CONVENTIONAL AND INNOVATIVE METHODS IN ATTEMPTING TO GUARANTEE WATER SUPPLY IN SEMIARID REGIONS

Adriana Cruz de Oliveira[1], Renato Sílvio da Frota Ribeiro[2], Claudivan Feitosa de Lacerda[3], Gláuber Pontes Rodrigues[4], Alexsandro Oliveira da Silva[5]

ABSTRACT: In arid and semiarid regions, a major challenge for governments is to provide water supplies to mitigate the effects of drought, common in these regions. Some proposed solutions are the execution of storage works (dams, cisterns, etc.), river perennialization, construction of canals, dams, waterworks, desalination and transposition of watersheds, etc., with the purpose of carrying water from surplus to deficit regions and from wet to dry years, increasing the resilience of populations and economic activities. Nevertheless, for each proposed solution there are difficulties and restrictions. Given this, this study aims to evaluate some of the works used for water supply. Water transfers between basins through channels usually involve greater difficulties as they deal with different socioeconomic, environmental and political realities. Another attempt to supply water in semiarid regions is through desalination, especially in coastal regions. Each method has its applicability and limitations and, based on this, it is necessary to adopt more innovative ideas such as the use of underwater pipes. The many examples of water transfer ventures from Brazil and around the world can teach valuable lessons about errors and successes in these projects and can also inspire new alternatives to mitigate the effects of water scarcity in arid and semiarid regions.

KEYWORDS: Basin transposition, semiarid, water scarcity

MÉTODOS CONVENCIONAIS E INOVADORES NA TENTATIVA DE GARANTIR O SUPRIMENTO HÍDRICO EM REGIÕES SEMIÁRIDAS

[1] Engª. Agrônoma, Universidade Federal do Ceará, Programa de Pós-Graduação em Engenharia Agrícola, Fortaleza, CE, Brasil.
[2] Prof. Titular, Universidade Federal do Ceará, Programa de Pós-Graduação em Engenharia Agrícola, Fortaleza, CE, Brasil
[3] Prof. Titular, Universidade Federal do Ceará, Programa de Pós-Graduação em Engenharia Agrícola, Fortaleza, CE, Brasil
[4] Mestre em Engenharia Agrícola, Universidade Federal do Ceará, Programa de Pós-Graduação em Engenharia Agrícola, Fortaleza, CE, Brasil
[5] Prof. Dr., Universidade Federal do Ceará, Programa de Pós-Graduação em Engenharia Agrícola, Fortaleza, CE, Brasil

RESUMO: Em regiões áridas e semiáridas, um grande desafio para os governos é prover o suprimento de água para mitigar os efeitos da estiagem, comum nessas regiões. Algumas soluções propostas são a execução de obras de armazenamento (açudes, cisternas, etc.), perenização de rios, construção de canais, barragens, obras de adução, dessalinização e de transposição de bacias hidrográficas, etc., com a finalidade de levar água de regiões superavitárias para regiões deficitárias e de anos úmidos para anos secos, aumentando a resiliência das populações e das atividades econômicas. Apesar disso, para cada solução proposta há dificuldades e restrições. Diante disso, este estudo pretende avaliar algumas das obras para suprimento hídrico utilizadas. Transferências de água entre bacias através de canais normalmente envolvem maiores dificuldades pois lidam com diferentes realidades socioeconômicas, ambientais e considerações políticas. Outra tentativa de suprimento de água em regiões semiáridas é através da dessalinização, principalmente em regiões litorâneas. Cada método possui suas aplicabilidades e limitações e, com base nisso, é necessária a adoção de ideias mais inovadoras como o uso de tubulações submarinas. Os muitos exemplos de empreendimentos de transferência de água do Brasil e do mundo podem ensinar lições valiosas sobre erros e acertos nesses projetos e ainda servir de inspiração para a criação de novas alternativas para mitigar os efeitos da escassez de água em regiões áridas e semiáridas.
PALAVRAS-CHAVE: Transposição de bacias, semiárido, escassez hídrica

INTRODUCTION

With the increase of social and economic transformations, there was a growth in the water demand for use and, together, the restriction in its supply, generating scarcity and competition (NEVES; CARDOSO, 2009). This problem is aggravated in arid and semiarid regions, where the water balance is deficient. In these regions, drought events are common, either throughout the year or between different years.

Since 2012, the Brazilian semiarid region has been going through a critical period, with below average rainfall, which worries the various sectors dependent on water resources. In this regard, a major challenge for governments is to provide water supply in these regions consisting of a water source, water treatment in treatment and storage stations and consumer distribution (ALBIERO et al, 2018).

To mitigate the effects of drought, some solutions are proposed, such as the execution of storage works (dams, cisterns, etc.), river perennialization, construction of canals, dams,

adduction, desalination and transposition works, with the purpose of bringing water from surplus regions to deficit areas and from wet to dry years, increasing the resilience of populations and economic activities.

Nevertheless, for each proposed solution there are difficulties and restrictions. Reservoir water storage systems, for example, are very sensitive to climate change and frequent droughts and extreme events hinder recharge (KHAN *et al*, 2015). Given the above, this study aims to evaluate some of the works for water supply used.

CONVENTIONAL WATER SUPPLY METHODS

Public policies for combating and living with droughts have undergone transformations over the past two centuries. It is considered that only after the Great Drought of 1877 to 1879 there were changes in the governmental and social views regarding droughts and, as a result, a second Imperial Commission was created to propose solutions against the drought phenomenon for the first Commission aimed to know the problems and potentialities of the region (CAMPOS, 2014).

The construction of the Cedro reservoir in the Brazilian Empire period marked the beginning of the "Hydraulic Solution", to reduce hydrological vulnerabilities in Ceará through infrastructure works, and was really implemented with the creation of the Inspection of Drought Works during the twentieth century. Currently, the São Francisco transposition is considered one of the most important works of this infrastructure and one of the most controversial in Brazil.

Transposing rivers, however, is not a new measure in the country and states such as São Paulo and Rio de Janeiro carry waters from the Piracicaba and Paraíba do Sul basins, without which, the development of these states would not be possible (LIMA, 2015). Added to this, there are international examples of the Colorado River Transposition, the Middle East Peace Channel, the San Men project on the Yellow River in China and many others (CAMPOS, 2014).

Water transfers between basins through channels usually involve greater difficulties as they deal with different socioeconomic, environmental and political realities. These works have positive and negative implications in many ways, in the donor and recipient basins and along the way. Therefore, there are no infrastructure and water transfer projects that are

completely without impact. Among the most discussed barriers, the high cost of transposition works is one of the most cited.

The São Francisco Integration Project is budgeted at R$ 20 billion, for example, and according to National Water Agency (ANA) Resolution N° 6/2019, the taxes for the provision of the raw water supply (transportation) service of the PISF by the federal operator, CODEVASF, is R$ 0.519 per m^3 of water for the consumption rate and R$ 0.263 / m^3 for the availability rate (ANA, 2019). It is worth noting, however, that governments always use very high values to try to reduce the damage of dry spells.

Another attempt to supply water in semiarid regions is through desalination, especially in coastal regions. Due to the increasing water demand of the growing population, industrial expansion, tourism and agriculture, desalination processes have grown, but cannot be considered as a universal solution for drinking water supply in all water-scarce regions, as it is cost prohibitive and because of the considerable increase in energy consumption (ALBIERO, 2018). Currently, the average price of desalinated water is between US$ 0.5 and US$ 1.5 / m^3 (COSÍN, 2018). However, economic feasibility studies more focused on the specificities of regions such as the Brazilian semiarid are still lacking.

Discussions about conventional methods of water supply are many, clearly. Each method has its applicability and limitations, and based on this, the adoption of more innovative ideas is required. An example is the use of subsea pipelines to import water from the mainland to nearby islands or from surplus islands in Seychelles, Malaysia and China (UNEP, 1998). Another example would be the economic feasibility study of submarine water transfer from rivers to Fortaleza, Dalian, Tel Aviv and Gaza as showed by Albiero *et al* (2018).

WATER FOOTPRINT AND VIRTUAL WATER

For the development of well-formed public policies, however, it is necessary to know a nation's water footprint and this means considering beyond national water use accounts restricted to the national territory. Water footprint accounts include data on the use of rainwater and water use for waste assimilation, as well as the use of water in other countries for producing export products (HOEKSTRA and MEKONNEN, 2012).

The water footprint, in turn, is the measure of human appropriation of freshwater, which occurs in three components: blue, green and gray. The blue water footprint refers to the consumption of surface and groundwater, or blue water resources, whose consumption is the

volume of water that evaporates or is incorporated into the product. This is usually smaller than water withdraw because part of the withdraw returns to the ground or surface water.

The green water footprint, or volume of green water, is the rainwater that is consumed, which is considerable in agricultural production. Finally, the volume of freshwater that is required to assimilate the pollutant load, based on existing ambient water quality standards, is known as the gray water footprint and indicates the degree of freshwater pollution (HOEKSTRA and MEKONNEN, 2012).

Another important reflection that should be made especially in regions that are constantly suffering from droughts is the water used throughout the production process of a good or, in other words, virtual water. Imports and exports are a means of transferring water resources between regions and activities such as agriculture require a large amount of water for their production just as their products are sources of water.

Some researchers argue that the exchange of virtual water between very productive countries to less productive countries may result in lower water use per crop, but this will not resolve inequalities with water availability. However, water transfers associated with food trade have saved 6% of water used in agriculture, demonstrating that virtual water exchange can also be beneficial and should be further exploited by public policies to combat low water availability. in arid and semi-arid regions (DALIN *et al*, 2012)

CONCLUSIONS

Despite often the high costs of water infrastructure works, governments generally also pay dearly continuously due to drought spending in arid and semiarid regions. What is observed, however, are clashes between the interests by the involved and the justifications are many: environmental aspects to consider, political, economic, social, etc. The many examples of water transfer ventures from Brazil and around the world can teach valuable lessons about errors and successes in these projects and can also inspire new alternatives to mitigate the effects of water scarcity in arid and semiarid regions.

ACKNOWLEDGMENTS

To CNPq and ADECE for the granting of the first author's scholarship and for the financial support for the research. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

BIBLIOGRAPHIC REFERENCES

ALBIERO, Daniel; SILVA, M. A. D. ; MELO, R. P. ; GARCIA, A. P. ; PRACIANO, A. C. ; FERNANDES, F. R. B. ; MONTEIRO, L. A.; CHIODEROLI, C. A. ; SILVA, A. O.; BARBOSA FILHO, J. A. D. . Economic feasibility of underwater adduction of rivers for metropolises in semiarid coastal environments: case studies. Water, v. 10, p. 215-249, 2018.

ANA- Agência Nacional de Águas. ANA define tarifas para adução de água bruta do Projeto de Integração do São Francisco em 2019. 2019. Disponível em: <https://www.ana.gov.br/noticias/ana-define-tarifas-para-aducao-de-agua-bruta-do-projeto-de-integracao-do-sao-francisco-em-2019>. Aces- so em: 20 jun. 2019.

CAMPOS, José Nilson B. Secas e políticas públicas no semiárido: ideias, pensadores e períodos. estudos avançados, v. 28, n. 82, p. 65-88, 2014.

COSÍN, Carlos. The evolution of rates in desalination (Part I). 2018. Disponível em: <https://smartwatermagazine.com/blogs/carlos-cosin/evolution-rates-desalination-part-i>. Acesso em: 14 jun. 2019.

DALIN, Carole et al. Evolution of the global virtual water trade network. **Proceedings of the National Academy of Sciences**, v. 109, n. 16, p. 5989-5994, 2012.

HOEKSTRA, Arjen Y.; MEKONNEN, Mesfin M. The water footprint of humanity. **Proceedings of the national academy of sciences**, v. 109, n. 9, p. 3232-3237, 2012.

KHAN, S.J.; DEERE, D.; LEUSCH, F.D.L.; HUMPAGE, A.; JENKINS, M.; CUNLIFFE, D. Extreme weather events: Should

drinking water quality management systems adapt to changing risk profiles? Water Res. 2015, 85, 124–134.

LIMA, Luiz Eduardo Corrêa. IMPORTÂNCIA DO RIO PARAÍBA DO SUL PARA O RIO DE JANEIRO: SEM ÁGUA, NÃO EXISTE VIDA. 2015. Disponível em: <https://www.profluizeduardo.com.br/tag/importancia-do-rio-paraiba-do-sul-para-o-rio-de-janeiro/>. Acesso em: 28 maio 2019.

NEVES, Cesar das; CARDOSO, Anderson Portugal. A EXPERIÊNCIA INTERNACIONAL COM PROJETOS DE TRANSPOSIÇÃO DE ÁGUAS - LIÇÕES PARA O DO RIO SÃO FRANCISCO. In: XXIX ENCONTRO NACIONAL DE ENGENHARIA DE PRODUÇÃO, 2009, Salvador. Anais... Salvador: Sn, 2009. p. 1 - 14.

UNEP. Sourcebook of Alternative Technologies for Freshwater Augumentation in Small Island Developing States;

ONU: New York, NY, USA, 1998.