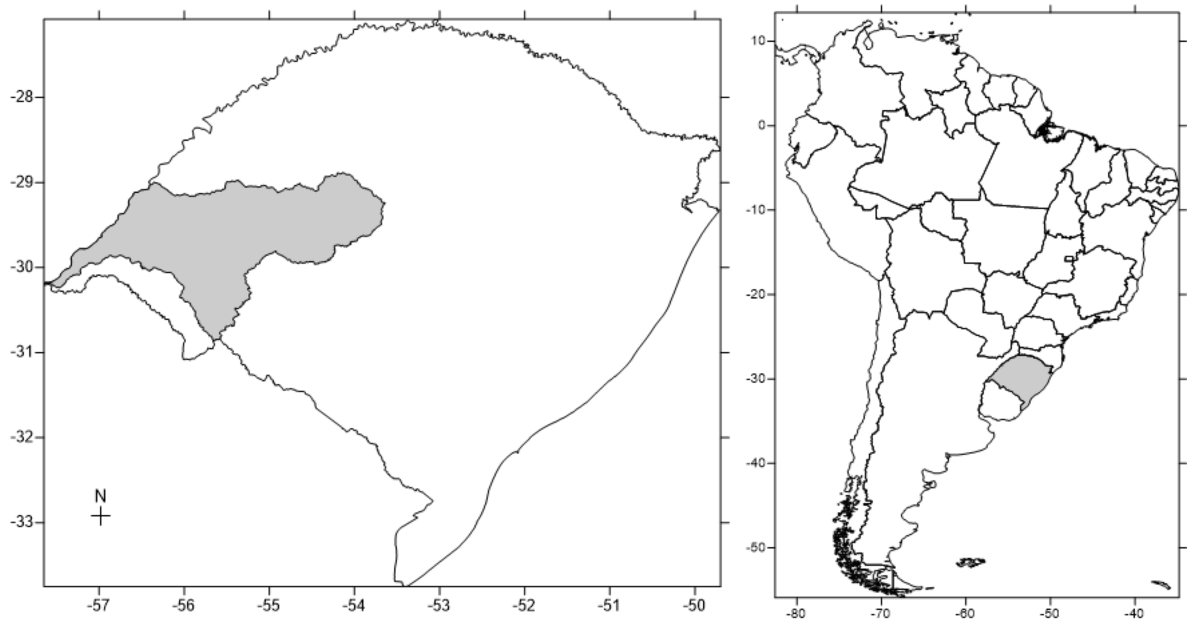

Fig. 1 Study area localization

Fig. 2 shows the steps of the work, the monthly precipitation data were extracted from the IPCC-AR5 database, the information is provided in grid points, and Grads (Grid Analysis and Display System) software was used to extract the results. Grads is a system of visualization and analysis of data in grid points, it works with binary data matrices, in which the variables can have up to four dimensions (longitude, latitude, vertical levels and time) [6]. After this stage, the historical data series and the data series with the climatic projections were organized.

III. Methodology

The projections were divided into three 25-year scenarios: Scenario-1 (2026-2050), Scenario-2 (2051-2075) and Scenario-3 (2076-2100). In the sequence, precipitation anomalies were calculated from the following equation:

$$APre\ (\%) = ((PMM - PMN)/\ PMN)*100 \qquad (1)$$

where APre (%) is the precipitation anomaly in percentage; PMM is the mean precipitation of the analyzed month; PMN is the climatological norm corresponding to the analyzed month.

World Meteorological Organization (WMO) defines climatological normal as averages of climatological data calculated for consecutive periods of 30 years.

IV. Results And Discussions

The permanence curve is important for the study of precipitation variability, being possible to verify the probability of occurrence of the events that occur in the watershed. The figures show the permanence curves for Ibicui River Basin (Fig. 3). The permanence curve shown below indicates that the tendency is to increase the maximum precipitation values. When analyzed, historical data show a probability of precipitation occurring around 11% for precipitations above 200 mm.

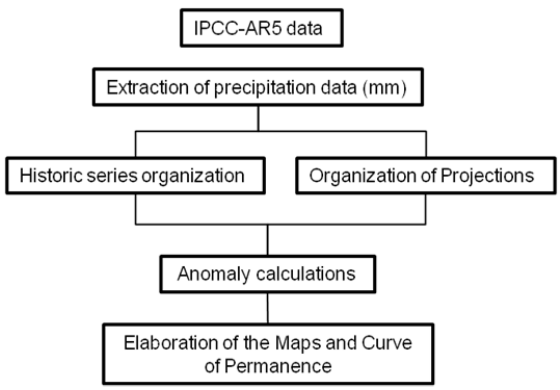

Fig. 2 Methodology flowchart

Figs. 4-6 show positive anomalies values for the three scenarios analyzed, mainly in the eastern half of the Ibicui River basin, with an increment of over 50 mm, mainly in scenarios 2 (Fig. 5) and 3 (Fig. 6), indicating a tendency in the precipitation increase in the region of due to the impacts of climate change.

For analysis of variance of the models, the three most representative of projections series of precipitation in the 21th century were evaluated.

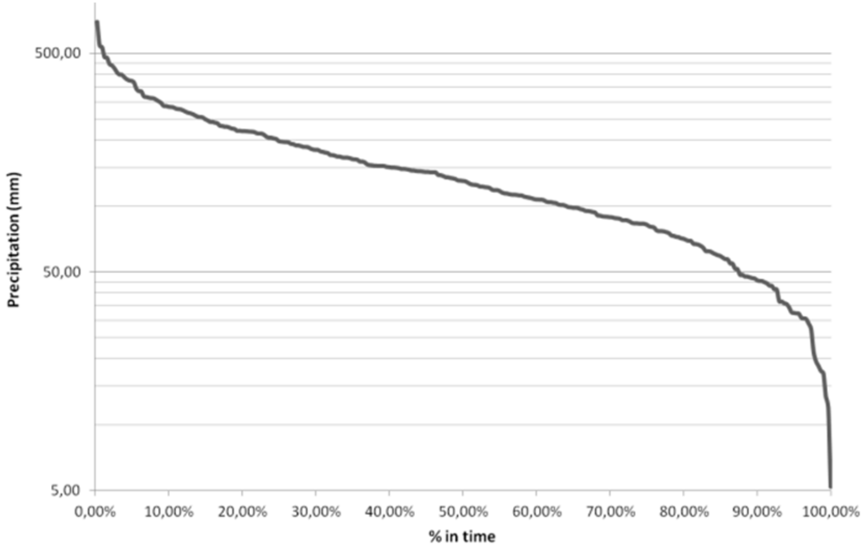

Fig. 3 Permanence curve of precipitation projections

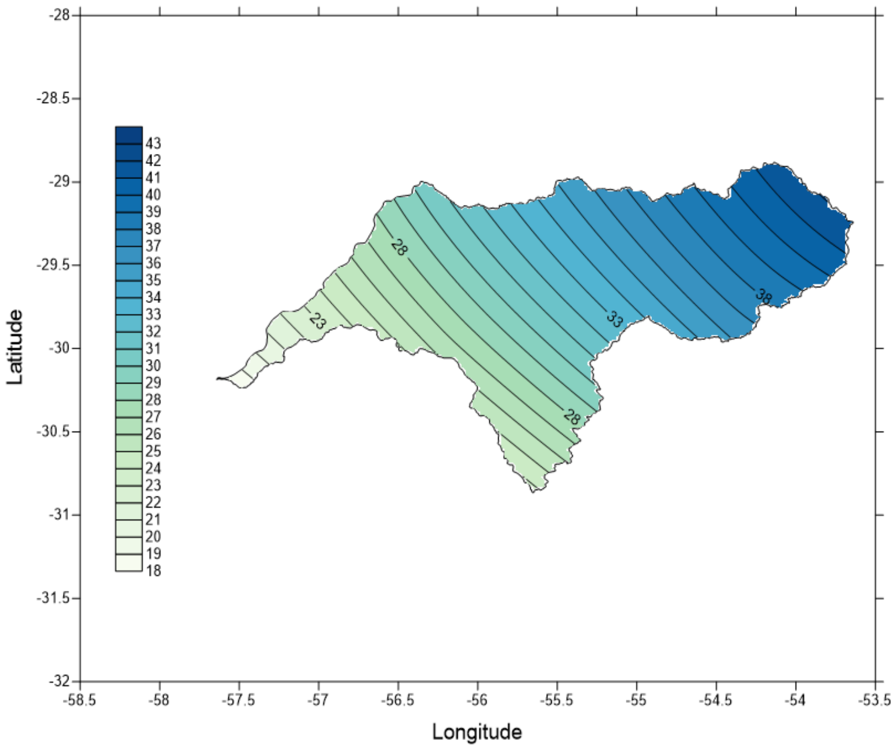

Fig. 4 Seasonal precipitation anomalies (scenario 1: 2026 – 2050)

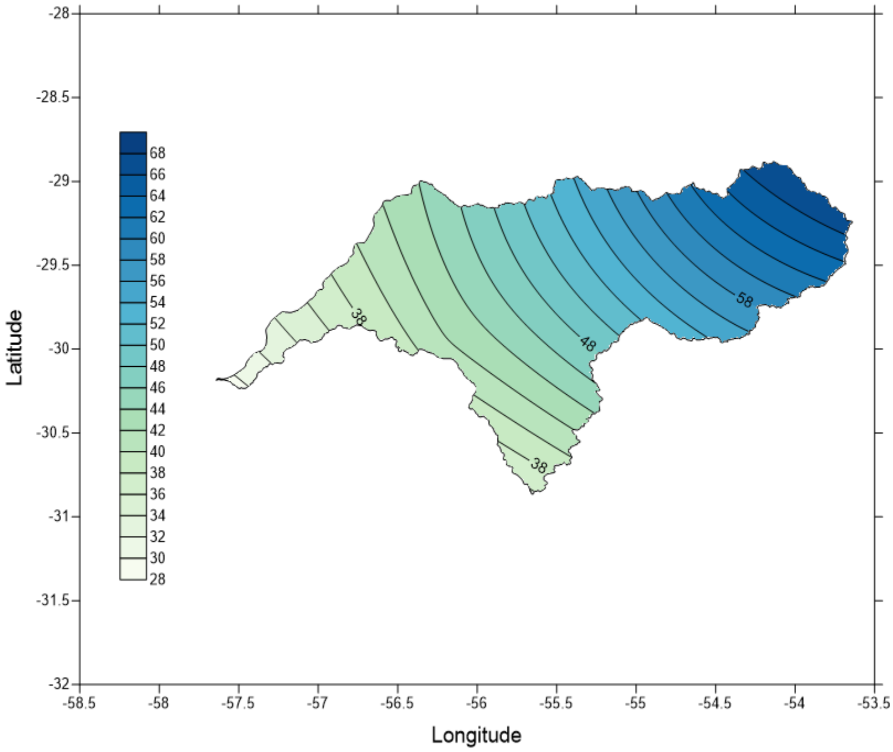

Fig. 5 Seasonal precipitation anomalies (scenario 2: 2051 - 2075)

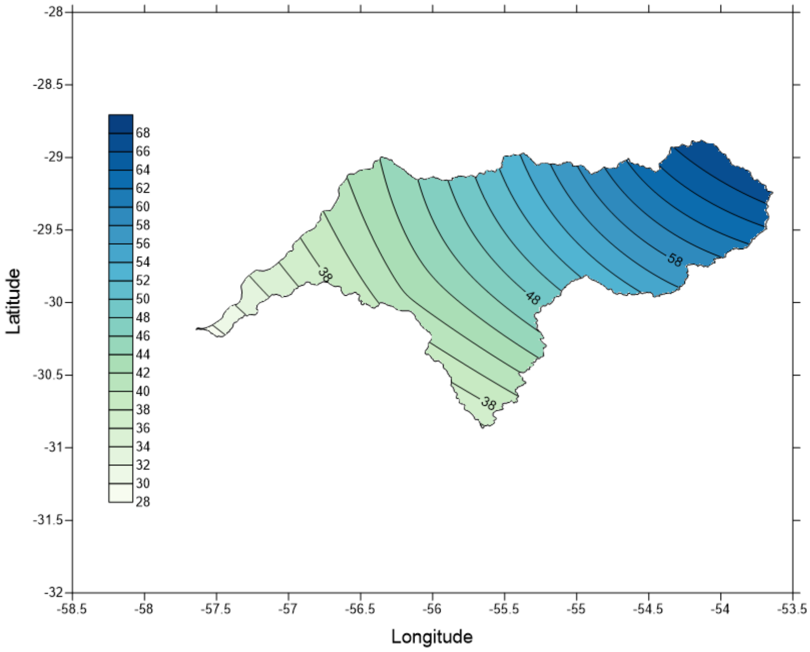

Fig. 6 Seasonal precipitation anomalies (scenario 3: 2076 - 2100)

Based on the average precipitation projections of the hydrographic basin where the Ibicui River is located, it was observed that the highest values of precipitation are found in the east half of the basin, fluctuating around 180 mm for scenario 1 (Fig. 7).

Scenario 2 (Fig. 8) and scenario 3 (Fig. 9) presented a precipitation projection of 200 mm in the easternmost region of the Ibicui River Basin and an increase of around 40 mm for scenario 2 and 3 in relation to the first scenario analyzed, thus verifying a trend without increased precipitation for a region of study.

Projections of future climate change throughout the 21th century are consistent with the forces imposed on them. Such projections are valuable information for mitigation actions such as planning adaptation actions and minimizing impacts and vulnerability [6].

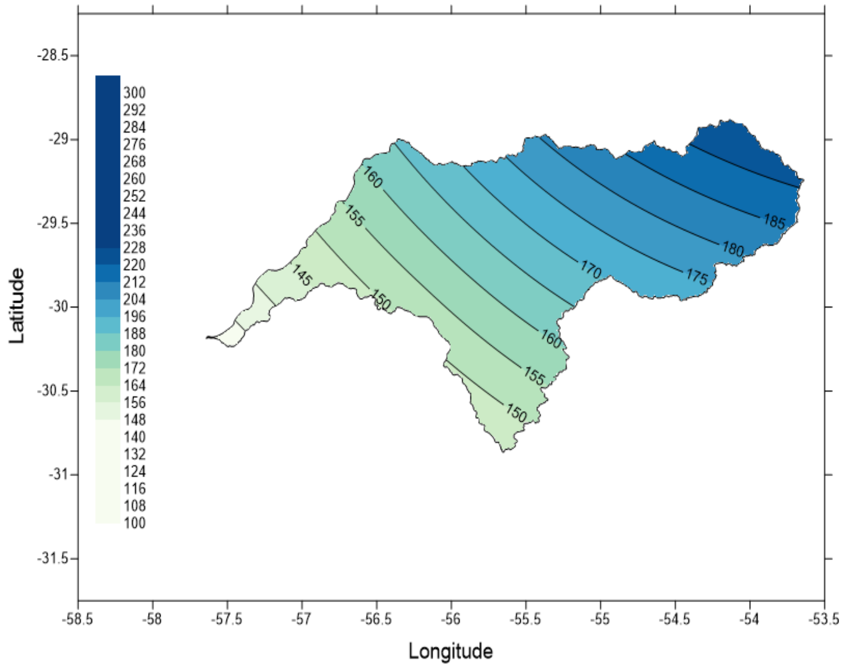

Fig. 7 Precipitation projections: scenario 1 (2026 – 2050)

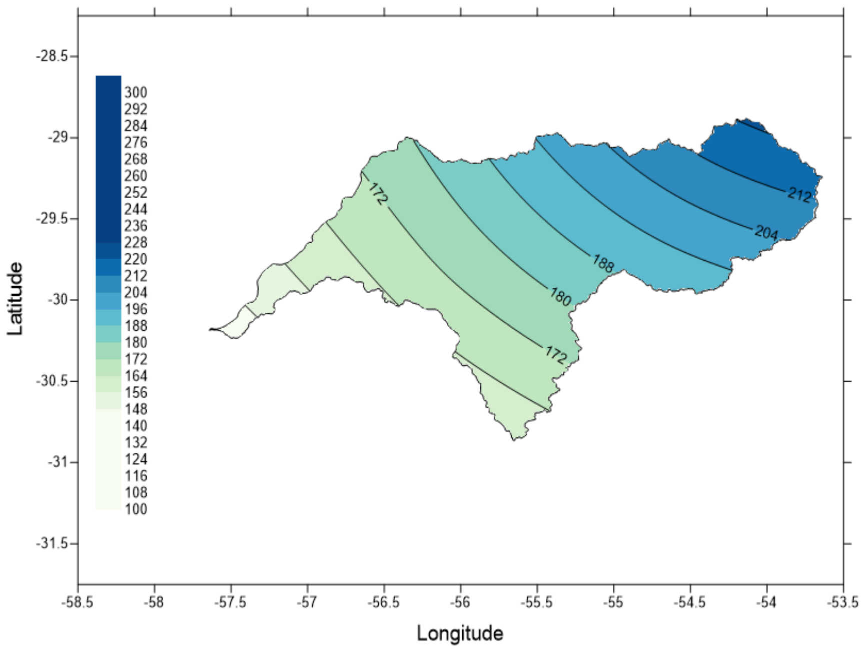

Fig. 8 Precipitation projections: scenario 2 (2051 – 2075)

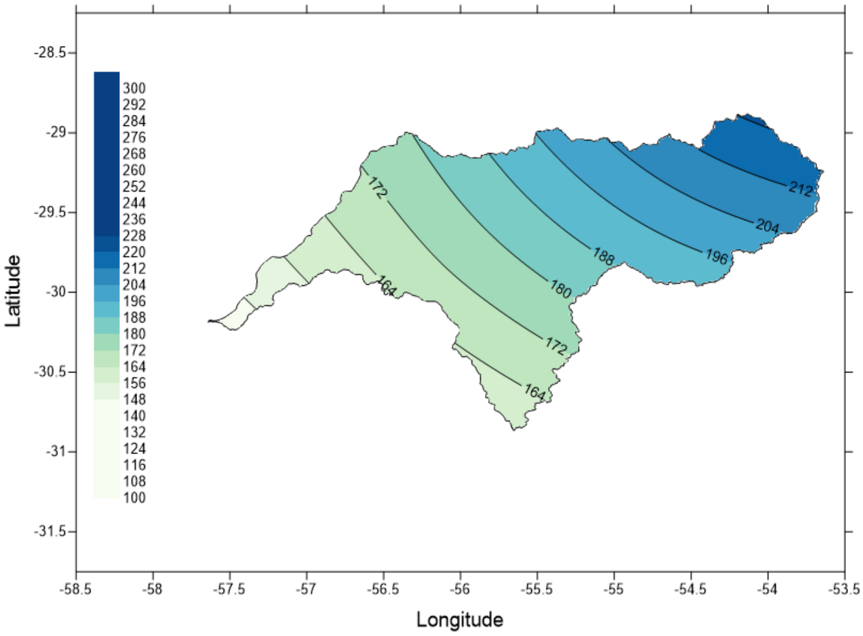

Fig. 9 Precipitation projections: scenario 3 (2076 – 2100)

V. Conclusion

The main objective of this paper was to present an analysis of the impacts of climate change without a rainfall regime for the Ibicui River Basin, RS, used as climatic projections of the models belonging to the CMIP5. After an analysis of the results for the future climate, there is a tendency, in relation to the present climate, for higher rainfall indices, especially in the autumn months for this Basin. In view of this projected framework for this hydrographic region, the importance of adequate management of the existing sources of water in the Ibicui River basin is emphasized, since the significant rainfall predicted for the coming years may compromise the dynamics of the ecosystems in the region. The model showed a positive tendency of precipitation in the period from 2026 to 2100, designing anomalies between 25 and 60 mm in each period of 24 years for a variable precipitation. A greater amplitude is observed in the precipitation of 2076-2100, indicating an increase in the occurrence of large precipitation events. We are increasing our scenarios analyzed, and it is concluded that the rainfall index tends to an increase, changing the precipitation regime of the region.

References

[1] Grimm, I. J. (2016). Mudanças Climáticas e Turismo: estratégias de adaptação e mitigação. Tese de Doutorado, Pós-graduação em Meio Ambiente e Desenvolvimento da Universidade Federal do Paraná. Curitiba, p. 248.

[2] Moraes, F. (2013). Entenda como são feitos os relatórios do IPCC. Disponível em: <http://www.oeco.org.br/dicionario-ambiental/27621-entenda-como-sao-feitos-os-relatorios-do-ipcc/>. Acesso em: 06 maio 2016.

[3] Nimer, E. (1989) Climatologia do Brasil.2. ed. Rio de Janeiro: IBGE.

[4] Van Vuuren, D. P.; Edmonsds, J.; Kainuma, M.; Riahi, K.; Thomsonm, A.; Hibbard, K.; Hurtt, G. C.; Kram T.; Krey, V.; Lamarque, J. F.; Masui, T.; Meinshausen, M.; Nakicenovic, N.; Smith, S. J.; Rose, S. K. (2011). The representative concentration pathways: an overview. Climatic Change, v. 109, p.5-31.

[5] Silveira, Cleiton da Silva et al. Mudanças climáticas na bacia do rio São Francisco: Uma análise para precipitação e temperatura. RBRH, Porto Alegre, v. 21, n. 2, p. 416-428, June 2016 Available from <http://www.scielo.br/scielo.php script=sci_arttext &pid=S2318-03312016000200416&lng=en&nrm=iso>. access on 11 Mar. 2017. http://dx.doi.org/10.21168/rbrh.v21n2.p416-428.

[6] Souza, E. Sampaio, G. Cândido, L. A. Rocha, E. Mudanças Ambientais de curto e Longo Prazo: Projeções Reversibilidade e atribuição. Primeiro Relatório de Avaliação Nacional GT1 – Volume 1. 2015.