CUADERNOS.INFO Nº 37 ISSN 0719-3661
Versión electrónica: ISSN 0719-367x
http://www.cuadernos.info
doi: 10.7764/cdi.37.691

Received: 02-16-2015 / Accepted: 10-01-2015

Scientific communication for cultural and economic development: the case of a zone with astronomical potentials in the Region of Antofagasta in Chile

La comunicación científica para el desarrollo cultural y económico: el caso de las potencialidades astronómicas de la Región de Antofagasta en Chile

A comunicação científica para o desenvolvimento cultural e económico: o caso do potencial astronômico da região de Antofagasta no Chile

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ABSTRACT

This article faces the opposite opinions of media, and scientific, social and political leaders regarding the importance of disclosing the astronomical potential towards cultural and economic development in the area. To answer the enquiry above, Delphi questionnaires were applied to 27 experts that exposed the lack of specialization within Chilean media regarding science and technology, and the gap between scientist and the media itself. That action lead to the understanding of the many contributions and changes that media might provide to the existing inequalities related to scientific literacy.

Keywords: Dissemination, communications, astronomy, science, scientific literacy, Delphi.

RESUMEN

En este artículo se confrontan las opiniones de medios de comunicación y líderes científicos, sociales y políticos de la Región de Antofagasta, Chile, sobre la importancia de divulgar las potencialidades astronómicas de la región para su desarrollo cultural-económico. Con tal fin se aplicó cuestionarios Delphi a 27 expertos, quienes destacaron la falta de especialización de los medios chilenos en ciencia y tecnología, y la distancia entre los científicos y esos mismos medios. Se concluye que son muchos los aportes que podrían realizar, por ejemplo, los medios de comunicación, en cuanto a las desigualdades existentes en materia de alfabetización científica.

Palabras clave: *Divulgación, comunicaciones, astronomía, ciencia, alfabetización científica, Delphi.*

RESUMO

Neste artigo, confrontam-se as opiniões dos meios de comunicação e dos líderes científicos, sociais e políticos da Região de Antofagasta, Chile, sobre a importância de divulgar o potencial astronômico da região para o seu desenvolvimento cultural-econômico. Com este propósito, foram entrevistados 27 peritos (método Delphi), que destacaram a falta de especialização dos meios de comunicação chilenos em ciência e tecnologia, juntamente com a distância entre os cientistas e os meios de comunicação. Conclui-se que há muitas contribuições que poderiam ser feitas, por exemplo, pelos meios de comunicação, em relação às desigualdades no campo da alfabetização científica.

Palavras-chave: Divulgação, comunicação, astronomia, ciência, alfabetização científica, Delphi.

•How to cite:
Vernal, T. (2015). La comunicación científica para el desarrollo cultural y económico: el caso de las potencialidades astronómicas de la Región de Antofagasta en Chile. *Cuadernos.info,* (37), 213-224. doi: 10.7764/cdi.37.691

INTRODUCTION

The Antofagasta Region of Chile has natural geographical features that make it a world-renowned astronomical heritage. That is how the Paranal Observatory, the Atacama Large Millimeter Array (ALMA), the Atacama Astronomical Park project and the not yet installed European Extremely Large Telescope (the world's largest telescope) are located in the desert of this area, opening the way to the development of the region and the country. However, this potential has yet to be seized in the educational, technological and economic fields. Thus Antofagasta, known primarily as a mining region[1], has given little room for science outside of that activity and practically, has been oriented only to mining as part of their culture and development.

Considering the great opportunities that astronomy gives to the region, it is necessary to strengthen a culture that generates awareness of the contribution that this science provides for vocational training, technological innovation and even for astrotourism. In these respects, many contributions and changes may come from the media, which has a large role in science (Boczkowski, 1998, interview with B. Lewenstein). Especially considering they constitute the more powerful and influential reporting tool worldwide, they relate strongly to citizenship and, therefore, are a key player in the knowledge society (Fontcuberta & Borrat, 2006).

According to the database of the University of Antofagasta, the region has approximately 32 media outlets –besides the national ones-, among which are five print media, seventeen radio stations, four TV studios and six digital media. The most prominent are the print media *El Mercurio de Antofagasta* [*Antofagasta`s Mercurio*] and *La Estrella del Norte* [*The Northern Star*]; the TV stations *Antofagasta Television*, *National Television Antofagasta* and *VLP Television*; the radio stations *Canal 95* [*Channel 95*], *Radio Universidad de Antofagasta* [*University of Antofagasta's radio*] and *Radio Madero*; and the digital press *El Nortero*. None of them has a specialized science section, apart from its science and technology news section. For example, *El Mercurio de Antofagasta* [*Antofagasta`s Mercurio*], publishes about astronomy just some Sundays.

Scientific disclosure, a responsibility often attributed to the media, is a shared task (Del Puerto, 1999). As well as the media, it involves academic actors, such as scientists and university professors; from the social area linked to organizations and institutions that disseminate and educate in science; and from the political arena, since government decisions makers are also a key factor to complement the informative work in any area of science and technology (Sánchez, 2004).

To know the media opinion, on the one hand, and the opinion of the scientific, social and political leaders in the Antofagasta Region of Chile, on the other, about the importance of disclosing astronomy for regional development, along with discussing the need to build a closer and more accessible scientific literacy for the community, it was applied the *Delphi* technique. This tool was quite appropriate, since it is a systematic and iterative process, which allows the production of opinions and consensus of a group of experts (Landeta, 2002).

> Unlike a survey, what it is sought is not the existence of statistically significant differences, but the most likely scenario outlined by the convergence of opinion. (Camisón, H., Camisón, Z., Fabra, Flores & Puig, 2009, p. 18).

FROM POTENTIALITY TO REALITY

GENERAL AND HISTORICAL ASPECTS OF ASTRONOMICAL DISCLOSURE

The publication in 1543 of the work De revolutionibus orbium caelestium (On the Revolutions of the Heavenly Spheres), by Nicolaus Copernicus, would have been the one to open the doors to astronomy and physics, an enterprise that lived a new momentum in the early seventeenth century when Galileo, from his studies through the telescope, affirmed that the earth revolved around the sun (Fernández & Angulo, 2011).

Galileo was one of the first promoters of astronomy and contributed to the advancement of humanity with his knowledge of physics, mathematics and astronomy. He strived to prove that the Earth moves, even having to publicly abjure his principles due to sustained persecution from the Catholic Church (Cortiñas, 2009). After his death, science began to position itself in an audience that was more aware of what was happening in history. The debate began to open, questioning about the established doctrines raised and new approaches were accepted, displacing the Church of these matters and removing the last word about them (Panza & Dams, 2002).

Astronomy is ranked as one of the most treated scientific subjects in the history of humankind. In France, for example, it has been the discipline with more followers and fans over time. One of the initiators of progress in the disclosure of astronomy would have been Camille Flammarion, a French astronomer who made great efforts to popularize this science (Cortiñas, 2009). Other communicators of astronomy have been Fontanelle in France, Comas i Solà in Spain, or the latest Isaac Asimov and Carl Sagan in the United States. Each and every one of them has managed to captivate the public in accordance with their times, promoting astronomy either through writing, or television in the most recent cases. It is said that the Catalan Josep Comas i Solà, from the twentieth century, was interested in science from an early age and in his childhood, while he was recovering from an illness, he gave astronomical talks to the maid who looked after him (Batllo, Cebrián, Olivier conference, Rock & Ruiz, 2004).

To motivate in the scientific knowledge it is required a good deal of talent, but the best scientists -or the best journalists, in the case of this study- are not necessarily the best promoters of science and technology (Consolmagno, 2009). There have been good examples of it, and throughout history, there has been those who have managed to captivate and excite the public, such as the renowned Carl Sagan or Richard Feynman, both linked and recognized in the world of physics. Carl Sagan was a brilliant astronomer and, at the same time, an excellent host, creator of the US television series *Cosmos*, where he talked about complex issues closely and easy for the average viewer (Reynolds, 2008). In addition, in the case of journalists, the development of new technologies has led those transmitting scientific information to the forefront of the disclosure of science and capturing the attention of people from different communities. For this they have had to motivate them, stimulating their emotions, because "a stimulus can become emotionally competent only connecting with another that already is by innate disposition or acquired by that person" (Ferrés, 2014, p. 164).

Among the promotion forms of astronomy that have been most successful is the participation of the public in activities such as Star parties, scientific lectures and exhibitions outdoors (Kowal & Watzke, 2013). The promotion of astronomy has also been through the media, according to the possibilities and tools that each provides. However, although they could be great transmitters of scientific knowledge and a great contribution to the astronomical promotion, the traditional media, and even those dependent on new technologies, such as social networks, cannot solve the problems of education alone, which is often beyond their competence.

McLuhan, in 1969, referred to the media as extensions of the human and psychic abilities. In that capacity, they have among their responsibilities to convey to the people the appropriate scientific knowledge to make of them an informed actor in these areas. It is up to each specialist or citizen to establish which of the outlets is most appropriate to fulfill this task in the areas of astronomy, but it is always important to play with the mystery and use anecdotes, daily messages or metaphors, because we have to try everything to enchant the population with the roads that science opens (Elias, 2008).

THE NEED FOR INTEGRATED SCIENCE LITERACY

Scientific literacy has been present in education on relevant problems of society, by supporting public participation in decision-making within its competence and encouraging critical and creative thinking about the natural world (Maienschein, 1998). A clear example of matters in which the society must have interference is the use of chemical fertilizers and pesticides to control insects, pests, weeds and fungi. Since World War II, it produced a real agricultural revolution and increased production significantly. However, a few years later, the World Commission on Environment and Development (1988) warned that its excessive use constituted a threat to human health, causing serious health risks to humans and animals (Gil & Vilches, 2006).

This poisoning of the planet had been informed in the late fifties by Rachel Carson in her book *Silent Spring*, which had plentiful and verified evidence of the harmful effects of DDT component (Dichloro Diphenyl Trichloroethane), which led her to be criticized by scientists and politicians. However, just ten years later it was recognized that DDT was really a dangerous poison and its use was prohibited, although several countries kept using it (Gil & Vilches, 2006). This is just one of the many situations related to pollution, which has occurred throughout the history of humankind. For Professor Fernández del Moral (Moreno, 2002),

the most critical time that has occurred as a result of the application of a scientific breakthrough was the explosion of the first atomic bomb on the Japanese city of Hiroshima, in August 1945.

In instances such as these the relationship between society and scientific advances would had become very noticeable. Through them it also became apparent how the media put the scope of scientific knowledge within reach of the communities (Moreno, 2002). Society requires to know in which lines of research work is being done to exert some control over scientific and technological developments and to accept or reject certain results. In that area, the year 1986 the Chernobyl accident released a global media scene, because the real-time coverage of the local impacts certainly generated in other countries an awareness about techno-scientific risks (Sanz, 2011).

As can be deduced from these examples, there are differences related to each community and its reality. In developed countries, the relationship between science, technology and society has contemplated and included the dimension of social control and legitimation of the democratization of knowledge and participation. In Latin America the situation is different, due to the limited power of citizen participation in decision making and also the lack of information (Chiappe & Fazio, 2011). In many developing countries, the practice of journalism discloses scientific subjects without asking questions, even about its nature and social role (Boczkowski, 1998, interview with B. Lewenstein).

In the United States, despite being a developed country, scientific literacy would be at a low level compared to other countries. Religious factors would fulfill a fundamental role in these deficits. Although conservative Christian activists would ensure their conflict with science it is only related to the theory of evolution or stem cell research, a study by Sherkat (2011) states that this conflict goes beyond these issues.

In Chile something similar happens, since health issues such as the morning after pill, abortion or therapeutic vaccines have meant conflicts between scientists and groups who oppose the actions linked to them, which has prevented a rigorous legislation in these areas.

On the other hand, in regions occurred related situations, generally, with the geographical characteristics of the areas. Antofagasta, for example, is a mining region that needs to keep the community informed about the advantages and disadvantages of the actions of the companies in the industry. That is essential, given that the alleged 'social responsibility' of mining has sometimes led some large companies to consider that with community facilities, cultural activities and financing of all kinds, they give back and contribute to communities, compensating them -for example- for the damage inflicted to the environment.

In astronomical topics similar events have occurred related to light pollution. The official website of the Unit of Astronomy at University of Antofagasta (www.astro.uantof.cl), in 2013 made a call to participate in the International Seminar on Light Pollution, a positive literacy initiative, because the damage luminaires generate for astronomical observations are not minor. It was in this instance that the group of astronomers participating said that light pollution is a problem that affects greatly the observational astronomy in the region. This little known form of contamination comes from all kinds of urban lighting, which installed inefficiently, disperses part of its light into the sky (rather than down) and damages notoriously the operations and investigations carried out in the great astronomical observatories. All this means, also, an important energetic waste, as well as economically.

What was mentioned above is often overlooked due to ignorance, lack of information and even the fear of citizens to large enterprises. Thus far is work of journalists to report rigorously, pressure on scientists to deliver clear information (Knight, 2003) and communicate with experts professionally (Hinman, 1998).

Scientific literacy is a right of the citizens to be informed, without distinction, on scientific issues affecting their environment. This is called by Kemp (2002) as 'practical scientific literacy'; and in previous years, as 'civic literacy' by Shen (1975), which means knowing how to use science in everyday life to civic and social purposes. In this case the role of the journalist specialized in science is essential, since it is necessary a high pedagogical and analytical ability to communicate in an impartial manner and thus to educate while informing (Calvo, 1997). In society, science education, scientific literacy, along with the promotion of science, are considered fundamental, because their main goal is to help man to judge the world as objective as possible (Calvo, 1992). In addition, decision-making in all areas affecting life should be a process where a

society with scientific knowledge is part of, allowing it to properly decide and distinguish between reliable and unsubstantiated claims and those with verifiable value (Maienschein, 1998).

THE SHARED RESPONSIBILITY OF SCIENTIFIC DISCLOSURE

Science disclosure is considered an essential component of a democratic society, in the sense that it is the support of a modern economy based on technology and promotes cultural values of society (Falk, Storksdieck & Dierking, 2007). Each community with a natural scientific heritage should integrate and bring science to the culture of all citizens. This is a big challenge for scientists, educators, universities, governments of all kinds, foundations, media, cultural centers (Sánchez, 2004), students, executives, bankers, buyers and all humankind (Fernández & Angulo, 2011).

The journalist and academic from The Institute of Astrophysics of the Canary Islands, Carmen del Puerto (1999), also agrees that scientific disclosure is the task of journalists, writers, teachers, organizations or institutions concerned with culture, popular education, entertainment and industry (Banerjee, 2013).

Scientific communication would be benefited even more if there was a clearer articulation and further exploration of the relationship between those responsible for disclosing the progress of science (the communications professionals) and the generators of these developments (scientists, educators, social institutions) (Trench & Bucchi, 2010). Unfortunately, today, we live in a society where we have little interest in each other's work and, therefore, it is not uncommon for scientists, for example, to not know about the law (they are the basis of our democratic society) and lawyers, on the other hand, know little about science (Falk et al., 2007).

One of the main reasons that scientific activities disclosure has suffered has been the discrepancy between scientists and journalists (Revuelta, 1999). An image of scientists has been imposed, as highly intelligent and elite people that raises questions that would not be available to everyone (Sánchez, 2004), while journalists are seen by scientists as lax and in many cases, as ignorant in the publicity work (Moreno, 2010). In this regard, it is important to understand that the purpose of scientific disclosure goes beyond content education and training future scientists, because it must be a way to cultural mediation and a development factor for progress. It is not meat to fill the mind of the individual interim knowledge, yet to teach him the rationality of scientific approach (Calvo, 1992).

METHODOLOGY

The methodological tool used for this study is the Delphi method that, although it uses quantitative data for its analysis, it is a purely qualitative tool (Landeta, 2002).

The procedure and the implementation of the Delphi technique was the author's own adaptation, following the approach and format by Jon Landeta (2002) and Spanish researchers Camisón et al. (2009) and Baladrón and Correyero (2008). This method was chosen for its ability to structure and organize group communication, making it useful in the search for accuracy in the context of a group agreement on certain issues (Goluchowicz & Blind, 2011). Moreover, it is a tool that, being well used, gives resolution to problems through a democratic and structured approach that leverages the collective wisdom of those involved (Powell, 2002).

Among the advantages of this tool is the opportunity to select the experts according to the orientation of their investigation; its utility to specify or pick interdisciplinary information from a large set of different perspectives, variables or factors involved; a greater access and easy communication between experts and the researcher; the lack of bias, due to the anonymity of the participants; the opportunity to review examinations, due to its iterative process; the possibility of greater attention, intimacy, tranquility, anonymity for analysis; low economic cost; and approach and extension of the area under investigation (Gaitan & Piñuel, 1998).

PROCESS AND METHODOLOGICAL FUNCTIONING

Phase 1: Formulation of the problem and objectives

At this early stage the main question of this study was reviewed: What the media, scientists, social and political leaders in the Antofagasta Region of Chile say on the importance of disseminating the astronomical potential of the region for its cultural and economic development? Then were presented possible areas of discussion that should unite the questions.

Phase 2: Establishment of the Steering Group

To Landeta (2002), the Delphi methodology is flexible, allowing the applicator to act autonomously. From that principle, the researcher was the one who took care of "identify and select the precise experts, design the first questionnaire, lead all the iterative process by centralizing and coordinating responses and processing them and forwarding them to the experts to reach the final results and, finally, prepare the final report" (Camisón et al, 2009, p. 19).

Phase 3: Preparation of the questionnaire

First, pilot questionnaires were made for each different type of participants, that is, for the media, for scientists and for political and social actors. These questionnaires were initially validated by three academic foreign to this investigation. Then the first four questionnaires for Delphi method were defined, divided into subjects concerning astronomical disclosure, astronomical valuation, science in the cultural and economic development, and scientific education.

The questions were generally oriented to a descriptive answer (Baladrón & Correyero, 2008) and that made it possible to compare the views of respondents to reach the final conclusion of the study.

Each questionnaire contemplated duration of between 25 and 35 minutes. It had a letter of explanation of the Delphi technique, along with a section of instructions that explained how to respond, how to send the questionnaire, the following procedures and confidentiality of the instrument.

Phase 4: Election of experts

The experts that participate in a Delphi must be chosen according to their knowledge, skills and group views on the subject to be evaluated (Swinkels, Pottie, Tugwell, Rashid & narasiah, 2011). Under these conditions, the sample of the expert group consisted of 27 participants with ages fluctuating between 29 and 74 years old. It was considered that they had more than five years of professional experience, work positions where they had put into practice their leadership, and a residence of more than five years in the Region of Antofagasta.

Among the experts -involved anonymously- are twelve professionals of communications (editors and journalists of media), five scientists linked to astronomy, five social experts (company foundations, corporations, museums, disclosure groups or scientific programs) and five politicians, from municipalities and regional ministries of the Region of Antofagasta.

The expert members of the panel were people skilled in the function and independent of each other, which brought together the features of the desired profile for the research (Camisón et al., 2009, p. 20). Each one of them contributed to a consensus, achieved mainly from their professional knowledge (Stewart, 2001). All were invited to participate through a letter by e-mail, which, when answered and confirmed, started their participation in the methodology. Throughout all the process the anonymity of responses was assured.

Phase 5: Launch of the questionnaires

Once the experts agreed to participate in the process, the first questionnaire for Delphi was sent online via Google Drive. Experts had fifteen days to answer it.

Phase 6: Development of the iterative and fed back process

After receiving the answers from the first questionnaire, analysis of the answers and develop of the second questionnaire was conducted, which contained –anonymously- some of the most outstanding views that emerged in the first questionnaire. All these opinions were sent to the participants, transformed in closed questions that allowed generating feedback between them.

The second round of questionnaires, unlike the first, was quantitative in nature. It was implemented using scoring techniques (Jairath & Weinstein, 1994) only for an order and better understanding of the results, since the results are qualitative.

This second questionnaire stuck to the same model to all participants and consisted of twenty-five closed questions and two open questions, divided into three items. Together, these questions represented the general topics of astronomy disclosure, astronomical valuation, science in the cultural and economic development and science education (some questions were quotes from the answers raised by the respondents themselves in the first questionnaire).

The approximate time to answer the second questionnaire was thirty-five minutes and its evaluation was performed with a Likert scale of 1 to 5, 1 being strongly disagree, 2 disagree, 3 neither agree nor disagree, 4 agree and 5 strongly agree. That is why its

analysis is categorized as median, mean and standard deviation for a better understanding. The mean was calculated as the average of each response, adding all the individual data and dividing it by the number of sample data; the median was obtained as a core value of a frequency distribution; and the standard deviation was measured to know the expected variation from the average.

In short, the process of the Delphi technique had an average duration of six months and based on two questionnaires, which were the means of communication among experts and between these and the director of research.

From the analysis of both questionnaires, the results and final conclusions emerged inductively.

RESULTS

ANTOFAGASTA'S ASTRONOMICAL LITERACY IS DEFICIENT

On the relationship the media in the Region of Antofagasta would have with the disclosure and scientific literacy in the area, all respondents agree that it would be a poor relationship and of regular quality. This would be due to the lack of rigor of the media when addressing science and, therefore, the remoteness of scientists to such media. In this regard, the communications expert no.12 states "the relationship between the media and the scientific disclosure undermines the knowledge of people themselves about the area with many natural conditions where they reside".

For all experts, citizenship is not updated, familiar or knowledgeable on issues of astronomical heritage, and the primary cause would be the low concern of those responsible for promoting the astronomical heritage in the community.

In the responses to questionnaires it was mentioned, as the main result of low literacy, the problems generated by the presence of pseudoscience in some Chilean families and that has been produced not only by ignorance, but by the lack of rigor with which the media deals with science. This feature, linked to the lack of motivation and inadequate information about science given at home, is listed as one of the causes of low interest in entering scientific careers. It is also proof that scientific literacy reaches only some households, those in which there is a formal science education or a real awareness about science and technology.

THE RELATIONSHIP BETWEEN JOURNALISTS AND SCIENTISTS IS DISTANT

From the responses to questionnaires it was possible to infer that academics and scientists from the Region of Antofagasta have an almost non-existent relationship with the media of the region, but both sectors believe that it can be improved through instances of approach to strengthen ties such as interactive seminars and professional specialization of journalists in science. On this regard, the communications expert no.1 exhibited in the first Delphi questionnaire that "the assessment should not come from the media, since are the same scientific organizations that should open their doors and promote their discoveries."

Both, scientists' experts and communication experts agree that improving relations between the two groups is a shared responsibility, with possible solutions, in the sense that scientists should improve their narrative to bring science to education and, on the other hand, journalists should be interested and specialize in astronomical topics.

As for the need for journalists to train in science and technology, all communication experts consider important scientific specialization for the media in the Region of Antofagasta. In addition, they argue that this would optimize their work time, improve the quality of scientific information and the transmission and reception of messages. They also point out that scientists, for their part, should play a motivational role in the school area, have a closer approach to reporters, use a familiar language and link Antofagasta`s community to astronomy. That is, an academic and informative work that, so far, is incipient.

The language was an important edge to the experts too, and in both Delphi questionnaires, they show the need for both, journalists and scientists, to be fluent in English and Castilian languages for better communication that will benefit the science disclosure.

ASTRONOMICAL DISCLOSURE HAS DIFFERENT ROLES

By confronting the opinions of the respondents, it is possible to interpret and confirm that, for them, scientists and academics from the region of Antofagasta should disclose their knowledge in a simple language, close to the community, and linked to education to generate a greater valuation of astronomy. It also raises the need

for science professionals to publicize the importance of the presence of observatories in the region, encourage scientific vocations among young people, to share their research and develop educational activities in schools.

On this last point, the social expert no.20 stands out as essential for scientists in the Region of Antofagasta to be linked to education, since "at present they continue to develop their work within four walls."

On the other hand, according to those interviewed, the participation of agencies working with science and technology in the region of Antofagasta would be limited to creating events, projects and professional relationships from his business interests. According to experts, these institutions should favor astrotourism projects, create local scientific events, provide forums for scientific activities, integrate astronomy to their regular programming and create competitive funds for the implementation of astronomical education material in order to make the disclosure of science more egalitarian to school level.

The work of politicians in the region of Antofagasta in the assessment of regional astronomy would have to do with financial, discursive and legislative contributions. For social expert no.22, "politicians should be the promoters and fighters in the National Congress and in the Executive, along with the northern forces, to secure the necessary resources that this region deserves."

However, three communication experts consider unnecessary for political leaders to have some participation in the generation of a greater appreciation of the astronomical potential in the region.

ASTRONOMY SHOULD BE DISCLOSED IN THE CONTEXT OF REGIONAL IDENTIFICATION

Experts interviewed agree that mining is a key factor to promote economic development in the region of Antofagasta. However, they also agree with the phrase cited by the scientific expert no.17 in the first Delphi questionnaire, when he states "the media always identify Antofagasta as the mining capital of Chile. That statement should be break, adding astronomy as part of the regional identification."

In this sense, it is possible to say that experts are aware of the need to recognize astronomy as an important part of identity and agree that it is a key factor to promoting economic development in the region of Antofagasta.

For the respondents, the link of astronomy with indigenous peoples in northern Chile would bring the community closer to its roots and would help them better understand the importance of this activity in the city. Thus, the political expert no.23 considers that "our Andean culture always valued Mother Nature; in a way, astronomy does the same; then there is a meeting between our roots and science today."

CONCLUSIONS

In this analysis it was possible to interpret that the current state of scientific literacy for cultural and economic development of Antofagasta it is characterized by a lack of knowledge about the economic potential that astronomy delivers to the region. Such ignorance is because the central interests for regional economic development have been in mining.

As Polino and Chiappe (2011) pose, developing countries have a deep economic, social and cultural segregation. A reflect of this, according to the results of this research, it is the existing centralism in Chile, which hurts regional outreach and scientific literacy. This is accompanied by educational differences in the public that receives information related to astronomy, resulting in large disparities in scientific literacy.

Astronomical literacy in Antofagasta is associated with a complex picture, because -like the issues raised by Moreno (2010)- the distance between scientists and journalists undermines the disclosure, which is related, on the one hand, to the lack of journalistic specialization, the lack of rigor and the media disinterest in disclosing these issues; and secondly, such distance is also due to the lack of disclosure of their work by the scientists themselves, in terms consistent with the cultural reality of the region. This situation brings the existence of an uninformed and indifferent public, leading to an uprooting of the population to an essential aspect to the region, as is his wealth in astronomical terms. Even in Antofagasta's community there is no knowledge or interest in regional astronomy. This situation coincides with what was planned by Bauer (2009), when he notes that, today, people would not provide much support for science, which would be a concern for scientific institutions.

Journalistic construction of science has been losing rigor, but gaining in expository, discursive and narrative resorurces (Moreno, 2010). However, and coinciding with Scherzler (2009), in Antofagasta there is a need to improve this relationship, although journalists appear more willing than scientists for that to happen.

It was possible to conclude, too, that one result of the deficiency in scientific literacy in the region has been the absence of astrotourism, which is directly related to political disinformation on regional astronomical significance. This coincides with the point made by Polino and Chiappe (2011) on the importance of political participation in science.

Another point highlighted by the research is the importance of the existence of bilingual journalists for astronomical outreach and the achievement of a fruitful scientific literacy. Undoubtedly, the knowledge of a language other than Castilian favors the relationship between disclosure and astronomical literacy, since between the astronomers are numerous foreigners. Much of the scientific information is in English, French, German or Italian.

Moreover, on the importance of disseminating the astronomical potential of Antofagasta, it is possible to conclude that the media in the region should specialize in science, modernize its infrastructure, address astronomy based on the regional identity, not to saturate the economic sphere with mining mentality, as has been the case until now, and encourage the creation of astrotourism. All this related to the approach of Lewenstein in an interview with Boczkowski (1998), when he says that the media has a great role in science.

Scientists are also vital in disclosing astronomy, but are often inaccessible in sharing their knowledge. In addition, often they lack the communication understanding, so they do not appreciate the role of journalists or manage to convey information closely. In this regard, they should exert a motivational role with students, develop closer approach to reporters, using a familiar language and link Antofagasta's community to astronomy.

The social leaders, even though they develop an acceptable job, must fight even more for public spaces dedicated to science and education. They can make their greatest contribution in the field of financing scientific projects, along with the incentive to the community through educational spaces, like workshops, exhibitions, lectures and others. While they do a positive work in their own field, they have yet to expand to the area of education.

It was possible to conclude, also, that the assessment of the astronomical potential in political discourse is essential to include this science in Chile and the world. In this regard, politicians must play a role in financial and legislative matters, for which they need to be accountable in financing projects and spaces that exalt regional astronomy, reaffirm the importance of astronomy in their speech, legislate for decisions related to science not to be centralized and to fight for the Ministry of Education to include astronomy, with much greater force, in national classes. It is fulfilled what Sanchez (2004) says, since scientific disclosure is a shared responsibility and each expert has a role to play.

Another important and emerging issue in research is the need to disclosure astronomy from the perspective of the Andean culture, which, undoubtedly, would achieve greater closeness between this science and Antofagasta's public. The ability to relate indigenous people with science has not been visualized yet, which opens a door to projects and studies on status of indigenous sectors of the region.

Among the benefits that would bring a good evaluation and dissemination of astronomy in Antofagasta, would be, mainly, an enhanced relationship between scientists and journalists, which would allow the creation of innovative media that would help the use of dynamic tools and community spaces and the increase of the interest in astronomy among the inhabitants of the area. In addition, a gateway to astrotourism and large employment opportunities would be opened.

FOOTNOTES

1. Field interview by Marcelo Lufin, Phd in economics from the Catholic University of the North, January 18, 2012, Antofagasta, Chile.

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