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DELPHI STUDY

Analysis of future trends in Climate Change research in Bolivia and Paraguay

INNOVA "Promoting research Management at Higher Education Institutions in Bolivia and Paraguay"

KA2 – Cooperación para la innovación y el intercambio de buenas prácticas – Desarrollo de capacidades en el ámbito de la Educación Superior

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Resignation

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1. Introduction

This guide was prepared within the framework of the INNOVA project "Promoting Research Management in Higher Education Institutions of Bolivia and Paraguay", funded by Erasmus + KA2 – Cooperation for innovation and the exchange of good practices – Training in the field of Higher Education. It is included in Work Package 1, Task 1.4.

The General Objective of the INNOVA project is to improve the research management of Higher Education Institutions in Bolivia and Paraguay, with a specific focus on Climate Change.

This guide summarizes the Delphi study carried out as the first pilot exercise and foray into the field of Foresight Methods for the INNOVA project and is divided into two main parts. The first part is essentially theoretical, where the general considerations of application of the technique are explored. The second part presents the practical work carried out on the application of the Delphi technique in the study Trends in Climate Change Research in Bolivia and Paraguay.

It is expected to help frame current cutting-edge research on future global trends in the field of climate change and consider hypothetical applications and development within the context of Bolivia and Paraguay and the elaboration of strategic recommendations to guide policymaking in the field. of R&D at the ES level in Latin America.

2. The Delphi Technique

The Delphi technique refers to a research tool characteristic mainly of qualitative research methods (OMT, 2001; Faucher, Everett and Lawson, 2008; Veal, 2006) and is based on the opinions and perspectives of people considered experts in the field or topic under study.

It aims to discuss complex and subjective problems or issues, so they require significant levels of knowledge and experience on the part of these people. Problems and issues that are generally not easily addressed using conventional questionnaires or interviews (Garrod and Fyall, 2005).

Thus, this technique allows to obtain a credible knowledge about a certain topic or thematic area that is not available or that is in some way limited or unclear, through the contribution of people with solid knowledge about the topic or topic under study, usually called specialists or experts and who constitute what is called a Delphi panel.

With a flexible and predominantly exploratory content, its application presupposes the structured and systematized collection of the perspectives and opinions of these specialists on the subject of study, in a non-face-to-face and anonymous way, through questionnaires that are answered in successive rounds. , together with the sending of controlled feedback on the answers and perspectives obtained in the previous round, in order to allow each expert to know the answers and global perspectives of the other experts, thus trying to build an acceptable consensus around the topic under study.

The interaction between the panel of experts is carried out virtually, preserving anonymity, where they are given the opportunity to express their opinions on a given topic in a reflective way and without the pressure and spontaneous character that other methodologies promote. The interaction takes place in several rounds in which it is possible, after knowing the general opinions of the initial round, rethinking, and reformulating the perspectives. The possibility of reformulation allows to obtain potentially more reliable data, however, the Delphi methodology is not presented as a substitute for other methodologies based, for example, on

statistical or analytical analysis, but as a very credible alternative for the investigation of topics. that require further analysis.

3. Brief historical context

The name Delphi arose from the idea of predicting future events that was originally associated with it. In Ancient Greece, and more precisely on the slopes of Mount Parnassus, there was a place called Delphi that was famous for its oracle (Oracle of Delphi) and for its ability to predict the future, although somewhat enigmatically. People consulted the oracle to ask questions and ask for advice about the future, accepting and respecting what the oracle said.

In modern academia this technique has been increasingly used in the Social Sciences, proving to be particularly useful and valuable in the fields of planning, prospecting, and decision-making.

As a research technique, it began to develop in the 1950s. XX by researchers of the American organization RAND Corporation and its first documented use was made by Delkey and Helmer in 1963 for military purposes, when they needed a reliable method that would allow to obtain a consensual opinion of several American specialists in the area of military defence on the effects of an eventual nuclear attack (Hsu and Sandford, 2007). Despite having been created for military purposes, its application has been extended to other areas of research. The peak of its application was in the 1980s, driven by the great acceptance of the academy for the realization of theses and dissertations and it was from then on, that its use stabilized and began to be seen more seriously by the scientific community as a valid research technique (Faucher, Everett and Lawson, 2008; Landeta, 2005; Garrod and Fyall, 2005).

In recent years this technique has been increasingly used in various areas, such as Tourism, Geography, Engineering, Technology, Health, Management, Climate Alterations, among others.

4. Scope

From the moment it began to be used, this technique found immediate application in the field of forecasting, especially those related to technological advances and the occurrence of certain types of events or happenings.

However, the Delphi technique has been used much more and goes beyond the field of forecasting, proving to be especially useful in the field of planning and development policies.

The Delphi technique is widely recognized as a flexible research tool that can add an extra dimension of rigor to more difficult research questions and problems using more conventional techniques.

Linstone and Turoff (1975) report that its usefulness is most relevant when the problem under study does not lend itself to precise analytical techniques but may benefit from subjective judgments on a collective basis. The direct contribution of specialists in the research process is also more reliable compared to other methods based on questionnaires or conventional interviews in which sample limitation can be a determinant of the veracity of the research results (Garrod and Fyall, 2005).

This technique can be seen as well as a structured method of communication between specialists grouped in a panel that can provide valuable inputs to the resolution of complex problems, in a flexible and relatively simple way to perform. That is, it is an effective form of group communication that allows a group of individuals to address a complex problem (Linstone and Turoff, 1975; Hsu and Sandford, 2007).

Faucher, Everett and Lawson (2008) differentiate three main types of applications of the Delphi method:

i) **classic method**, predictive of future events.

ii) **political method**, oriented to the development of policies or public affairs.

iii) **decision-making method**, in which an attempt is made to address a given issue to lead to decision-making on strategic measures.

In addition to these three main types, a combination of typologies can be verified, giving rise to what is called **the hybrid method**.

5. General considerations of application of the technique

The application of the technique is carried out by a coordinator (or a coordinating team), which usually coincides with the researcher himself or a member of his team.

First, the coordinator must constitute the panel of experts, first identifying the people to be integrated and then requesting these people to be part of that panel.

Once the panel is defined, the different phases of questionnaires begin, called rounds, whose main objective will be to collect the perspectives and opinions of the experts, in a non-face-to-face, anonymous, structured, and systematic way, on the subject or topic under study. The individual perspectives and opinions of each specialist, even if subjective, will necessarily be based on their knowledge and experiences on the topics under consideration, but may nevertheless be shaped or consolidated as they learn about the panel's global perspectives round after round.

5.1. Profile of experts and constitution of the panel

One of the most sensitive issues in the application of this technique concerns the constitution of the panel of experts. Since its application is based on the qualified opinion of a group of people considered experts, the selection of these people is necessarily conditioned by the disciplinary areas that are associated with the topic under discussion, so it must be a duly weighted process.

In addition to the need to consistently analyse the applicability of the technique to the specific study problem and the care that must be taken in the preparation of the questionnaires and the dissemination of the results of each round, the process of choosing the experts to be included in the panel is fundamental.

The criteria used to choose the specialists, as well as the lack of motivation that they can demonstrate in the development of the study, can negatively influence the results, or even make new rounds unfeasible due to the high desistence of the specialists.

It will be pertinent to consider, therefore, that the experts to be included in the panel have interest in the results. The fact of carrying out a study in a certain area and including specialists who in their institutional, professional, or academic environment may be interested in the results can be a good motivation strategy.

It should also be noted that the balance of the panel in terms of the origin of the specialists (academic, professional, institutional, etc.) is another factor to consider throughout the successive rounds to avoid biased deviations of perspectives or the degree of consensus. Thus, some issues related to the profile, the selection criteria, and the number of elements that each panel must integrate must be adequately addressed.

In the literature there are no previously defined general criteria to structure the profile of individuals to integrate a Delphi panel, as evidenced by Hsu and Stanford (2007), however, some specific criteria have been identified and considered valid, namely, the fact that individuals have personal or professional experience in the thematic area or subject of study, they can contribute with their perspectives to the construction of a more solid knowledge on the subject of study and are willing to review their initial or previous perspectives to try to obtain a global consensus perspective. If the latter criterion is more subjective and difficult to weigh and apply, the criteria associated with previous experience and the ability or willingness to contribute with their perspectives to the construction of more solid knowledge are easier to delimit, assuming that when individuals with experience and/or specialized knowledge are integrated by those who have agreed to be part of the study and the aforementioned panel, and implicitly they will be admitting that they will be interested in contributing with their testimony to the increase of knowledge around the subject under study.

Once the profile of the specialists has been defined, it is important to work throughout the selection process of the members to be integrated from the universe of potential specialists who could be of interest to the study from the beginning.

Different criteria can also be used here:

i) **the geographical restriction** of the members to integrate, choosing specialists who work or reside in the geographical area of study.

ii) **the accentuated specificity of the subject of study**, which can lead to a bottleneck of individuals considered specialists in that subject.

iii) **the appointment of new participants** by a restricted initial group that from the beginning integrates the panel, calling this method "snowball" (Lee and King, 2008) because by asking the members of the panel to nominate other members with recognized knowledge in the area under study, the panel is gaining in size. In the latter case, it must be considered that the first members of the panel may point out or suggest other specialists closer to them and, eventually, that they even agree with their points of view, which can lead to biases or conditioning of these results of the study.

5.2. Number of experts to include in the panel

As for the number of experts to be part of the panel, there is no consensus in the literature regarding the number of elements or the ideal size of the panel (Hu and Stanford, 2007). In this regard, Smith (1995), cited by Garrod and Fyall (2005), states that, although there are successful studies made up of panels ranging from 4 to 904 specialists, the ideal number would be between 40 and 50. Other authors, such as Yong et al. (1989), suggest that, in general, a number between 15 and 20 would suffice. Delbecq et al (1986) argue that researchers should use as few specialists as possible, however, seeking to verify the results in subsequent research. For these authors, if the group is homogeneous, between 10 and 15

specialists will be sufficient, if the group is heterogeneous from the beginning, more participants will be needed. Ludwig (1997) notes that the number of specialists to be used in a Delphi study is generally determined by the minimum necessary to constitute a representative exchange of perspectives and by the information processing capacity of the coordinator or his team, considering that most Delphi studies involve between **15 and 20 participants**.

That said, we can consider that the number of participants in Delphi studies varies, depending on the objectives of the study, the characteristics of the coordinator (or his team), and the availability and characteristics of the participants themselves. The same is to say that quality and the degree of specialization matter more to the detriment of the number of specialists.

5.3. On the possibility of forming a test panel

There is the possibility of constituting a test panel, with characteristics of the effective panel, to which a pilot questionnaire can be submitted to test it and eventually improve or adjust it.

However, this situation raises some sensitive questions that, depending on the type of research and the universe of potential specialists to be integrated, can generate some difficulties in its implementation.

The main difficulty concerns the arguments that will be presented to the members to be part of the test panel and who will not be part of the final panel. That is, on the one hand, the expert is recognized as such, but, on the other hand, he is not integrated into the effective panel.

Despite its relevance, the use of a test panel is not widespread, since the characteristics of the Delphi process involve adjustments and reformulations in the questionnaires from the first to the second round and, as such, can allow to fill the gaps or gaps. identified in the questionnaires of the first round.

5.4. Rounds

Once the Delphi panel has been configured, the application of the rounds of questionnaires must be initiated, which can be carried out via email, postal mail, face-to-face or telephone, always depending on the needs and objectives inherent in the research itself and the characteristics and specificities. associated with the panel and its members.

The necessary information must be previously provided to contextualize the topic and the research, and then the first questionnaire must be sent with a deadline to be filled out and returned.

Some reminders may be sent in the period between shipment and deadline to mitigate failures in filling and delivery.

In the first round, the questions are usually exploratory to get a general opinion on the topic and evaluate the points of greatest interest that need to be discussed, often called the exploratory round. The data collected in this round will form the basis of the structure of the questionnaire to be applied in the second round and so on.

There are also several possible formats in the structure of the questionnaires since they are often adjusted and moulded according to the characteristics of the research itself.

Questionnaires can be developed with open and/or closed questions and may or may not have a delimited predictive character with a predefined time horizon.

When initially there is not much information available on the subject under study, in the first round of questionnaires the questions are usually open to collect basic information that allows structuring and clarifying the proposals that will integrate the second round of questionnaires.

It is also recommended that, in all rounds of questionnaires, experts have the possibility, if they wish, to justify their views or opinions and to add new ideas or information that they consider relevant to the ongoing debate.

Due to the prospective nature that characterizes this technique, in addition to the open questions, it is also common to use questions related to the probability of occurrence of a certain future event, requesting the indication of a time limit or expected year of occurrence, as well as the use of questions aimed at the assessment of the agreement or definition of priorities in relation to the proposals presented, specifically through the use of measurement scales, with special emphasis on the Likert scale that is frequently used in the preparation of questionnaires.

Examples of questions:

In your opinion, what will be the factors that will most influence climate change?

How likely are these factors to profoundly affect life on the planet? [Indicate a value between 0% and 100%]; if you answered 100%, indicate the year in which it will take place

Indicate for each of these climatic factors your degree of agreement or disagreement [7 - strongly agree; 1 - strongly disagree]

After collecting and processing the data of the first round, a next round is sent structured based on the results of the previous round, in which specialists can reinforce or reformulate their proposals and it is possible to consult all the answers given. in the previous round (controlled feedback).

All this procedure is repeated according to the number of laps to be performed. In this way, an attempt is made to build a convergence of perspectives to form a general opinion of the group on the subject under study and the number of rounds will be greater or lesser depending on the degree of consensus obtained. In each round, participants are invited to review their perspective, considering the data collected and the views expressed by the panel so far.

Once the process referred to the last round is completed, the last step is to transpose the information obtained to the research topic and a final summary is usually sent to the group with the information obtained and the conclusions drawn, which can be at the end of the Delphi study, or at the end of the current research.

The interaction between specialists and the coordinator is increasingly supported by information and communication technologies and the sending of questionnaires and data processing are very useful and versatile tools on the Internet and in computer programs (example: Google Forms, SurveyMonkey, eDelphi.org)

5.5. General characteristics of the Delphi technique

Four main characteristics of the application of this technique are usually identified in the literature (Garrod and Fyall, 2005; Rowe and Wright, 1999):

i) anonymity
ii) iteration
iii) controlled feedback
iv) statistical treatment of group responses

The preservation of anonymity can refer, on the one hand, to the impossibility of the members of the panel to know the individual response of each of the other members (they only know the general and grouped contributions) and, on the other hand, to the ignorance, during the successive rounds, of who the remaining members of the panel are. However, the latter factor varies from study to study. For example, if the "snowball" method mentioned above is used, all or almost all members will know each other, the same happens in cases where the coordinator chooses to hold a general assembly prior to the presentation of the objectives of the research. In any case, even if the experts know each other, it is possible to

maintain the anonymity of the answers. That is, not knowing which of the experts gave a certain answer.

The iteration (or repetition) allows a deeper thought by the experts on the topics under analysis since the panel can analyse the responses of the group and rethink their own answers in each round, being able to progressively build their lines of analysis, expand perspectives and reformulate opinions or even base initial propositions. In this context, anonymity can facilitate the change of initial statements, something that would be more difficult if it were a public debate or a personal confrontation with another expert.

Controlled feedback is presented as the means to measure the degree of consensus obtained after each round of questionnaires and give an idea to the general opinion group. It is usually presented in the form of a mean or percentage value, hence the importance and need for statistical treatment, and the answers can be grouped according to the degree of consensus or number of answers obtained. It also allows to collect the justifications that are presented for some answers.

Thus, the ideal number of rounds that should be carried out, the possible withdrawal of specialists in successive rounds, the time that is generally required for the realization of the whole process and the degree of consensus that is considered acceptable, or even the lack of it, are also sensitive issues that are somehow interconnected.

The number of rounds varies from study to study; however, it is generally accepted that two to three rounds should be conducted (Edwards et al., 2008; Woudenberg, 1991). This number will necessarily depend on the factors associated with the greater or lesser degree of withdrawal of the participants that is verified between rounds, the degree of consensus obtained, or the stability of responses reached at the end of each round or through the predefinition of a fixed number of stipulated rounds. by the coordinator. As an example, Garrrod and Fyall (2005) completed the Delphi study at the end of the third round, after having registered a significant number of dropouts, even opting not to use the data

collected in the third round. Edwards et al. (2008) emphasize that more than two or three rounds may be inadvisable because participants, faced with several successive questionnaires and around the same topic, may feel unmotivated to continue participating in the study and, therefore, contribute to its development. increased attrition rates.

As for consensus, although it is often mentioned that this is the main objective of the technique, that is, to build an acceptable consensus around the topic under discussion (Landeta, 2005; Linstone and Turoff, 1975; Veal, 2006; Garrod and Fyal, 2005); Hsu and Sandford, 2007; Moeller and Shafer, 1994), its increasing application has often removed the restriction around consensus (Landeta, 2006). For Gupta and Clarke (1996), the Delphi technique is not only intended to generate consensus, but to obtain, from a panel of experts, answers and opinions of high quality and credibility on a particular topic under analysis. Dalkey (1967), quoted by Woudenberg (1991), argues that, although consensus is indeed important, it should not be seen as the main objective of the application of this technique, proving in many cases that both the collection of information and consensus are important, already quite high after the second round, noting that in the following rounds the trend is towards a greater and more consistent increase in consensus, compared to tabbing. Also in this context, Gordon (1994) argues that the Delphi technique can be seen as a controlled debate in which the reasons for extreme opinions are explicit and feedback is presented neutrally, without the association of feelings on the part of others. the researcher in relation to the trend of the responses. Usually, expert groups move towards consensus, but even when such consensus does not occur, the reasons for taking different positions are clarified. The analyses and conclusions drawn by the coordinator are based not only on the reasons given by the expert group, but also on his own knowledge and objectives. The value of the Delphi technique is thus translated into the global set of ideas it generates, whether through consensus or not. Because the number of respondents is normally small, the Delphi technique does not produce, nor does it claim to produce, statistically significant results. That is, the results obtained by any Delphi

group do not predict the response of a larger population or even a different Delphi group. They represent the synthesis of the opinion of a particular group, that's all (Gordon, 1994).

The number of rounds to be made will in turn affect the time needed to apply the technique, and this factor is also seen as a sensitive point of its application. In addition to choosing the panel and elaborating the first questionnaire, it will be necessary to process the information obtained, organize it and build the following questionnaires, all so that the study remains interesting and attractive to the participants. Hence, in the structuring and application of the Delphi technique, it is necessary to have a greater concern to comply with the main steps for its application, in a rigorous, clear and transparent way, thus contributing to the construction of scientific knowledge that can be contrasted and replicated The application of a Delphi study usually takes a relatively long period of time, especially when there are a lot of open-ended questions that will require more time for experts to prepare the answers. Garrod and Fyall (2005) mention that the time required to apply a Delphi study can go beyond 12 months. Specialists usually have two to three weeks to answer and return each questionnaire (Delbecq, 1986; Garrod and Fyall, 2005), however, it may be necessary to extend the deadlines previously established for this purpose, sometimes due to the delay in return. of some questionnaires, at other times by the request for extension of the initial deadlines by specialists who need more time to prepare their responses, which may involve extending the time initially planned for the entire process until its completion in weeks or even months, which will also contribute to delays or difficulties in the processing of the collected data and the structuring of the following questionnaires by the coordinator. To mitigate any difficulties related to the temporary extension of the study, all these aspects must be planned and managed in the best possible way.

5.6. Main limitations in the application of the Delphi technique

Despite the identification of numerous advantages in the application of this technique in the field of tourism, and especially in the context of destination management, it is important to mention that there are some limitations to consider. The very structuring of the expert panel can be a complex and difficult process to execute, since it is not an easy task to mobilize people considered experts in a certain domain and who have the time and motivation to participate in a relatively small, long research process that requires great consideration in the elaboration of the answers. In addition to the necessary initial mobilization to form the panel, we must also try to guarantee the continuity of the participants and the minimum possible number of casualties. Hence, one of the most important and sensitive phases of a Delphi study is precisely the selection of experts and the construction of the panel. The initial presentation of the research work to be carried out and the clear explanation of all the processes and characteristics of the Delphi technique to potential participants can be very important to try to mitigate future abandonments, since the elements that accept to be part of the study will already be prepared from the beginning for a process that requires availability of time, it implies repetition and insistence on the same subject and that can give rise to opinions different from one's own. On the other hand, it will also be of great importance that experts are motivated to participate in the study. Once again, when structuring the panel, the choice of specialists interested in the subject of study, in the territory of analysis or in the results that will be produced must be taken into account. While some researchers choose monetary remuneration as a form of motivation, others choose to try to emphasize the importance of the study to the participants themselves by building knowledge that will be made available to them practically first-hand and that may be useful to them at any given time. professional and/or professional or academic level.

6. Application of the Delphi technique in the study on Trends in Climate Change Research in Bolivia and Paraguay

6.1. Study framework

The study presented here is part of the INNOVA project - "Promoting Research Management in Higher Education Institutions in Bolivia and Paraguay", funded by the Erasmus+/KA2 programme – Cooperation for innovation and the exchange of good practices – Development of competences in the field of Higher Education.

Table 1: Study work plan1

WP Task	Activity	Time period	Responsible
T1.4. DELPHI STUDY: Analysis of future trends in Climate Change research	1. Drafting of the Delphi Study methodology – Minutes and Guidelines	June 2021	UA, UPT
	2. Nomination of experts (3 experts * 10 HEIs = 30 experts)	October 2021	all INNOVA partners
	3. Desk research → Cross-cutting trends: SDGs, Paris Agreement, national legislation	September-November 2021	UA, UPT
	4. Execution of the first Delphi round and analysis of results	December - January 2022	UPT and UA with the support of INNOVA partners
	5. Execution of the second Delphi round and analysis of results	February 2022	UPT and UA with the support of INNOVA partners
	6. Drafting of the final report: "Estudio Delphi. Analysis of future trends in Climate Change research in Bolivia and Paraguay"	March – August 2022	UPT, UA

The Delphi study is a pilot exercise of incursion into the field of Foresight Methods for the INNOVA project, which aims to identify and evaluate future global trends of cutting-edge research in the field of climate change, focusing on hypothetical applications for development within the context of Bolivia and Paraguay, and the development of strategic recommendations to guide policy formulation in the field of R&D at the HE level in Latin America.

The design of the methodology oversaw the University of Alicante (UA) and the University Portucalense (UPT) and had the following minimum requirements:

- Participation of at least 3 proven experts from each institution within the INNOVA consortium (partners may also consider including external experts): 3*11=33 experts.
- Execution of at least 2 rounds of consultation feedback with the expert panel during the Delphi study.
- Gender perspective and indigenous knowledge.
- Methodologies of Initiation to Foresight

A work plan was drawn up with the planned activities, the dates of implementation and the teams responsible for their execution, which can be seen in Figure 1.

6.2. Choice of experts

To integrate the panel of experts, two specific profiles of participants were stipulated:

A) Expert in research management (1 per institution)

   a. Accredited experience for holding a research management position at the level of Higher Education.

   b. Research work carried out in Bolivia and/or Paraguay and familiarization with the region (Does not apply to EU partners).

B) Expert in climate change (2 per institution).

a. Experience accredited by participation in research projects or publications in the fields related to Climate Change.

b. Research work carried out in Bolivia and/or Paraguay and familiarization with the region (Does not apply to EU partners).

In total, each partner institution of the project identified 3 experts who met the criteria. Then, a formal invitation was sent to participate in this Delphi study. From the potential list of experts (Figure 2), we were able to draw up a final list of participants (Figure 3). These constitute what we call the Delphi panel. The panel is balanced, as it includes representatives from all partner universities and, as such, allows all of them to contribute their contributions around the topic under study.

The formal invitation was sent by the Universidad San Francisco Xavier de Chuquisaca (USFX), coordinator of the project, and explained the context of the project, the objectives and the contribution expected from the specialists.

Dear Expert,

USFX is pleased to invite you to join our panel of international experts, which will take part in the Delphi study on future trends in climate change research in Bolivia & Paraguay. This study is part of the INNOVA initiative, an Erasmus + project / Key Action 2: Cooperation for innovation and the exchange of good practices: capacity building in higher education, co-financed by the European Commission and coordinated by the San Francisco Xavier University of Chuquisaca.

The objective of this study, which will have a multidisciplinary approach, is to evaluate the future impact (with the time horizon marked in 2030) that various research topics related to the fulfilment of the Sustainable Development Goals (SDGs) may have in the specific context of Bolivia and Paraguay.

As part of the panel of participating experts, you will only have to answer two questionnaires, in an iterative and anonymous process, evaluating the relevance of different research topics, from a climate change perspective in Bolivia and Paraguay. These questionnaires will be shared with you virtually.

Participation in this study ensures recognition as a member of the panel of international experts of the INNOVA project, accredited by the USFX, by taking an active part in this study, which is one of the key activities in the initial phase of this 3-year project. The general objective of this project is to improve the research management of Higher Education Institutions in Bolivia and Paraguay, with a specific focus on Climate Change.

Waiting for you to accept this invitation, we remain at your disposal.

Receive a cordial greeting,

San Francisco Xavier University of Chuquisaca

Table 2: Structure of the expert panel2

Country	Experts by institution
Bolivia	3 experts from the Universidad Mayor Real y Pontificia de San Francisco Xavier de Chuquisaca (public) 3 experts from Gabriel René Moreno University (public) 3 experts from the Bolivian Catholic University (private) 3 experts from the Private University of Santa Cruz de la Sierra (private) 3 experts from the Ministry of Education of the Plurinational State of Bolivia
Paraguay	3 experts from the National University of Asunción (public) 3 experts from the National University of the East (public) 3 experts from the Catholic University of Our Lady of the Assumption (private) 3 experts from the Ministry of Education and Science
Spain	3 experts from the University of Alicante
Portugal	3 experts from the Portucalense University

Table 3: List of the expert panel3

Number	Surnames	Institution
John Paul	Alvarez Orias	Universidad Mayor De San Francisco Xavier De Chuquisaca Bolivia
Edgar Arthur	Iñiguez Araujo	Universidad Mayor De San Francisco Xavier De Chuquisaca Bolivia
July	Montero Torres	Universidad Mayor De San Francisco Xavier De Chuquisaca Bolivia
David	Salazar Towers	Universidad Mayor De San Francisco Xavier De Chuquisaca Bolivia
Marisol	Toledo	Gabriel Rene Moreno Autonomous University
Alejandro	Moscosos Villacorta	Gabriel Rene Moreno Autonomous University
Julius Caesar	Magne Salazar	Gabriel Rene Moreno Autonomous University
Daniel	Valverde Aparicio	Gabriel Rene Moreno Autonomous University
Freddy	Soria Cespedes	Bolivian Catholic University "San Pablo"
Georgina Aurelia	Chavez Lizárraga	Bolivian Catholic University "San Pablo"
Vidfa Carolina	Garvizu Auza	Bolivian Catholic University "San Pablo"
Luciano	Roman Medina	Catholic University of Our Lady of the Assumption
Victor	Gonzalez Caballero	Catholic University of Our Lady of the Assumption
Javier	Medina Vasquez	University of Alicante
Henry	Low	University of Alicante
Roberto	Escarré Urueña	University of Alicante
Maria Fatima	Yubero De Servian	National University of Asunción
Fernando Jose	Mendez	National University of Asunción
Abel	Delgado Villalba	National University of Asunción
Osvaldo	Fruits	National University of Asunción
Pedro Luis	Paniagua Alcaraz	National University of Asunción
Marina Aurelia	Stonemason Benitez	National University of the East
Enrique	Rodriguez Cabral	National University of the East
Mirna Josefina	German Franc	National University of the East
Rene Gaston	Mejia Brown	Private University of Santa Cruz de la Sierra
Cynthia	Bojanic Helbingen	Private University of Santa Cruz de la Sierra
Heberto Hernan	Peña Galarza	Private University of Santa Cruz de la Sierra
Martha	Serrano Pacheco	San Francisco Xavier De Chuquisaca University
Khusen	Ibragimov	Portucalense University

Ricardo	Cayollan	Portucalense University
Helena	Albuquerque	Portucalense University

7. Structure of questionnaires and their application

7.1. 1st round: December - January 2022

The first questionnaire was designed based on the report "UNESCO Science Report: the race against time for smarter development" and specifically addressed the issue of trends on climate change research topics in Bolivia and Paraguay, linked to the fulfilment of the SDGs.

The instructions for completing the first questionnaire were as follows:

- Read the introductory text carefully before responding, it will help you understand the context and objectives of the study, as well as the procedure we are going to follow.
- It is not necessary to answer all the questions, only those in which you feel comfortable contributing your opinion.
- When you have finished the questionnaire remember to press the send button. You can confirm that the form has been submitted successfully if you can view the confirmation message correctly.
- After confirmation of message send, you will receive by email a copy of your answers to the address you provided when completing the questionnaire. That same email will give you access to your answers in case you want to modify any of them.

Structure of the Questionnaire round 1:

Title:

Trends on climate change research topics in Bolivia and Paraguay, linked to the fulfilment of the SDGs.

Summary:

This section of the present questionnaire serves as an introduction to the objectives, scope and methodology of the study, as well as the objectives of the INNOVA project itself:

The objective of this Delphi study is to evaluate the future impact (with the time horizon marked in 2030) that various research topics related to the fulfilment of the Sustainable Development Goals (SDGs) may have in the specific context of Bolivia and Paraguay.

The following questionnaire presents various research topics related to the fulfilment of the Sustainable Development Goals (SDGs). These themes have been identified in the "UNESCO SCIENCE REPORT: The race against time for smarter development" as https://www.unesco.org/reports/science/2021/es/download-the-report the most addressed by the scientific community at a global level, considering the objective of advancing the 2030 agenda.

We invite all participating experts to provide feedback, based on their areas of expertise, on the relevance they attach to the main research topics identified by UNESCO in relation to the SDGs, from a climate change perspective in Bolivia and Paraguay. Similarly, in the last part of the questionnaire we offer you the possibility of proposing other relevant topics not contemplated in the UNESCO report.

This questionnaire is configured as the first iteration of a DELPHI technique investigation. To this end, this questionnaire will be answered by 33 other experts in various disciplines related to climate change research, with experience in the context of Bolivia and Paraguay. This panel is presented with successive questionnaires to be answered anonymously, with a flexible content and a predominantly exploratory character. In each round of questionnaires, controlled feedback of the answers obtained in the previous round is shared, so that each specialist can reflect on the global responses and perspectives of other experts, thus trying to build an acceptable consensus on the topic under study. This questionnaire would be the first of two planned rounds.

This action is framed within the Activity 1.4 DELPHI STUDY: Analysis of future trends in climate change research in Bolivia & Paraguay of the INNOVA project.

This initiative is an Erasmus+ project / Key Action 2: Cooperation for innovation and the exchange of good practices: capacity building in higher education, co-financed by the European Commission and coordinated by the San Francisco Xavier University of Chuquisaca. The action is focused on improving the research management of Higher Education Institutions in Bolivia and Paraguay, with a specific focus on Climate Change. With a planned duration of 3 years, INNOVA will contribute to address the low performance in Research and Innovation in Bolivia and Paraguay in the field of Higher Education.

Selection of lines of research and construction of the questionnaire:

Among all the SDGs mentioned in the UNESCO SCIENCE REPORT, the seven that have the greatest potential impact for the context of Bolivia and Paraguay were selected. They are as follows:

SDG 2: Zero hunger

SDG 3: Health and Well-being

SDG 6: Clean water and sanitation

SDG 7: Clean and affordable energy

SDG 9: Infrastructure, industrialization, and innovation

SDG 13: Climate action

SDG 15: Life on land

For each of them, the **47 lines of research** that, at the international level, had a **greater number of scientific publications** were presented and the regional relevance of lines of research linked to the SDGs was asked:

"Please indicate the degree of potential future impact (time horizon 2030) of the following topics in the field of climate change research, within the specific context of Bolivia and Paraguay, being 0 = very low and 10 = very high.

Remember that you are not required to answer all questions. All questions that remain unanswered will be counted as Do not know/Do not answer.

If you deem it appropriate, you may include additional comments that complement your responses."

Question 1: SDG 2 – Zero Hunger

- Pest-resistant crops
- Aid to small-scale food producers
- Precision agriculture
- Agroecology
- Maintaining the genetic diversity of food crops
- Traditional knowledge

Question 2: SDG 3 – Health and Well-being

- Reproductive health and neonatology
- Human immunodeficiency virus (HIV)
- Tropical communicable diseases
- Human resistance to antibiotics
- Regenerative medicine
- Health impact of soil, freshwater and air pollution
- Drugs and vaccines for tuberculosis
- New or re-emerging viruses that can infect humans
- Type 2 diabetes

Question 3: SDG 6 – Clean water and sanitation

- Sustainable freshwater extraction and supply
- Water collection
- Wastewater treatment, recycling, and reuse
- Integrated national water resources management
- Transboundary water resources management

Question 4: SDG 7 – Clean and affordable energy

- Cleaner fossil fuel technology
- Photovoltaic
- Hydropower
- Biofuels and biomass
- Wind turbine technologies
- Geothermal energy
- Nuclear fusion
- Hydrogen energy
- Smart Grid Technology

Question 5: SDG 9 – Infrastructure, industrialization, and innovation

- Carbon pricing
- Eco-industrial waste management
- Ecoconstruction materials
- Increased battery efficiency
- Sustainable transport

Question 6: SDG 13 – Climate action

- National and urban greenhouse gas emissions
- Carbon capture and storage
- Local impact of climate-related hazards and disasters
- New technologies to protect against climate-related hazards
- Local disaster risk reduction strategies
- Climate-ready crops

Question 7: SDG 15 – Life on land

- Sustainable use of terrestrial ecosystems
- State of terrestrial biodiversity
- Minimize poaching and trafficking of protected species

- Addressing invasive alien species
- Use of ecosystem-based approaches in terrestrial protected areas
- Extension of water-related ecosystems
- Socio-ecological impact of terrestrial protected areas

Question 8:

The last section of this first round gave the experts the possibility that, if they considered it appropriate, they would propose other priority lines of research that had not been identified in the UNESCO SCIENCE REPORT.

"In this section you can include, optionally, a maximum of 5 topics of research on climate change not previously contemplated within the "UNESCO SCIENCE REPORT: The race against time for smarter development" (See report here: https://www.unesco.org/reports/science/2021/es/download-the-report) and that you consider of special relevance in the context of Bolivia and Paraguay"

7.2. 2nd round: February 2022

As mentioned above, the questions of this second round were built based on the results obtained in round 1. The aggregation of the individual assessments of the potential impact of each line in Bolivia and Paraguay allowed to obtain a hierarchy of these considering the opinion of all the members of the panel.

In this case the 7 questions presented the following statement scheme:

From the analysis of the responses obtained in the previous round, it is extracted that the proposed lines of research related to the ODSX, ordered from GREATER TO LESSER impact, would be as follows:

[the order of priority lines mentioned above for each SDG is presented. This order is shown below for each of the 7 questions]

Do you consider that the order described above CORRESPONDS TO THE POTENTIAL IMPACT that may arise from the development of each of these lines

of research IN THE REGION OF SOUTH AMERICA/YOUR COUNTRY/YOUR INSTITUTION?

Being 0 = strongly disagree and 10 = strongly agree.

Structure of the Questionnaire round 2:

Title:

DELPHI INNOVA STUDY - Questionnaire 2nd round

Summary:

This is the second and last questionnaire of the Delphi study on trends in climate change research topics in Bolivia and Paraguay, linked to the fulfilment of the SDGs.

This questionnaire has been constructed based on their responses in the first round.

On this occasion, the objective is focused on finding out the degree of agreement or disagreement with the overall results obtained in the previous round.

In the last section of the questionnaire, we will ask you to evaluate the potential impact of the lines of research additionally proposed by you in the previous round.

Question 1: SDG 2 – Zero Hunger

1. *Maintaining the genetic diversity of food crops*
2. *Agroecology*
3. *Aid to small-scale food producers*
4. *Traditional knowledge*
5. *Pest-resistant crops*
6. *Precision agriculture*

Question 2 SDG 3 – Health and Well-being

1. *New or re-emerging viruses that can infect humans*
2. *Health impact of soil, freshwater and air pollution*
3. *Tropical communicable diseases*

4. *Human resistance to antibiotics*
5. *Regenerative medicine*
6. *Reproductive health and neonatology*
7. *Type 2 diabetes*
8. *Drugs and vaccines for tuberculosis*
9. *Human immunodeficiency virus (HIV)*

Question 3: SDG 6 – Clean water and sanitation

1. *Sustainable freshwater extraction and supply*
2. *Integrated national water resources management*
3. *Transboundary water resources management*
4. *Water collection*
5. *Wastewater treatment, recycling, and reuse*

Question 4: SDG 7 – Clean and affordable energy

1. *Cleaner fossil fuel technology*
2. *Hydropower*
3. *Biofuels and biomass*
4. *Smart Grid Technology*
5. *Photovoltaic*
6. *Nuclear fusion*
7. *Wind turbine technologies*
8. *Geothermal energy*
9. *Hydrogen energy*

Question 5: SDG 9 – Infrastructure, industrialization, and innovation

1. *Sustainable transport*
2. *Eco-industrial waste management*
3. *Increased battery efficiency*
4. *Ecoconstruction materials*

5. *Carbon pricing*

Question 6: SDG 13 – Climate action

1. *Local impact of climate-related hazards and disasters*
2. *Local disaster risk reduction strategies*
3. *New technologies to protect against climate-related hazards*
4. *Climate-ready crops*
5. *National and urban greenhouse gas emissions*
6. *Carbon capture and storage*

Question 7: SDG 15 – Life on land

1. *State of terrestrial biodiversity*
2. *Sustainable use of terrestrial ecosystems*
3. *Extension of water-related ecosystems*
4. *Socio-ecological impact of terrestrial protected areas*
5. *Use of ecosystem-based approaches in terrestrial protected areas*
6. *Minimize poaching and trafficking of protected species*
7. *Addressing invasive alien species*

Question 8:

This last question is oriented to the prioritization of the other research topics mentioned at the end of round 1 by the experts. The question was worded as follows:

In the previous round, we asked you to identify 5 specific thematic lines that were not initially included in the proposals submitted. Based on the analysis of the responses collected, the following list was drawn up:

- Development of the circular economy- Planning and territorial planning- Migration phenomena- Images of the future in young people- Impact of fires- The use of plastics- Sustainable cities- Education on the environment and climate change-

Radical creativity and participatory foresight- Current state of pollinators and their relationship with agricultural production- Alternatives for the reduction of the import of used clothing- Control of Methane emissions- Democracy and institutionalism- Public policies for development- Causes of deforestation- Poverty and inequality- Tourism management

Now what we ask is that, from the list presented, please SELECT THE 5 PROPOSALS THAT YOU CONSIDER PRIORITIES FOR RESEARCH IN THE REGION, with line 1 being the most priority and line of 5 the least priority.

7.3. Round 1 Results

Looking at the graphs presented in the following pages of this section, and which show the results of the impact assessment for each of the identified lines of research, we can see that all of them have obtained a positive impact assessment (greater than 5 on a scale of 0 out of 10) by more than 50% of the participants. This is corroborated by the calculation of the median for each of the lines of research, none of them being less than 6 (out of 10).

Likewise, for all the SDGs observed, the lines of research with the best impact assessments have medians equal to or greater than 8, which demonstrates the high degree of consensus among experts regarding the expected positive impact of the lines of research that have been extracted from the UNESCO SCIENCE REPORT, which are considered as the lines of greatest impact at a global level linked are the fulfilment of SDGs.

On the other hand, it can also be observed that all lines of research present a considerable number of very positive evaluations (these are, 9 or 10), which shows a high expectation of experts in the potential impact of such research. On the other hand, it is also observed that only 9 lines of research (out of a total of 47) have obtained evaluations that we can consider very negative (of 0 or 1). In this sense,

we can add that in none of these 9 cases there are more than two valuations of this type.

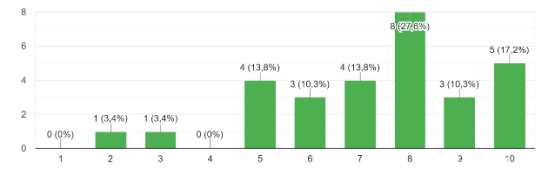
Regarding the level of consensus among the experts consulted, and in view of the results described above, in the first 7 questions a high degree of agreement is observed, which confirms the relevance and potential impact (in the context of Bolivia as in Paraguay) that the experts give to the lines of research linked to the SDGs that have greater scientific production at a global level.

The graphs shown on the following pages show the distribution of the experts' assessments regarding the impact of each of the 47 lines of research that have been considered, each of them linked to a specific SDG.

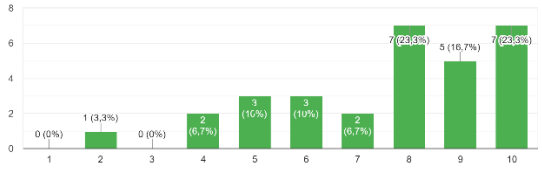
In this section we do not go into assessing the specific results for each of the lines. This assessment will be developed for the results of the second Delphi round, whose questionnaire is based on the results presented here.

Question 1: Assessments for the lines linked to SDG 2 – Zero hunger

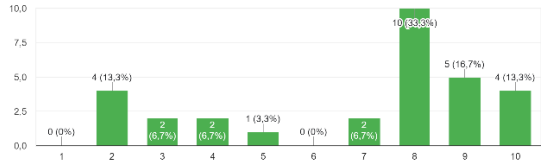
Cultivos resistentes a plagas
29 respostas



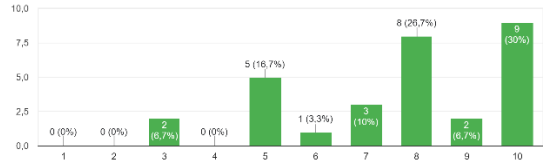
Ayuda a los pequeños productores de alimentos
30 respostas



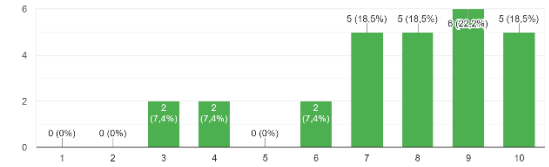
Agricultura de precisión
30 respostas



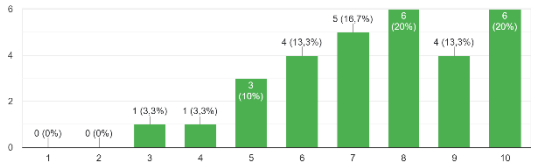
Agro-ecología
30 respostas



Mantener la diversidad genética de los cultivos alimentarios
27 respostas

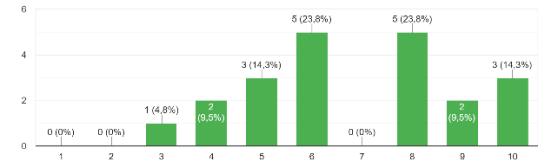


Conocimiento tradicional
30 respostas

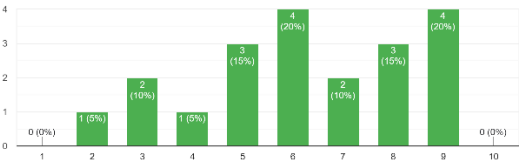


Question 2: Assessments for the lines linked to SDG 3 – Health and well-being

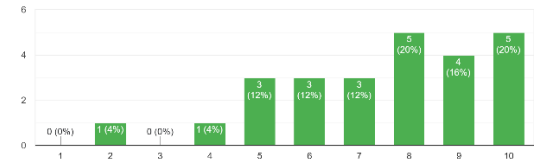
Salud reproductiva y neonatología
21 respostas



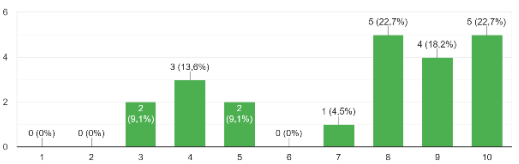
Virus de inmunodeficiencia humana (VIH)
20 respostas



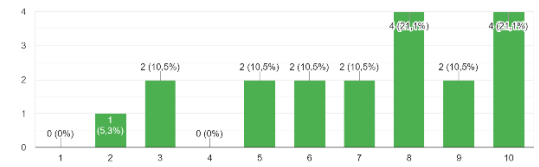
Enfermedades transmisibles tropicales
25 respostas



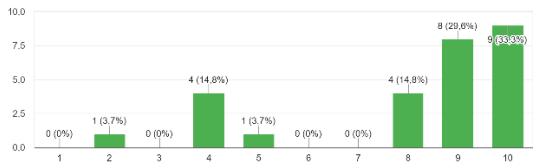
Resistencia humana a los antibióticos
22 respostas



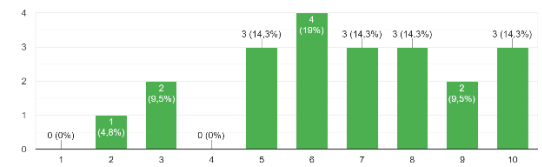
Medicina regenerativa
19 respostas



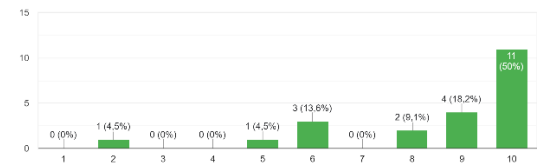
Impacto en la salud de la contaminación del suelo, el agua dulce y el aire
27 respostas



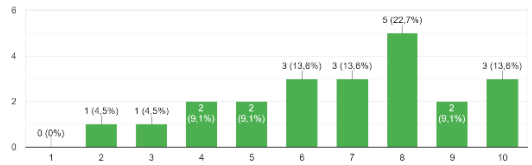
Medicamentos y vacunas para la tuberculosis
21 respostas



Virus nuevos o reemergentes que pueden infectar a los seres humanos
22 respostas

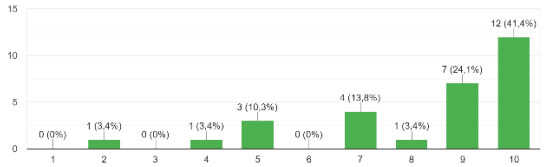


Diabetes tipo 2
22 respostas

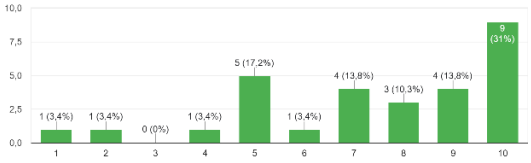


Question 3: Assessments for SDG 6 lines – Clean water and sanitation

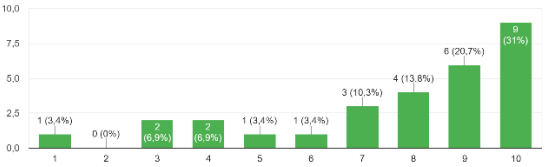
Extracción y suministro sostenibles de agua dulce
29 respostas



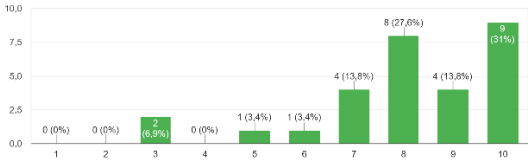
Recolección de agua
29 respostas



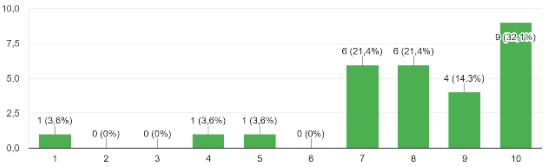
Tratamiento, reciclaje y reutilización de aguas residuales
29 respostas



Gestión nacional integrada de los recursos hídricos
29 respostas

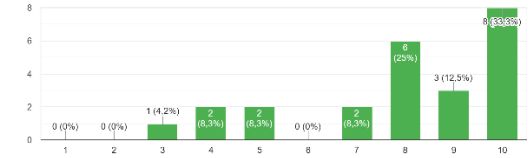


Gestión de recursos hídricos transfronterizos
28 respostas

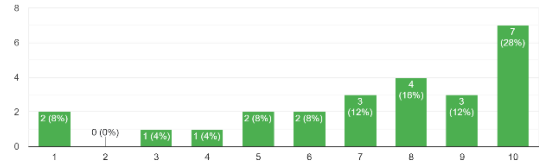


Question 4: Assessments for the lines linked to SDG 7 – Clean and affordable energy

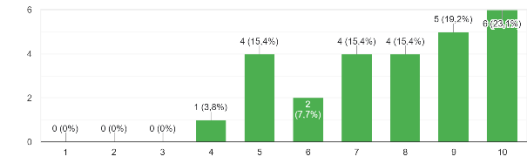
Tecnología de combustibles fósiles más limpia
24 respostas



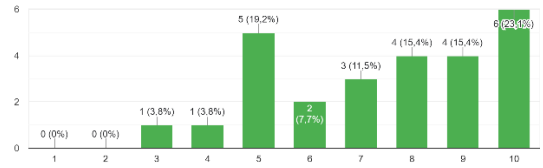
Fotovoltaica
25 respostas



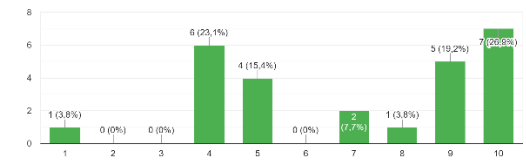
Energía hidroeléctrica
26 respostas



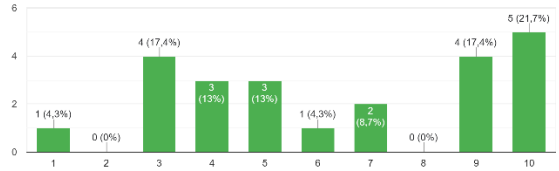
Biocombustibles y biomasa
26 respostas



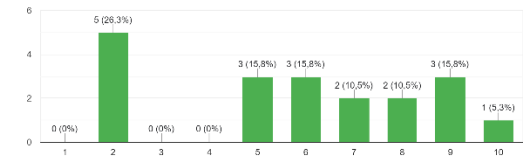
Tecnologías de turbinas eólicas
26 respostas



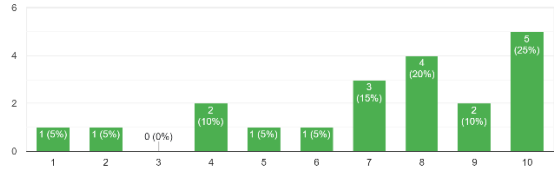
Energía geotérmica
23 respostas



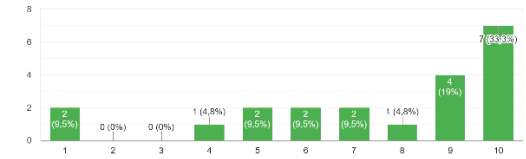
Fusión nuclear
19 respostas



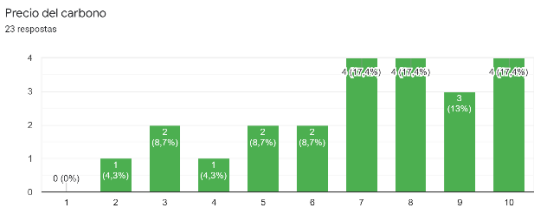
Energía de hidrógeno
20 respostas

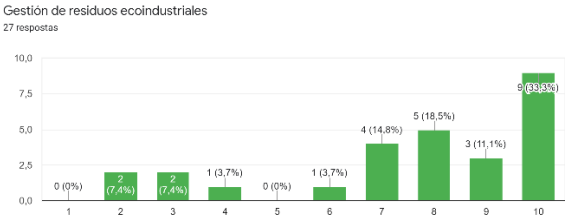


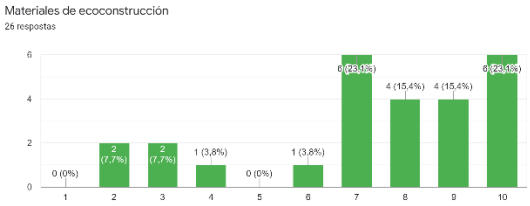
Tecnología de red inteligente
21 respostas

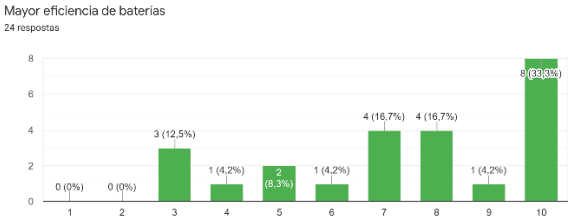


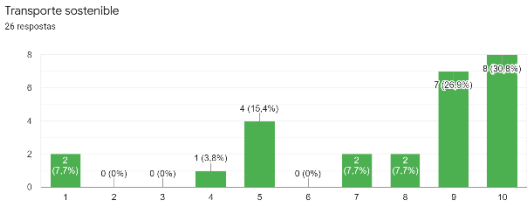
Question 5: Assessments for the lines linked to SDG 9 – Infrastructure, industrialization, and innovation





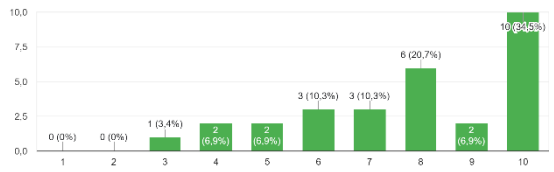




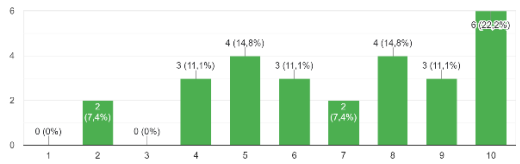


Question 6: Assessments for the lines linked to SDG 13 – Climate action

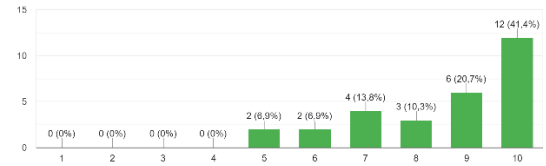
Emisiones de gases de efecto invernadero nacionales y urbanos
29 respostas



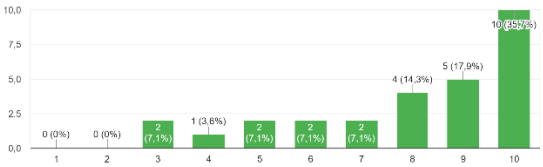
Captura y almacenamiento de carbono
27 respostas



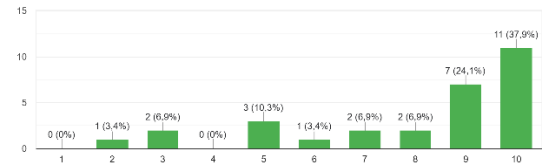
Impacto local de los peligros y desastres relacionados con el clima
29 respostas



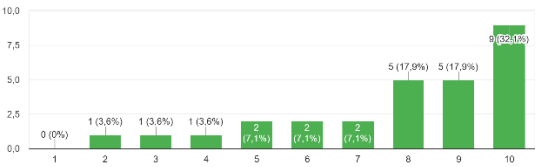
Nuevas tecnologías para protegerse de los peligros relacionados con el clima
28 respostas



Estrategias locales de reducción del riesgo de desastres
29 respostas

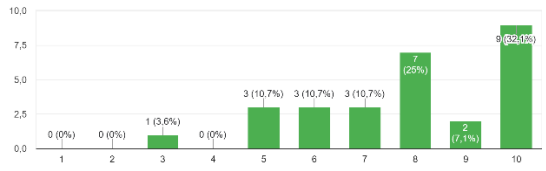


Cultivos preparados para el clima
28 respostas

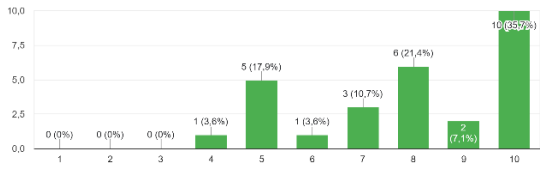


Question 7: Assessments for the lines linked to SDG 15 – Life on Earth

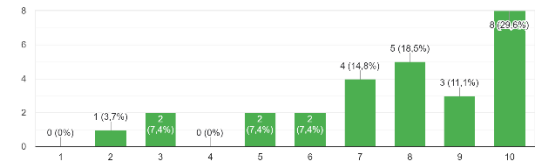
Uso sostenible de ecosistemas terrestres
28 respostas



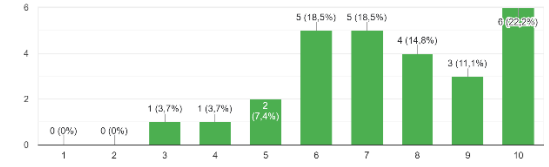
Estado de la biodiversidad terrestre
28 respostas



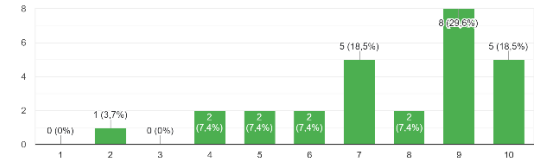
Minimizar la caza furtiva y el tráfico de especies protegidas
27 respostas



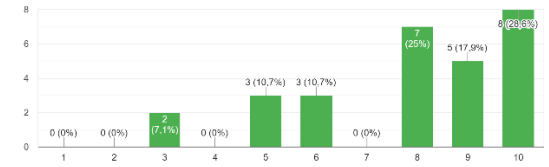
Abordar las especies exóticas invasoras
27 respostas



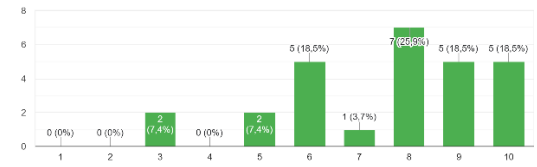
Uso de enfoques basados en ecosistemas en áreas protegidas terrestres
27 respostas



Extensión de los ecosistemas relacionados con el agua
28 respostas



Impacto socioecológico de las áreas protegidas terrestres
27 respostas



Question 8: Other research topics not included in the previous sections

The topics not included in the 7 previous questions and that the experts considered appropriate to include in the scope of this study are the following:

- Development of the circular economy
- Planning and territorial planning
- Migration phenomena
- Images of the future in young people
- Impact of fires
- The use of plastics
- Sustainable cities
- Education on the environment and climate change
- Radical creativity and participatory foresight
- Status of pollinators and their relationship to agricultural production
- Alternatives for reducing the import of used clothing
- Control of Methane emissions
- Democracy and institutionalism
- Public policies for development
- Causes of deforestation
- Poverty and inequality
- Tourism management

These lines will be incorporated into the questionnaire of the second Delphi round, with the aim of obtaining an assessment, by the experts, that order of priority should be established among them according to their potential impact on the region.

7.4. Round 2 Results

The calculation of the mean and quartiles for each of the questions asked in the previous round, have allowed to establish a hierarchy between the lines of research presented, according to two criteria:

- The value of the mean, which allows to calculate the value of the scale that improves represents the consensus among all the participants in the study.
- The value of the percentiles, which will serve to measure the dispersion between the evaluations of the participants for each of the lines of research.

Based on these two values, a hierarchy was established between those lines that had obtained the highest degree of consensus in each of the SDGs.

In this case, the objective of this second Delphi round was to measure the degree of agreement or disagreement that each of the participating experts showed with respect to the rankings obtained from the results of the previous round. This degree of agreement or disagreement should be expressed regarding the impact of the lines of research at both the regional (Latin American) and national levels (in the case of experts from Bolivia and Paraguay):

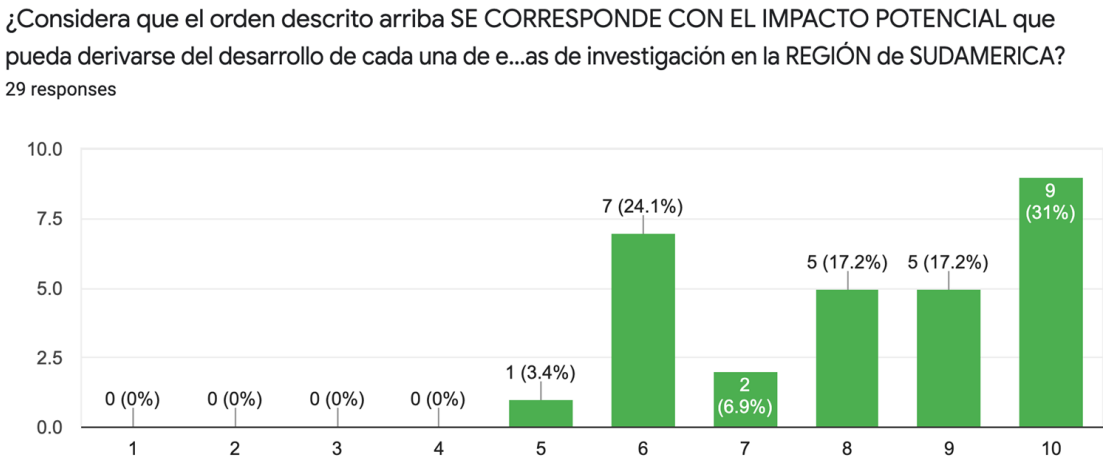
Below are the results of the assessment of these rankings in each of the observed SDGs:

Question 1: SDG 2 – Zero hunger

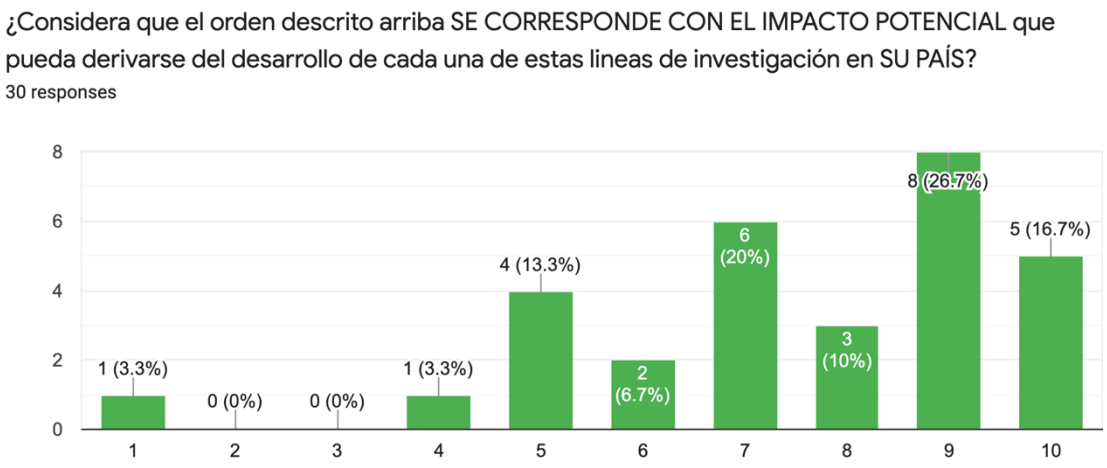
Ranking obtained in the previous round:

1. Maintaining the genetic diversity of food crops
2. Agroecology
3. Aid to small-scale food producers
4. Traditional knowledge
5. Pest-resistant crops
6. Precision agriculture

Reading the following graph allows us to obtain a clear view of the high degree of consensus that exists among the members of the panel, with 31% of them showing total agreement (10) with the order resulting from the previous round. On the other hand, we can highlight that 24.1% of the panel shows a moderate degree of agreement (6). In their complementary assessments, some of the experts consulted have considered that lines such as agroecology or precision agriculture can have a greater potential impact on the South American region.



Regarding the potential impact at the country level, we see that the degree of agreement with the proposed scale is still high, although it is true that the concentration of results is lower. The distribution of the results also shows two disagreeing opinions of experts who consider that this order does not correspond to the priorities in their country (Paraguay).



Question 2: SDG 3 – Health and well-being

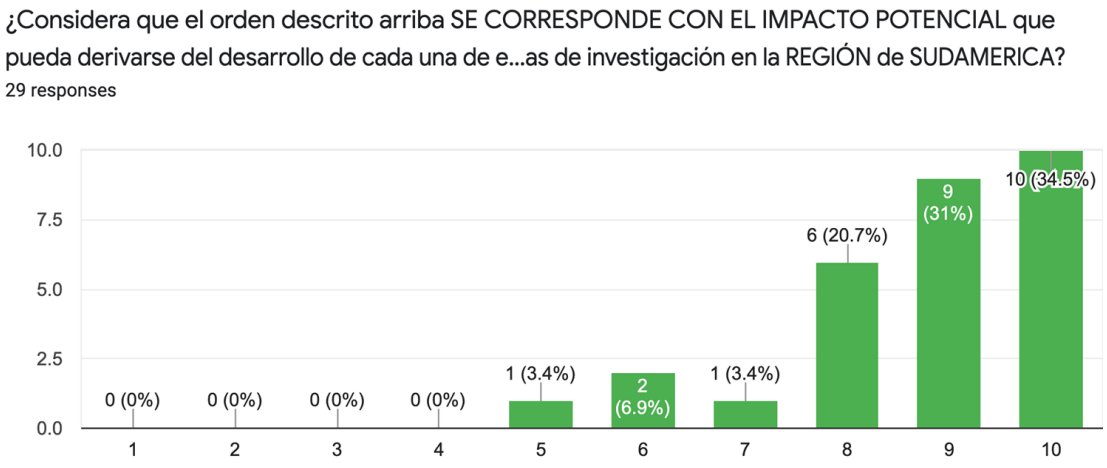
Ranking obtained in the previous round:

1. New or re-emerging viruses that can infect humans
2. Health impact of soil, freshwater and air pollution
3. Tropical communicable diseases
4. Human resistance to antibiotics
5. Regenerative medicine
6. Reproductive health and neonatology
7. Type 2 diabetes
8. Drugs and vaccines for tuberculosis
9. Human immunodeficiency virus (HIV)

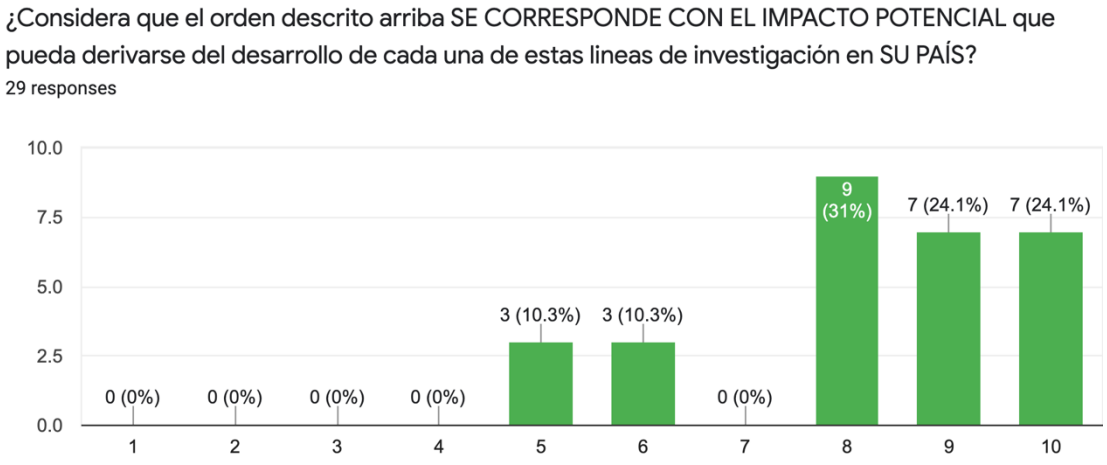
In this case, the graph shows an even greater degree of agreement than in the lines of research presented for the previous SDG. We can see how 65.5% of the participants showed a degree of total agreement (10) or very high (9) with the established order. Experts who show a more moderate degree of agreement base their position on the line "Impact on health of soil, freshwater and air pollution".

A fact to highlight, which was mentioned by several participants, has been the effect that the appearance of COVID has had on the opinion of the panel, placing

as a line of research with greater impact at the regional level research on "new or emerging viruses that can infect humans".



If we look at the following graph, we observe a similar assessment of the impact of the lines linked to "SDG3 - Greetings and Well-being" at the country level, although showing a more moderate degree of agreement than at the regional level.



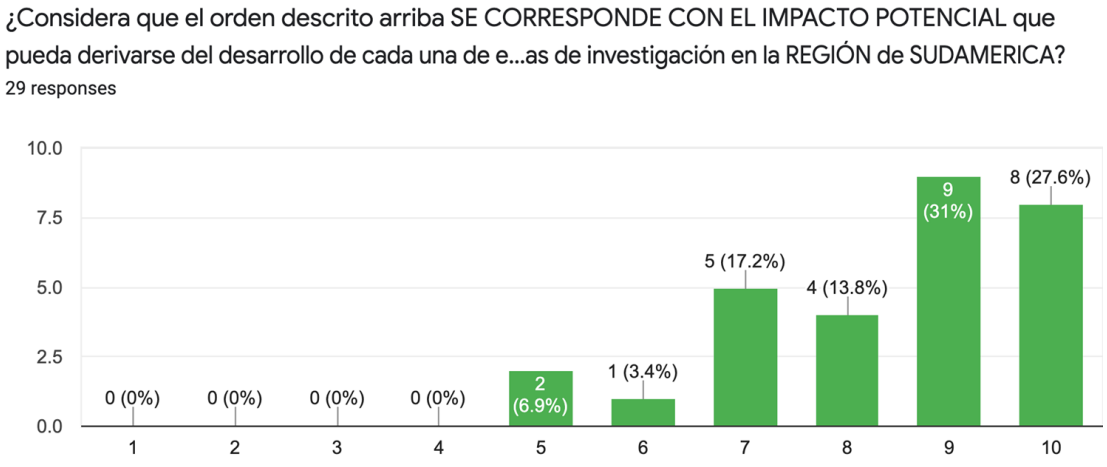
Question 3: SDG 6 – Clean water and sanitation

Ranking obtained in the previous round:

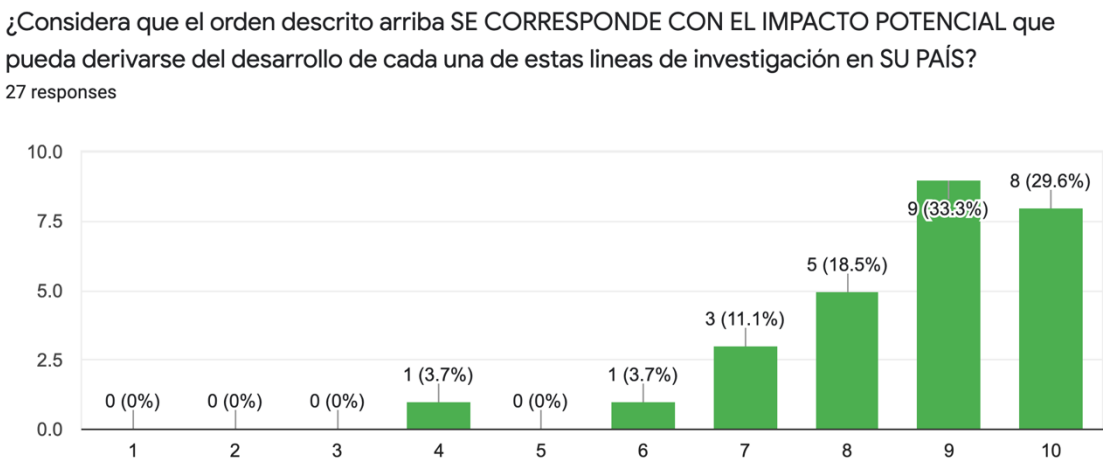
1. Sustainable freshwater extraction and supply

2. Integrated national water resources management
3. Transboundary water resources management
4. Water collection
5. Wastewater treatment, recycling, and reuse

The order presented for the lines of research linked to "SDG 6 – Clean water and sanitation" also has a degree of total agreement (10) or very high (9) of 58.6% of the panel. In their complementary assessments, the experts have agreed to point out the importance of the lines linked to this SDG, although it is true that local or national particularities can mark in some way which of these lines can have the greatest impact.



In line with what has been stated at the regional level, the results at the national level show a degree of total (10) or very high (9) agreement among 62.9% of the participants, with a single participant showing a minimum level of disagreement (4), and who considers that this order corresponds to the potential impact of each of these lines in their country (Paraguay).



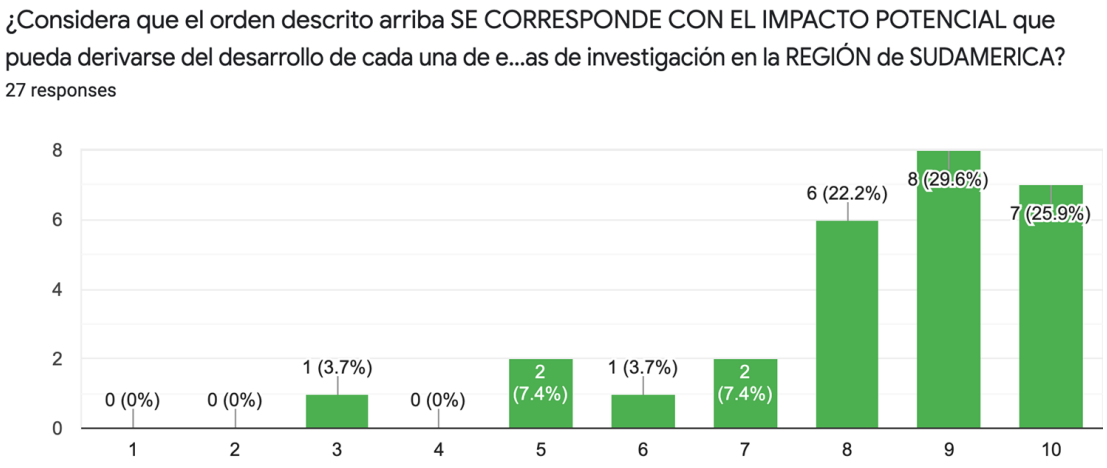
Question 4: SDG 7 – Clean and affordable energy

Ranking obtained in the previous round

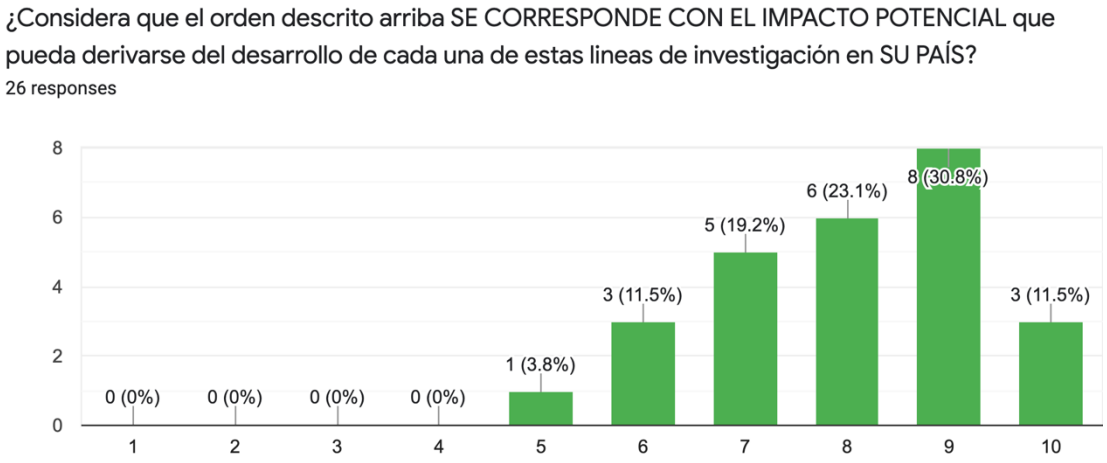
1. Cleaner fossil fuel technology
2. Hydropower
3. Biofuels and biomass
4. Smart Grid Technology
5. Photovoltaic
6. Nuclear fusion
7. Wind turbine technologies
8. Geothermal energy
9. Hydrogen energy

As in the case of the previous SDG, the results show a majority of the panel (55.5%) positioning themselves as total (10) or strongly in agreement (9) with the order presented for the lines of research linked to "SDG 7 – Clean and affordable energy". The rest of the panel, which show a more moderate degree of agreement (or even disagreement in one of the cases), considers that the impact of some of the lines does not correspond to the reality of the region, as is the case of "Smart Grid Technologies" or nuclear fusion. On the other hand, they consider that

research on "Hydrogen Energy" should have greater prominence based on its potential impact on the region.



The assessments presented at the country level for this SDG are like those mentioned at the regional level, although it is true that here the degree of total agreement (10) is only 11.5% of the entire panel. Among the observations on the lines that have the greatest impact at the national level, it is worth highlighting the case of "Photovoltaic Energy", considered as an energy source of great potential in Bolivia.

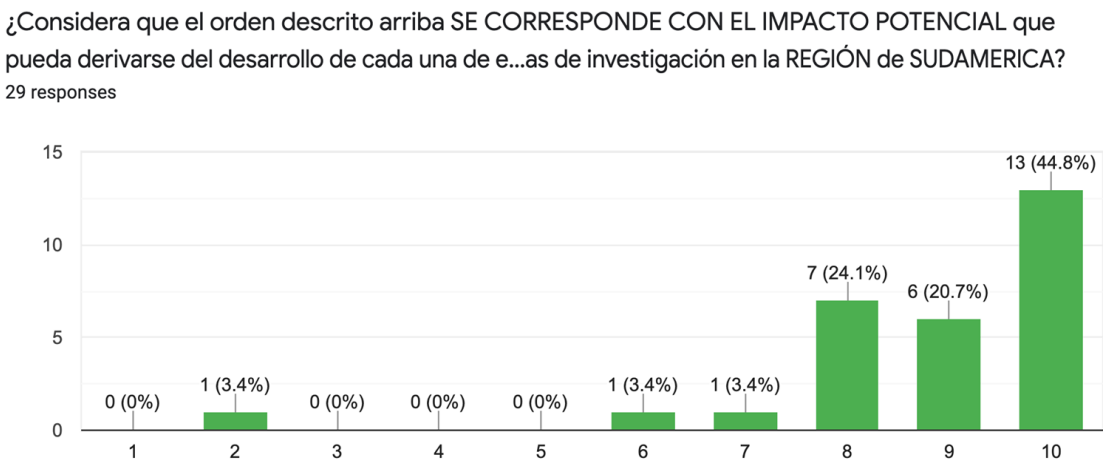


Question 5: SDG 9 – Infrastructure, industrialization and innovation

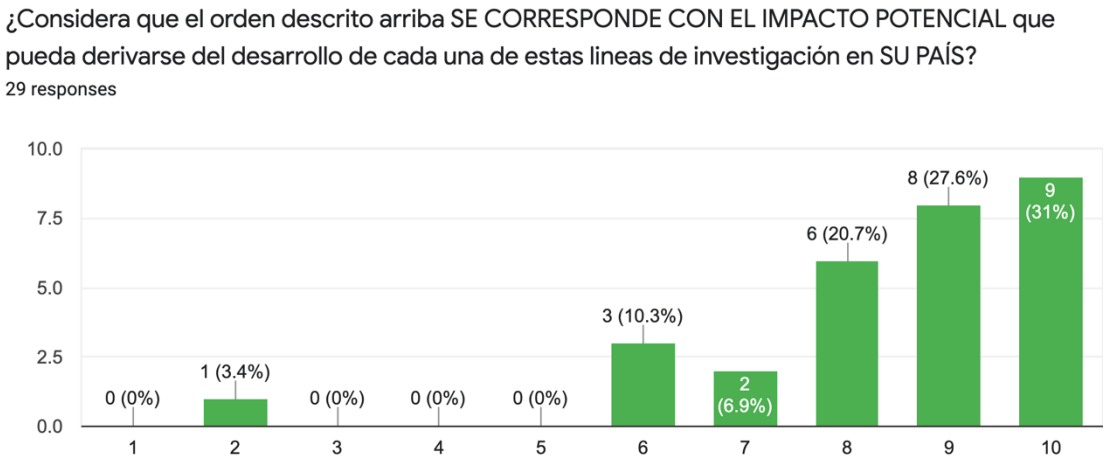
Ranking obtained in the previous round

1. Sustainable transport
2. Eco-industrial waste management
3. Increased battery efficiency
4. Ecoconstruction materials
5. Carbon pricing

As we have already observed in the previous SDGs, for the lines of research linked to "SDG 9 – Infrastructure, industrialization and innovation" the panel of experts has shown a very high degree of agreement on their potential impact on the region, with a degree of total agreement (10) or very high (9) among 65.5% of the panel. A generalized comment among several experts has been to point out the importance for the region of the development of research in "Sustainable Transport", which is considered the line of research with the most potential impact regarding this SDG. The most notable discrepancy with respect to the established order corresponds to the position of the research line "Eco-construction materials", indicated by one of the experts as a line of great potential in the region.



At the national level, the results reflect a similar opinion of the panel at the regional level. In this case, Bolivian experts have pointed out the great potential impact that the "Sustainable Transport" and "Greater battery efficiency" lines can have. The assessment on a greater importance of the importance of the line of research on "Eco-construction materials" is also observed at the national level.

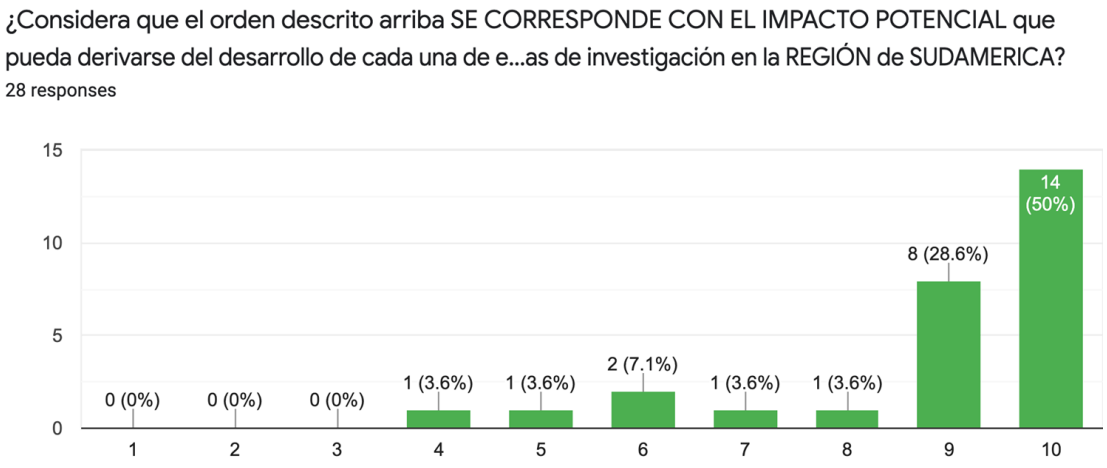


Question 6: SDG 13 – Climate action

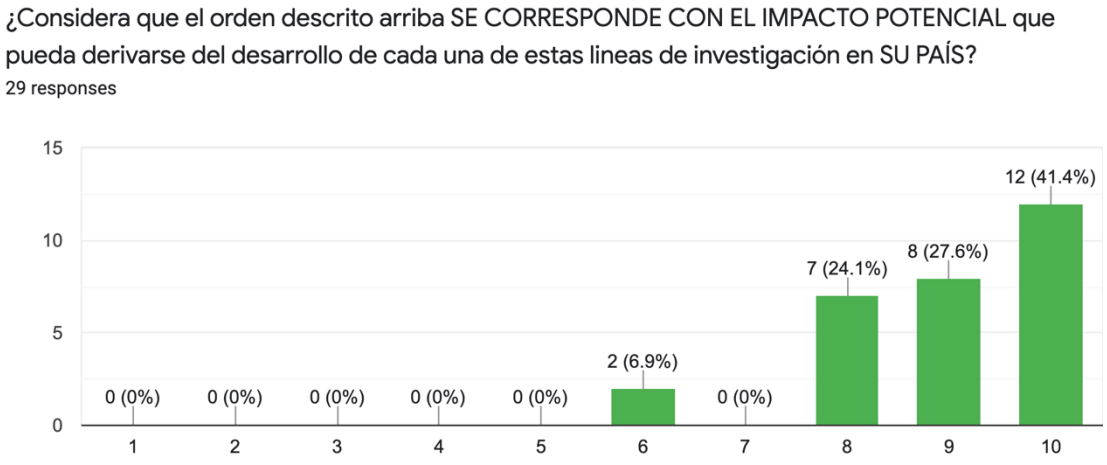
1. Local impact of climate-related hazards and disasters
2. Local disaster risk reduction strategies
3. New technologies to protect against climate-related hazards
4. Climate-ready crops
5. National and urban greenhouse gas emissions
6. Carbon capture and storage

The lines of research linked to "SDG 13 – Climate Action" also have a high degree of agreement with respect to the impact ranking established at the regional level, with a degree of total agreement (10) or very high (9) among 78.6% of the panel. However, we can observe a case that shows a small degree of disagreement (4), which considers that research on "national and urban

greenhouse gas emissions" should be considered as the line of greatest impact linked to this SDG.



At the national level we observed a greater concentration in the distribution of responses, where we did not find any experts who show any degree of disagreement with the established order. Likewise, the opinion of one of the experts who considers research on "national and urban greenhouse gas emissions" as the line of greatest impact linked to this SDG is reiterated at the national level.

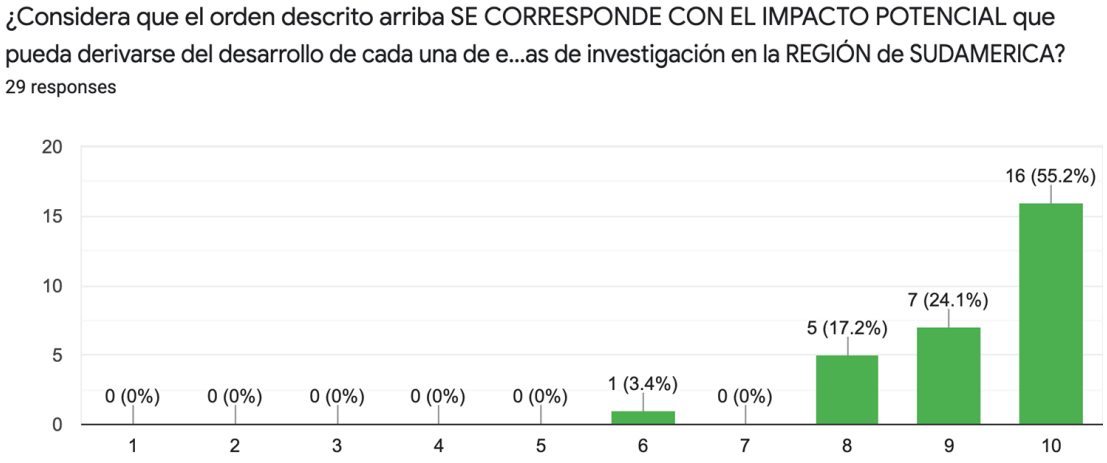


Question 7: SDG 15: Life on Earth

Ranking obtained in the previous round

1. State of terrestrial biodiversity
2. Sustainable use of terrestrial ecosystems
3. Extension of water-related ecosystems
4. Socio-ecological impact of terrestrial protected areas
5. Use of ecosystem-based approaches in terrestrial protected areas
6. Minimize poaching and trafficking of protected species
7. Addressing invasive alien species

The lines of research linked to "SDG 15 – Life on Earth" are those that have had a greater degree of agreement with respect to the impact ranking established at the regional level, with a degree of total agreement (10) or very high (9) among 79.3% of the panel. Likewise, we did not find any opinion in disagreement with the ranking of potential impact for the proposed lines of research.



The results obtained at the country level also reflect a very similar degree of agreement with respect to the ranking presented. However, it is at the national level where we find comments from some experts who consider research on Biodiversity, specifically on "Ecosystems in terrestrial protected areas", as well as

research on "The sustainable use of terrestrial ecosystems", to have the greatest potential impact.

Question 8:

In this last question, the experts were asked to establish a ranking of the lines of research that they considered to have the greatest potential impact in the region, with line 1 being the most priority and line 5 being the least priority.

Based on the results reflected in the graph above, we can see that the lines of research on "Planning and territorial planning", "Development of the circular economy" and "Sustainable cities" are those that stand out above the rest of the proposed lines, the first two being those that have been valued as priority 1 or 2 by a greater number of experts.

It should also be noted that the line of "Education on the environment", is considered by 4 of the experts as the line that deserves a higher level of priority,

although this position does not have as much consensus among the experts as the 3 lines mentioned above.

8. Conclusions

The Delphi study that has been presented within this report sought the identification and evaluation of future global trends of cutting-edge research in the field of climate change, focusing on hypothetical applications for development within the context of Bolivia and Paraguay.

The first step in this was to find a source of contrasting and reliable information that would allow us to identify which were the lines of research that were currently experiencing the greatest scientific production, specifically those linked to the SDGs whose fulfilment can have a greater direct impact on Bolivia and Paraguay.

This desktop *research* work developed by the research team responsible for this study allowed to have a clear and concise vision of global research trends in climate change. Information on these trends was the key element presented to the INNOVA project expert panel, tasked with assessing the potential impact that such trends could have at both national and regional levels.

The first assessment of these trends by experts has served to corroborate that trends in climate change research at the global level present a high degree of potential impact in the region. Thus, the fact that researchers and research centres from all over the world are working on lines of interest for the region, and especially for Bolivia and Paraguay, becomes one of the main incentives for researchers and

research centres in these two Latin American countries to try to find international connections in the field of research. In this sense, the international connection with research networks focused on these lines will become one of the main success factors for the promotion of climate change research in Bolivia and Paraguay.

The second assessment carried out by the panel of experts has allowed to propose a series of lines of research on climate change that are priorities for the region, focusing on those that are considered to have the greatest potential impact in Bolivia and Paraguay. In this sense, the prioritization of these lines presents a double utility: on the one hand, it presents an orientation to the public administration and financing entities on the lines of research that present the greatest potential to generate an impact at the national and regional level; on the other, they guide researchers on which are the lines that can allow the creation of networks or research centres aimed at the development of research that may be key to the development of the region and the fight against climate change. In this way, we present, in a summarized way, the main conclusions regarding the prioritization of the lines of research.

In **SDG 2 – Zero hunger**, the priority line of research at the regional level is related to the theme "Maintaining the genetic diversity of food crops", followed in order of importance, "Agroecology", "Helping small food producers", "Traditional knowledge", "Pest resistant crops" and "Precision agriculture". This strategic alignment had a high degree of consensus for the Latin American context. About the potential impact at the country level, the level of agreement remains high, although it is known that the concentration of results is lower, considering some experts that this order does not correspond to the priorities in Paraguay.

In the case of **SDG 3 – Health and well-being**, the main line of research at the regional level is related to "New or re-emerging viruses that can infect humans", followed by "Health impact of soil, freshwater and air pollution", "Communicable tropical diseases", "Human resistance to antibiotics", "Regenerative medicine", "Reproductive Health and Neonatology", "Type 2 Diabetes", "Tuberculosis Drugs and Vaccines" and "Human Immunodeficiency Virus (HIV)". In this case, the

participants show a high degree of total or very high agreement. The emergence of COVID appears to have had a strong impact on this assessment. As for countries, we observed a similar assessment, although showing a more moderate degree of agreement than at the regional level.

In **SDG 6 – Clean water and sanitation**, the priority line refers to "Sustainable freshwater extraction and supply", followed by "Integrated national water resources management", "Transboundary water resources management", "Water collection" and "Wastewater treatment, recycling and reuse". This order has a high degree of total or very high agreement at the regional level. The results at the national level also show a high degree of total or very high agreement, with a single participant demonstrating a minimum level of disagreement and considering that this order corresponds to the potential impact of each of these lines in their country (Paraguay).

In **SDG 7 – Clean and affordable energy**, the priority line is "Cleaner Fossil Fuel Technology", followed by "Hydropower", "Biofuels and Biomass", "Smart Red Technology", "Photovoltaics", "Nuclear Fusion", "Wind Turbine Technologies", "Geothermal Energy" and "Hydrogen Energy". Here, too, the results show a high degree of total or very high agreement. The rest of the panel, which shows a more moderate degree of agreement (including the lack of agreement in one of the cases), considers that the impact of some of the lines does not correspond to the reality of the region, as is the case of "Smart Red Technologies" or nuclear fusion. On the other hand, they consider that research on "Hydrogen Energy" should have a greater role depending on its potential impact on the region. For countries, the assessments are similar to those mentioned at the regional level, if they know that here the degree of total agreement is lower. Among the observations on the lines of greatest impact at the national level, it is worth highlighting the case of "Photovoltaic Energy", considered as an energy source of great potential in Bolivia.

Regarding **SDG 9 – Infrastructure, industrialization and innovation**, the priority line refers to "Sustainable transport", followed by "Eco-industrial waste management", "Greater battery efficiency", "Eco-construction materials" and

"Carbon price". Here, too, the panel of experts has shown a high degree of agreement on its potential impact on the region. The most notable discrepancy with respect to the established order corresponds to the position of the research line "Eco-construction materials", pointed out by one of the experts as a line of great potential in the region. At the national level, the results reflect a similar view, with Bolivian experts pointing out the great potential impact that in particular the combined lines of "Sustainable Transport" and "High Battery Efficiency" can have. The assessment of a greater relevance of the research line "Eco-construction materials" is also observed at the national level.

In **SDG 13 – Climate action**, the priority line refers to the "Local impact of climate-related hazards and disasters". It is followed by "Local Strategies for Disaster Risk Reduction", "New Technologies to Protect from Climate-Related Risks", "Climate-Ready Crops", "National and Urban Greenhouse Gas Emissions" and "Carbon Capture and Storage". These lines of research are also highly valued at the regional level. However, there is a small degree of disagreement regarding research on "national and urban greenhouse gas emissions" that should be considered as the line of greatest impact linked to this SDG. At the national level there is a greater concentration in the distribution of responses, where we do not find any expert who demonstrates any degree of disagreement with the established order.

In **SDG 15 – Life on Earth**, the priority line is "State of terrestrial biodiversity", followed by "Sustainable use of terrestrial ecosystems", "Extension of water-related ecosystems", "Socio-ecological impact of terrestrial protected areas", "Use of ecosystem-based approaches in terrestrial protected areas", "Minimize poaching and trafficking of protected species" and "Address invasive alien species". These lines are the ones that have had a greater degree of agreement with respect to the impact ranking established at the regional level. The results obtained at the country level also reflect a degree of agreement very similar to the ranking presented. However, it is at the national level where we find comments from some experts who consider research on biodiversity to have the greatest potential impact,

specifically on "Ecosystems in protected terrestrial areas", in addition to research on "The sustainable use of terrestrial resources".

Finally, the panel identified other priority lines that were not included in the SDGs initially discussed, namely "Planning and territorial planning", "Development of the circular economy", "Sustainable cities" and "Environmental Education".

9. References

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