European Journal of Sustainable Development (2017), **6**, 4, 444-454 ISSN: 2239-5938
Doi: 10.14207/ejsd.2017.v6n4p444

The Plan of Action of the Agriculture and Irrigation Sector against Climate Change: An Opportunity to Articulate Efforts

By Dra. Marta Tostes[1], Claudia Motta[2], Alfredo Villavicencio[3]

Abstract
The participation of the Peruvian greenhouse gasses emissions in the agriculture sector in the total emissions grew from 13% in 2005 to 15% in 2010 and 2012 (MINAM, 2016). However, do the global increase in Peruvian GHG emissions and the raising participation of the agriculture and livestock sector from 2005 to 2012 result from a lack of action around climate change? There are more than 25 strategies, plans and programs that exhibit actions about mitigation, adaptation and disasters risk management on the agriculture and irrigation sector. This investigation aims to demonstrate that these policies were made with a soft integration among them. For these matters, a density, weight and intermediation analysis through Gephi's software, which constructs nets based on the proposed measures on all those documents for adaptation, mitigation and disasters risk management, will be made. Preliminary results show that the most articulated document for adaptation is the National Strategy against Climate Change, for mitigation the iNDC, the coffee's and oil palm's NAMAs and the Plan of Action for Adaptation and Mitigation against Climate Change, for disasters risk management the Budget Program 068, and in general the Ministry of Agriculture's Multiannual Sectorial Strategic Plan.

Keywords: Agriculture, irrigation, climate change, articulation, mitigation, adaptation, disasters risk management

1. Introduction

This article aims to respond to the challenge Latin American countries are facing to develop public policies that will reduce GHG emissions and contribute to the economic growth of the region. Therefore, there is a need to have planned and coherent policies with each other and aligned with development objectives (Magrin, 2015).
In recent years, Peru has assumed multiple commitments at the international level, showing the policymakers' will to carry out new actions required to tackle climate change. However, a high level of disarticulation between the Agriculture and Irrigation Sector (AIS) policy institutions directly linked can still be perceived; this lack of articulation extends to other sectors also involved in executing this transition.
In this sense, the objective of the present investigation seeks to quantify and calculate the level of the policies documents articulation from the Agriculture and Irrigation Sector combating climate change. To this end, a methodology based on the network approach is used through a technological tool: Gephi software.
This paper's structure includes the theoretical framework of this research and the reality of the Peruvian context in which it is carried out. Then, the applied methodology is

[1]Main professor at Pontificia Universidad Católica del Perú (PUCP) in the Management Science Academic Department
[2]Main investigator at ExceDesa, Social Manager from Management Faculty of Pontificia Universidad Católica del Perú (PUCP)
[3]ExceDesa's Senior Investigator, , is a graduated Economist from Pontificia Universidad Católica del Perú (PUCP)

presented and an important part is dedicated to the results obtained with the Gephi program. Finally, the research conclusions and the application of the methodology are outlined.

2. Literature Review

The theoretical framework that supports the present research will be presented in this section. As a first issue, climate change is generally tackled, secondly, public policies on climate change and, finally, the articulation of public policies.

Climate change is an imminent phenomenon. The temperature of the planet earth has increased about 1 ° C since the beginning of the industrial period. Concentrations of CO2, the most important greenhouse gases, ranged from 200-300 particles per million (ppm) over 800,000 years, but in the last 150 years these figures have increased to around 387 ppm (World Bank, 2010).

Faced with this reality, according to the World Bank, developing countries are the most exposed territories and at the same time the least resilient. In the case of Latin America for instance, glaciers in the Andes would be the first to disappear, which would change the amount of water available to several countries, thus generating water stress to at least 77 million people by 2020 and affecting energy from hydroelectric power plants. Another major impact would be the disappearance of the Amazon rainforest and its conversion into large areas of savanna, which would have serious consequences for the region's climate (World Bank, 2010). This situation has awakened the alert in several countries of the region so that efforts have been made to establish regional and national policies to address this global problem.

Even though the countries of the region have made progress in including the issue in decision-making processes, it has been difficult to incorporate relevant **environmental public policies**.

Governments face a challenge regarding the type of measures they must take in the sight of climate change, considering a context where not only environmental but also economic and social factors interact, financing is limited and development is closely linked to the exploitation of natural resources. Given this situation, it is urgent to establish comprehensive public policies that address the various challenges and connect actions to adapt to climate change with other climate policies such as mitigation, disaster risk management and other development actions (Magrin, 2015).

However, these policies cannot be dealt with in isolation; they must be articulated in order to align the actions of the different actors towards the same objective. In this sense, the articulation of public policies must take place from their design to fit with other policies of the environment. *"The articulation of policies is usually carried out, in a first deployment through plans and in a more detailed deployment through programs, projects and even public actions that do not always reach such a structured degree of articulation."* (Agencia de Evaluación y calidad, 2010, pág. 50)

Therefore, the highest levels of strategic planning are expected to be in agreement without requiring this detail at a more operational level, but without losing the interdependence among actions. In this context, Dunn (2004), emphasizes not taking a problem and breaking it down to its particularity because it loses the look of the

interdependence of problems with each other. On the contrary, the author considers that it is necessary to have a comprehensive view of the issues and to design policies or packages of policies that are connected to each other which attack a problem integrally.

On the other hand, Olavarría mentions that each policy builds its own network; that is, administrative, regulatory, organizational and financial links are generated with other policies in the environment. Thus, one can speak of two types of interdependencies among policies: the vertical and the horizontal. The vertical model refers to the relations within the network that vary in their degree of interdependence (national and sub national) for the implementation of public policies that require the distribution of services and benefits. On the other hand, horizontal interdependence refers to the degrees of articulation between actors and other networks (Olavarría, 2007). Talking about public policies from a network concept helps to have a vision of the total relations and actors that are involved around a problem

Finally, in terms of evaluation, the articulation is analyzed from the relevance of public policy. This aspect emphasizes the relationship among objectives, priorities and instruments of a public policy (Dirección General de Planificación y Evaluación de Políticas para el Desarrollo, 2007). The relevance of a public policy will depend on the relationship it maintains with others at the level of objectives so that they are aligned to face a problem.

3. Context

Within the work on climate change, at least three concepts must be defined: mitigation, adaptation, and disaster risk management. First, mitigation is considered as the anthropogenic intervention that aims to reduce and stabilize sources or improve sinks of greenhouse gases. Some of the climatic vulnerabilities in mitigation considered for the Peruvian case are: fire and forest fire exposure; deforestation; use of synthetic fertilizers and pesticides; burning of agricultural waste; among others. Moreover, the concept of adaptation is understood as the integrated and flexible process of human or natural systems adjustments to new or changing environments, in response to projected or actual stimuli or climatic effects that can moderate the damage or take positive advantage from those changes. In the Peruvian case in particular, the variables considered in the adaptation topic for the AIS are: exposure to intense or persistent rains, to low temperatures, to the El Niño (FEN); socio-environmental conflicts; among others. Finally, disaster risk management is defined as the social process whose ultimate goal is to forecast, reduce and permanently control disaster risk factors in a society, aligned and integrated with the achievement of sustainable development patterns.

Following this conceptual framework, it becomes crucial to understand the engagement of national policies and international commitments in all three areas. On the national side, there are the National Environmental Action Plan (PLANAA), the National Strategy for Climate Change (ENCC) and AgendAmbiente. These are three of the main policy documents that reflect actions and objectives against climate change. In addition, there is a wide number of strategies, plans and programs that relate to this, such as the National Biodiversity Strategy (ENDB), the National Strategy to Combat Desertification and Drought (ENLDS), the National Forest Strategy and Climate Change (ENBCC),

among others. For the agricultural case, the Plan of Action of the Agriculture and Irrigation Sector (PLANSARCC) is framed within the National Agricultural Policy (PNA), the Multi-Year Strategic Sectoral Plan (PESEM Agriculture 2015-2021), the Strategic Institutional Plan (PEI 2016-2018), the Disaster Risk Management Plan and Adaptation to Climate Change in the Agrarian Sector (PLANGRACC-A, 2012-2021), etc. Furthermore, Peru has actively participated and adopted a large number of international commitments. Among them, the main ones are the Sustainable Development Goals (SDGs), the environmental recommendations of the OECD for Peru to become a member, and the Conferences of the Parties, in particular the COP20 (hosted in Lima), and the COP21 (Paris), in which Peru was a key actor in the drafting of the finally achieved Paris Agreement. In this area, commitments can be observed in terms of financing for climate change, international technical and financial cooperation, among others, such as strategies against water, air, and land pollution and waste management.

Out of the 171,310 gigagrams of carbon dioxide emitted by Peru, according to the National Inventory of Greenhouse Gases (INGEI) in 2012, agriculture is ranked as the third sector with the highest GHG emissions in Peru, with 15% of the total (after 51% by USCUSS and 26% of energy). It should be noted that its participation in total emissions has increased since 2005, when it was 13%, and that it influences the LULUCF sector (since migratory agriculture is the main cause of deforestation of Amazonian forests). In response to this, several measures have been taken at the national level to mitigate these emissions in the agricultural and irrigation sectors. The main ones are: the National Contribution of Peru (iNDC), the Projects for the Reduction of GHG emissions caused by Deforestation and Forest Degradation (REDD+), Resilient and Low Emission Development Strategies (LEDs) and the Adaptation and Mitigation Action Plan to Climate Change (PAAMCC). Other strategies that tackle indirectly this mitigation processes are the ENCC, the Peruvian National Forest Strategy (ENFP) and the ENBCC.

Likewise, climate change is having clear consequences on rainfall, temperature, frequency and magnitude of natural disasters. By 2009, such was the case that the district of Puno in forty years increased their precipitations in 19.6%, while the district of Juancito reduced them in 93.7%. Regarding temperatures, Chiquian grew at 1.5 °C of its historical maximum, while Matucana reduced its historical minimum average by at least 0.21 °C (SENAMHI, 2009). These changes in the environment mean constant threats to society and economic activities, as well as sporadic opportunities. That is why, in this area, the actions also come from several initiatives, such as PLANGRACC-A, PAAMCC, and indirectly ENDB, ENCC, and ENCLDS.

Furthermore, natural disasters from 2003 to 2012 affected 9,610,999 people and 742,240 houses (PCM, 2014). In addition, from January to March 2017, the recent El Niño Phenomenon in Peru claimed more than 100 lives, the victims reached 150,000 and more than one million Peruvians were affected (COEN, 2017). In such a context, disaster risk management becomes urgent, and this is why the actions have had a long trajectory. These include the National Plan for Disaster Risk Management (PLANAGERD), the Multisectoral Action Plan against Probable Occurrence of the El Niño Phenomenon and the Rainy Season 2015-2016, among others. At the same time,

various joint actions are being undertaken in response to the emergencies presented by the recent El Niño Phenomenon, such as the displacement of health brigades in affected areas, the installation of shelters, donations of tents, facilitation and transport of humanitarian aid to victims, etc.

4. Methodology

The methodology used in the present research is based on the **networks approach**. Martin (2001) points out that someone could think of society in terms of structures, which would consist of relationships among different actors, while their set of links or relationships form networks. In the network, actors are represented by points or nodes, while relationships are the lines that unite them: *"the concept of social network goes from being a metaphor to an analytical operative tool that uses the mathematical language of graph theory, of matrix and of relational algebra"* (Sanz Menéndez, 2003, pág. 6). Once the network is set up, we proceed to analyze the strength of the link between the nodes and how the actors are characterized for the creation of these links.

To carry out the networks analysis, at the present research, there are some computer tools that take the information provided and help to propose measures according to what the researcher wants to analyze. The most known and used tool has been UCINET, but for this study GEPHI is being used: a free software that is constituted as a tool with greater facilities, as it allows to enter more characteristics about the links. In this regard, to perform the networks analysis there are several measures of centrality that calculate aspects of the structure that are network characteristics. Two of those used for this research are the following. First, the "degree" term refers to the number of links of an actor in the network, which is how many relationships that actor has in total with all other actors. The second important measure is "intermediation", which is the frequency with which a node is between two nodes of the network, this being the shortest path. When talking about intermediation, this is usually associated directly with communication among nodes, which is why we can conclude about a potential control in communications. The choice of one or other of these properties will depend on the objectives of the research (Polanco, 2006).

For this study, the methodology was developed considering the networks, but not based on the actors' interrelation, despite in the interrelation of public policies of the Agriculture and Irrigation Sector against climate change. As a consequence, the network nodes were considered as documents in order to analyze their articulation and the types of links among them.

The first step was the compilation of documents on the subject. For this purpose, secondary sources were reviewed, and interviews were conducted with experts. Each of the documents became a node in the network. The documents identified and compiled were classified for a better order and obtaining results. Two types of classification were used: document level (plan or program) and document topic (adaptation, mitigation, disaster risk management, and general/transversal policies).
Through the review of each of these policy documents, the existence of a link among them was identified, and then assigned a weight to the identified link. In order to establish this link, the recommendations of the National Center for Strategic Planning

(CEPLAN) were used in its "General Directive of the Strategic Planning Process - National System of Strategic Planning", which mentions in Article 21 that strategic plans are articulated through their strategic objectives, indicators and targets (CEPLAN, 2015, p. 28).

The network analysis not only allows to obtain assessments for the level of articulation, but also shows the strength of the links among nodes. Not every relationship is the same: some can be considered normal, while others can be said to be very good. Wasserman and Faust referred to certain characteristics that are used to assign a value, which can be strength or intensity, frequency of interaction, and even monetary amounts or appreciation of friendship (Wasserman & Faust, 2013, pág. 164). For this research, the two variables mentioned by CEPLAN considered as criteria were strategic objectives and indicators based on these factors, a weight was assigned to each of the links. The detail of both criteria is shown below.

Chart 2. Criteria of qualification of link between the documents of planning of the Sector Agriculture and Irrigation with subjects related to the climatic change

Weight	Link qualification	Strategic Objectives	Indicator
1	There is no mention on the document, but there is an unrecognized common goal	NO	NO
2	There is a mention to the document because a common goal or topic is recognized, but there is no mention to the articulation processes	NO	NO
3	There is a mention to the document and a direct recall on the strategic goals alignment	YES	NO
4	The strategic goals alignment is mentioned, as it happens with the indicators articulation processes	YES	YES

In order to build the network, the Gephi software was used: a free download software that allows, through information entered through an array, to build the network graph and to quickly visualize the layout of the different nodes. In addition, it allows the calculation of the degree of centrality, input, output, intermediation, modularity and closeness for both the network in general and for specific nodes.

The analysis that will be carried out not only focuses on the articulation of the entire network, but also on a more specific analysis by topics. In this way, the degree of density in each of the nets built can be appreciated by the topics related to climate change mentioned above: adaptation, mitigation, and disaster risk management. The study took into consideration an additional topic (general or transversal policies) that emphasizes those documents that are directly about management or that facilitates the work on the other three thematics.

5. Findings

The network of documents obtained with the software as well as the quantitative results by theme are studied next.

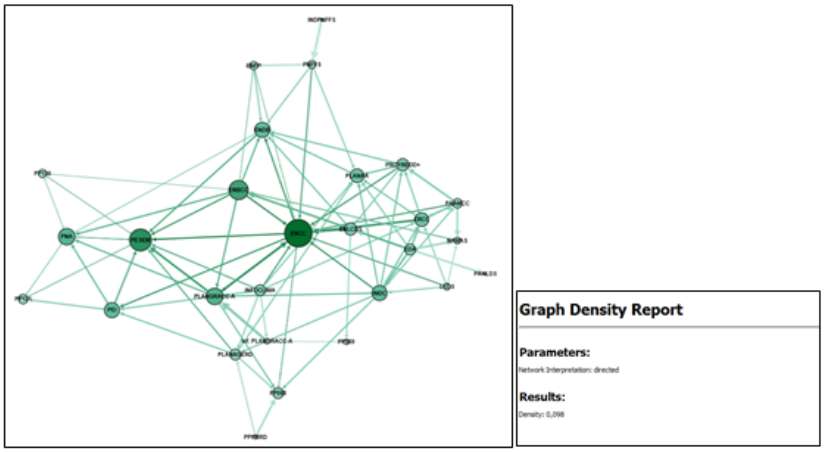

Fig. 1. Policy documents network for the Agriculture and Irrigation Sector

The graph shows the network of documents based on the number of links each one has. The color and size is an advantage that the program provides to facilitate the distinction of nodes that have a greater number of links. The main indicator to support the seriousness of the problem of articulation of documents is the density of the network, because as mentioned before, it refers to the number of connections existing in relation to the total of possible connections.

It can be seen that the network has a density of 0.098; i.e the network is connected at 9.8%. This shows that the level of articulation among documents is very low because there is little connectivity within the network. To identify the characterization of this density, the analysis was made based on the topics related to climate change. In relation to **adaptation**, the following were identified.

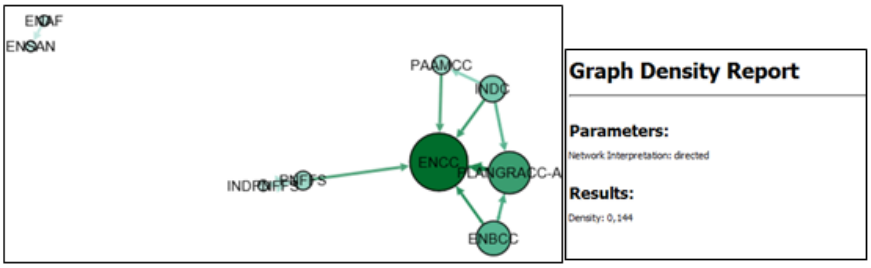

Fig. 2. Policy documents network based on "Adaptation"

The documents that correspond to plans and programs with adaptation objectives have a density of 14.4%. This percentage is greater than that obtained in the general network, although it is still a low value among the documents that follow this theme. The graph shows that the ENCC (National Strategy for Climate Change) is the central document of the network, that is, the one with the most links. It can also be observed that there are two documents that are isolated from the main network but connected to each other; these are: ENSAN (National Strategy of Food and Nutritional

Security) and ENAF (National Strategy of Family Agriculture). These documents are not aligned with other documents marking their own policy guidelines.
On the other hand, on the subject of **mitigation**, the following graph and degree of density was obtained.

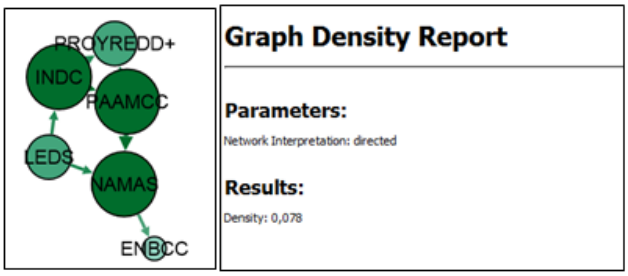

Fig. 3. Policy documents network based on "Mitigation"

The degree of density obtained was 7.8%, which is lower than that obtained in the general network, which is why it is one of the reasons that explains the low articulation in the first network. It is thus clear that documents aimed at mitigation objectives must be worked to achieve better articulation. Also, in the case of "Mitigation", there is no single document that has a centrality in the network, although there are three documents that have the greatest number of links: INDC (National Predicted and Determined Contribution), PAAMCC Of Adaptation and Mitigation Action on Climate Change) and NAMAS of coffee and oil palm. In terms of space (in the graph) you cannot appreciate the nodes that are not connected to the network and are, in addition, isolated from each other. These documents are: PNDF (National Forest Development Program), PANLDS (National Action Program to Combat Desertification and Drought), PNFFS (National Forestry and Wildlife Policy) and Report on proposals to revitalize PLANGRACC -TO. These correspond to critical points that need to be integrated into the network in order to achieve unified actions and greater impacts around the thematic on which they deal.

The following results were obtained for the subject of **disaster risk management**:

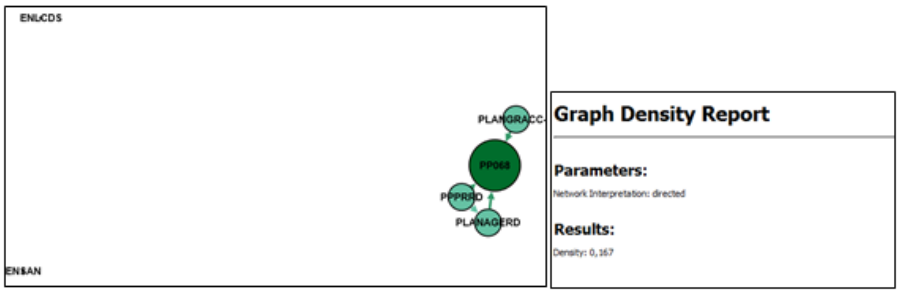

Fig. 4. Policy documents network based on "Disaster Risk Management"

The results of the degree of density in this subject are well above that obtained

in the general network. If you look at the graph you can see that there are only two documents isolated from the network (unlike the previous ones that show four). In this network, the document with the greatest number of links is the Budget Program 068, which is presented as a central node. The two nodes outside the network are ENLCDS (National Strategy to Combat Desertification and Drought) and ENSAN (National Strategy for Food and Nutrition Security).

The last subject covers documents that present aspects that are transversal or general in relation to Climate Change. The density of these documents is shown below.

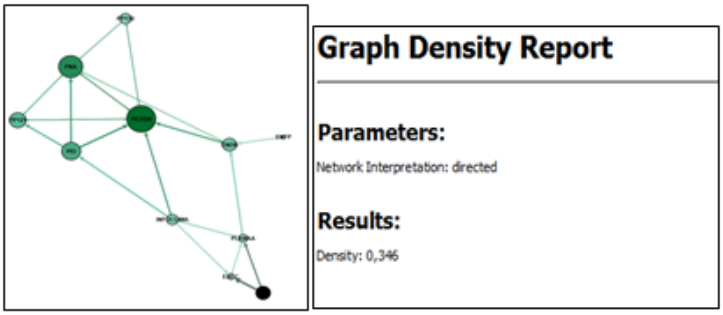

Fig. 5. Policy documents network based on "General / Crossed Policy"

The density of these documents is the highest of all (34.6%), which doubles the measure obtained from the network in general, and demonstrates a better articulation of these documents. This could be explained because it is linked better because they touch on more general issues and pose actions that can be applied to the previous topics.
It is seen on the web that the main document is the PESEM (Multicultural Sector Strategic Plan), which results from central relevance followed by the National Agricultural Policy (PNA).This explains why both documents are the guiding principles for the subject of Peruvian agriculture. Also, there is an isolated document (for space reason it had to be cut the graph): the Budget Program 089.

Another indicator that was measured was the level of intermediation of the three most relevant plans for the sector. The results are shown below.

Chart 2. Intermediation Degree of the Three Most Relevant Plans for the Sector

ID	Label	Betweeness Centrality
PESEM	The Multi-Year Strategic Sectoral Plan (PESEM Agricultura, 2015 – 2021)	31.5
PLANGRACC-A	Disaster Risk Management Plan and Adaptation to Climate Change in the Agrarian Sector PLANGRACC-A, 2012 – 2021)	21.0
PNA	Strategic Institutional Plan (PEI 2016-2018), National Agricultural Policy (PNA)	12.2

Intermediation allows to see which documents serve as connectors between two others. In this case it is observed that the PESEM plays an important role of the network as the

second document with the best degree of intermediation, after the ENCC.

Another result was the weight of budget programs within the network. The program yields the following results for PP068, PP089, PP130.

Chart 3. Weight of Budgetary Programs

ID	Label	Weighted Degree
PP068	PP068: Vulnerability reduction and disaster emergency attention	12
PP089	PP089: Reduction of land degradation	5
PP130	PP130: Competitiveness and sustainable use of forest resources and wildlife	5

From the table it can be concluded that PP068 is the one that has a greater bond strength compared to the other two Budgetary Programs. This means that PP068 has a better articulation with the other documents and is more often aligned in terms of its objectives and indicators. However, if it is analyzed at the level of all documents, the weight of the links of the Budgetary Programs is quite low because it is 24 points below the first (ENCC).

6. Conclusions and Final Remarks

The research sought to apply the methodology of networks to calculate the level of articulation among documents against a specific topic such as climate change.

As a conclusion, it can be stated that the disarticulation among strategic policy documents in the Agriculture and Irrigation Sector in the face of climate change is quite high (90.2%). This is a matter of concern about the design processes of public policies. It has been shown that the alignment among policies is not contemplated, but rather that isolated efforts are generated which hampers an integrated action in favor of reducing the effects of climate change.

On the other hand, the methodology applied for this case is important insofar as it explores the networks approach, not only from the interconnection among actors in an environment, but also among documents on a thematic. It was necessary to establish the criteria to be taken into account in order to clearly establish a link among the different mapped policy documents. Finally, the use of the Gephi software is still a tool that facilitates the network construction process and the analysis of the indicators to obtain quantitative results that support the initial hypotheses.

References

Agencia de Evaluación y calidad. (2010). Fundamentos de Evaluación de Políticas Públicas. Madrid: Ministerio de Política Territorial y Administración Pública.

COEN. (2017). COEN Informa. Boletín Informativo de Emergencias. 03/04/2017.

Dirección General de Planificación y Evaluación de Políticas para el Desarrollo. (2007). Evaluación de la Cooperación Española con Marruecos. Madrid: Ministerio de Asuntos Exteriores y de Cooperación.

Dunn, W. (2004). Public Policy Analysis. An Introduction. New Jersey: Pearson Prentice Hall.

Magrin, G. (2015). Adaptación al cambio climático en América Latina y el Caribe. Santiago de Chile: CEPAL.
Martín Gutierrez, P. (2001). Mapas sociales: método y ejemplos prácticos. En Diálogos: Educación y formación de personas adultas (págs. 26-36).
MINAGRI. (2012). Plan de Gestión de Riesgos y Adaptación al Cambio Climático en el Sector Agrario: periodo 2012-2021. Plan GRACC-A. Lima: MINAGRI.
MINAGRI. (2016). Plan de Acción del Sector Agricultura y Riego frente al Cambio Climático. Lima: MINAGRI.
Olavarría, M. (2007). Conceptos Básicos en el Análisis de Políticas Públicas. Santiago de Chile: Instituto de Asuntos Público de la Universidad de Chile.
PCM. (2014). Plan Nacional de Gestión del Riesgo de Desastres: PLANAGERD 2014-2021. Lima: PCM.
Polanco, X. (2006). Análisis de redes: Introducción. Buenos Aires: RICYT, CYTED, UNESCO.
Sanz Menéndez, L. (2003). Análisis de redes sociales: o cómo representar las estructuras sociales subyacentes. Apuntes de Ciencia y Tecnología(7), 21-29.
SENAMHI. (2009). Caracterización climática: analizando la información histórica para detectar el cambio climático. Obtenido de http://www.senamhi.gob.pe/pdf/40aniv/ppt_coria.pdf
The World Bank. (2010). World Development Report: Development and Climate Change. Washington DC: The World Bank.
Wasserman, S., & Faust, K. (2013). Análisis de redes sociales: métodos y aplicaciones. Madrid: CIS - Centro de Investigaciones Sociológicas.