



## Development of a georeferenced system for the management, mobility and monitoring of primary care in community health

### Desarrollo de un sistema georreferenciado para la gestión, movilidad y monitoreo de atención primaria de la salud comunitaria

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**ABSTRACT** Community health agents carry out significant actions on the ground to provide prevention and care and bring health services to families. These practices in the field constitute a constant collective mapping process using the knowledge of the territory that the agents possess. Based on intensive fieldwork starting in 2012 in conjunction with local social organizations and health institutions in Brazil and Argentina, the binational project App+Health (*App+Salud* in Spanish and *App+Saúde* in Portuguese) was initiated. The project's objective was to develop a monitoring and georeferencing system for community health management in the form of an application for cell phones or tablets with internet access, which would take into account the basic conditions of the environment and movement history of users and connect map updating methodologies using social cartography with free collaborative mapping platforms. As a result, the beta version of App+Health was developed, through a heightened process of exchange of interdisciplinary knowledge.

**KEY WORDS** Community Health Services; Geographic Information Systems; Technological Development; Argentina; Brazil.

**RESUMEN** Los agentes de salud comunitaria en terreno practican acciones de fuerte impronta territorial, tanto en relación con prevención y asistencia, como a partir de un acercamiento de los servicios de salud a las familias. Estas prácticas en terreno, construyen un permanente mapeo colectivo basado en el conocimiento que los agentes poseen del territorio de actuación. A partir de un intenso trabajo de campo iniciado en el año 2012, en conjunto con organizaciones sociales locales e instituciones de salud de Brasil y Argentina, se inició el proyecto binacional App+Salud, que tiene como objetivo el desarrollo de un sistema de monitoreo y georreferencia para la gestión de la salud comunitaria, en formato de aplicación, para celular o tablet y acceso web, que considere la condiciones básicas, de ambiente y movilidad histórica de los usuarios, y que vincule metodologías de actualización cartográfica a partir de cartografía social con plataformas de mapeos colaborativos libres. Como resultado, se ha obtenido el desarrollo del sistema App+Salud, en nivel beta, para lo cual se profundizó en un trabajo de intercambio de saberes interdisciplinarios.

**PALABRAS CLAVES** Servicios de Salud Comunitaria; Sistemas de Información Geográfica; Desarrollo Tecnológico; Argentina; Brasil.

## INTRODUCTION

In 2012, the Action, Territory and Geography Research Group (GIGAT) [*Grupo de Investigación Geografía, Acción y Territorio*] within the Institute of Geographic Research from Patagonia (IGEOPAT) [*Instituto de Investigaciones Geográficas de la Patagonia*] of the Universidad Nacional de la Patagonia San Juan Bosco began to work along with the staff of the Associate's Degree in Community Health, in the province of Chubut, to collaborate with students and graduates in two different processes: (a) the analysis of health accessibility practices in rural areas; and (b) the development of collective methodologies to aid the community health workers in their practice on the ground.

The practice of community health workers give rise to actions of territorial anchoring, which may be classified into health promotion and prevention, collection of relevant sociosanitary data, implementation of governmental programs as well as national or provincial plans at the community level, and strengthening of bonds with the population located near the primary health care centers in their area of influence<sup>(1)</sup>; all these actions aim to improve people's health through the access and fair provision of health care services, based on the basic human right to have access to integrated healthcare protection.<sup>(2)</sup>

As part of the actions of sociosanitary data collection, community health workers perform their daily tasks by regularly visiting families under a certain social and public health program. These systematic visits to the family, known as rounds, provide the healthcare system with information related to the environment, to the individuals-of each household. The data is currently collected using paper documentation, so the level and possibility of systematization and data-crossing is very low. This situation limits the analysis and use of information when outlining interventions that intend to change the health

care services provided to the affected population.

Therefore, the GIGAT began the project with the idea of holding social cartography workshops using the methodology adopted by our group since 2011.<sup>(3,4)</sup> These workshops were aimed at community health workers in several localities in the province of Chubut, where different methodological protocols were developed in order to address problems such as accessibility, daily practices, and territorial surveys, among others.

These social cartography workshops exposed the need to revise the current practices regarding the use of the data after its collection and its potential systematization and reutilization in a historical context of monitoring for every family and/or individual. The revision of practices included the analysis of the procedure of visits, together with the mapping used by community health technicians, the procedure of rounds and the systems to collect data (known as *family forms*.) Thus, in 2013, a database was developed, linked to a system of georeferenced information that helped to transfer the data from paper documentation to a digital and georeferenced format.

After developing the database, along with the Laboratório de Urbanismo (LABurb) and the Faculdade de Arquitetura de la Universidade Federal de Pelotas (UFPel) in Brazil, we began to conceive the first steps to integrate these solutions into the collection of data and the systematization and integration of methodologies into a complex and georeferenced system that may facilitate the work of community health workers and help the faster management of data, link and make complex visualizations and also recover the social territorial fabric.

The system was named, by both research groups, *App + Health (App + Saúde*, in Portuguese) and is currently in a trial and development stage, available in two versions: *smartphone application* (for Android users) and *web-based*, open to

the public for trial (<http://www.appsalud.unp.edu.ar>)

The objective of this development is to create a monitoring georeferenced system that organizes the local sociosanitary information, divided into family and individual units, and that, at the same time, facilitates an integral analysis including the particular features of the territory where these families and individuals live.

The system is organized in three major structures: (a) a georeferenced monitoring system that organizes the public health information of the territory and facilitates access to the status, prevention and forecast of events; (b) a smartphone application, restricted to health workers, and a webpage open to the community, to improve geographic data for monitoring purposes; and (c) a methodological protocol to translate social cartography information that includes social, cultural, temporary and relevant elements in general mappings (such as garbage dumps, state of watercourses, recurring presence of smoke, and so on).

In order to develop the application, currently in the trial stage, different aspects were analyzed: practices, methodologies and working instruments on the ground of community health workers, the particular features of health access in rural and vulnerable urban areas, and the types of mapping developed by health workers.

This article intends to account for the process addressed (but not completed yet) by a multidisciplinary group of geographers, physicians, architects, health community technicians, computer programmers, social communicators and students, among others. The conclusions and results are partial, given the nature of the process of creating a continuous project, and the approaches based on aspects of phenomenology and cartography which we adopted.<sup>(5,6)</sup>

## Initial approach, experiences and development

Our experience on the ground, through community health practice, promotes dialogue as a producer of knowledge that leads to multiple territories and particular features as ingredients for new practices in our daily work. In that sense, the argument presented here is on the basis that there is not “only one territory” to approach, but, as a construction, the territory is multiple, varied and heterogeneous, having social and local characteristics that make it complex<sup>(7)</sup> when trying to homogenize representations.<sup>(8)</sup>

Initially, we focused on the perspective of experience as a method, in which space is expressed as a learning experience and, at the same time, as a social collectivized product. We use the term collectivized since we understand that the experiential perspective focuses on a reality known from experience, that is to say, from the union of thought and feeling, as stated by Yi-Fu Tuan,<sup>(9)</sup> and we also regard the social subject and social object as connected in that union. Therefore, as Kastrup says, the process of shared and mobile experience among participants of the research and production process blends.<sup>(10)</sup> This is, in itself, a process of experience that places both the researcher and the object of the social research study in a common ground. At this level, experience is the unifying process that encourages the dialogue and exchange of information by which both researcher and the subject being researched (normally, the object under study) share elements of experience. Therefore, an enrichment of the knowledge of experienced reality arises, from the dialogue of heterogeneous subjects that share common events through different subjectivities.<sup>(9)</sup>

In the practice of community health-care workers, space evidences as a communal work that is constantly under

construction, where the collective work of public health care regarding the different realities of every household, family, neighborhood and locality enhances new possibilities of intervention and approach. The many singularities (environmental, social or relational) that identify these spaces of intervention, when made to interact, immediately turn into a feasible scenario to be addressed through different methods and disciplines that also interact but that, at the same time, regard the territory as a narrative.<sup>(11)</sup>

As for the development of the App+Health project, we must mention two articles that discuss the notions of place, space and program. In the first place, Breilh's article,<sup>(12)</sup> which suggests the possibility of adopting an emancipatory approach of the health issues in the territory, with the purpose of "overcoming the typical restrictions on the urban space theory and the reductionist conceptions about health and environment, in order to encounter the collective need."<sup>(12)</sup> Thus, Breilh highlights the need of an approach that may include the historical process of social space as part of the construction of multiple singularities that altogether make "collective ways of living." The author, therefore, emphasizes the relationship between critical epidemiology and critical geography as an alternative to approach a point of view beyond the empirical reductionist perspective of *place*, fixed from the Euclidean idea of "space as receptacle." Following this idea, Breilh states that there is no urban space of health that is static, restrained and passive; the space is always complex and mobile.<sup>(12)</sup> From this perspective, we agree on the possibility of approaching – both from social cartography and the development of interactive technological applications that recover the social and environmental fabric – tools that facilitate the process of systematization and comprehensive management of the territorial information,

with the perspective of an integrated transformation of the community.

In the second place, Spinelli's article<sup>(13)</sup> mentions that the territory encourages the articulation of new questions; therefore, in the practice on the ground, "Confronting that which was not contemplated, and accepting the shattering of certainty, allows for the asking of questions and avoids the common roads of naturalizing, complaining, and anecdotal storytelling."<sup>(13)</sup> This way, Spinelli delves into concepts of critical geography and Milton Santos' theory that depicts the territory as an unfinished element and as a kaleidoscope that, at a micro level, becomes complex. Spinelli also contextualizes the territory based on the rhizome model suggested by Deleuz, and therefore states that:

...In this process of mapping there are no protocols possible as the practice is resolutely micropolitical and singular. In this light, the only overruling imperative is to intervene, to play, to trigger processes without certainties, faithful to the desire and the risks that are generated, attempting to make actions into a bridge between potency and power.<sup>(13)</sup>

Following this idea, we planned the design of our methodology of work and development of an application, which is based on the community health worker's work of creating participatory forms, the micro-cartography of surveys of healthcare centers and social cartography workshops, exclusively based on phenomenology. Therefore, we completely agree with Spinelli's theory when he states:

...It is necessary to understand that there is no method or technique with which to intervene in the social game of the territory. This text expresses the effort to escape rationalist models that dominate the ways of working with and thinking about the social, so as to move on to dynamics marked by the game, the

becoming and the uncertainty that are inherent to the social.<sup>(13)</sup>

As for georeferencing, there are multiple works that may be mentioned, both in Argentina and other countries. One of the latest works by Buzai, "Space Analysis in Health Geography"<sup>(14)</sup> [*Análisis espacial en Geografía de la Salud*] provides a wide variety of tools and procedures for processing and analyzing health information, from an analytical territorial approach. Other works, such as Barcellos *et al.*<sup>(15)</sup> and Hino *et al.*<sup>(16)</sup> exemplify the possibilities of applying techniques of geoprocessing and methods of study with an analytical approach. Nevertheless, the works by Muller, Cubas and Bastos<sup>(17)</sup> and Da Fonseca<sup>(18)</sup> emphasize the creation of a methodology that should take into account the knowledge of community health workers in the production of schemes of analysis itself.

The project App+Health may be framed within the practice defined by the World Health Organization (WHO) as mHealth (abbreviation for *mobile health*), which includes all the development initiatives regarding mobile devices for the management, geoprocessing, control, communication and monitoring of cases and exchanges of health information. Within this area, one project that stands out is Commcare,<sup>(19)</sup> currently in use in South Africa by several NGOs, international organizations and local governments.<sup>(20,21,22)</sup>

The creation of App+Health cannot be simply explained as the development of a software application to address the process of systematization and georeferencing. It is in itself a process of involved experience, shared by different subjects, places, practices and professions. Basically, from a Deleuzian perspective, it is the difference between dialogue and its resistance forces that gives rise to new elements, from its own complexity, intrinsically rich, and a multiplicity perspective.<sup>(23)</sup>

## METHODS AND FIRST EXPERIENCES IN RURAL AREAS

### Social cartography and GIS, with community health workers in Argentina

In 2013, based on the work between the GIGAT, the staff of the Associate's Degree in Community Health and on the social cartography workshops carried out – where the video *Essays about Social Cartography*<sup>(24)</sup> [*Ensayos de Cartografía Social en Patagonia*] was filmed – a research and intervention protocol was developed, which studied the localities of Alto Rio Senguer and Aldea Beleiro (Province of Chubut, Argentina). This work protocol,<sup>(25)</sup> which lasted one week in each locality, was created entirely with relevant local and referential figures from the province, and it focused on the question "What are the local strategies of population and of health workers to guarantee general access to health care?" In this sense, the experience of community health workers was prioritized, given the close relationship with the local population and their daily work.

The methodology of work was organized from a research protocol, as detailed in Chanampa *et al.*,<sup>(26)</sup> and divided into two great domains:

- a. Investigation of the local public health practices and the relationship between primary health care and the community, based on social cartography workshops, for the analysis of health care accessibility, strategies of mobility, and possibilities or difficulties regarding access to health care.
- b. Georeferencing processing of families aided by community health workers, where the information collected in the *family forms* was systematized.

For domain "a," a five-day work protocol was designed, which consisted in visiting the families of the mentioned localities in the company of community health workers. Interviews with referential figures were prepared and, along with local health workers, a social cartography workshop was planned, aimed at

the analysis of health care accessibility.<sup>(13)</sup> The workshop was primarily focused on aspects such as accessibility and strategies, causes to request medical attention and location of health centers, access possibilities or difficulties, and transportation, based on the strategies of the local population to access health care.

This first domain included seven semi-structured interviews, conducted between 2012 and 2015, with health care referential figures at national, provincial and local level, and with community health workers; four social cartography workshops (including about 25 participants divided into groups of five people)

held between 2013 and 2015 in Comodoro Rivadavia, Aldea Beileiro, Rio Senguier (Argentina), and Pelotas (Brazil), with the participation of health workers and families that they summoned; and two workshops to discuss the practice of family-visiting: one at Comodoro Rivadavia, in the Administration of the South Programmatic Area in 2014, and one in Pelotas in the Administration of Regional Health within the district in 2015, both with the participation of ten community health referential figures.

For domain “b,” the methodology was focused on the design of a database within a system of georeferenced

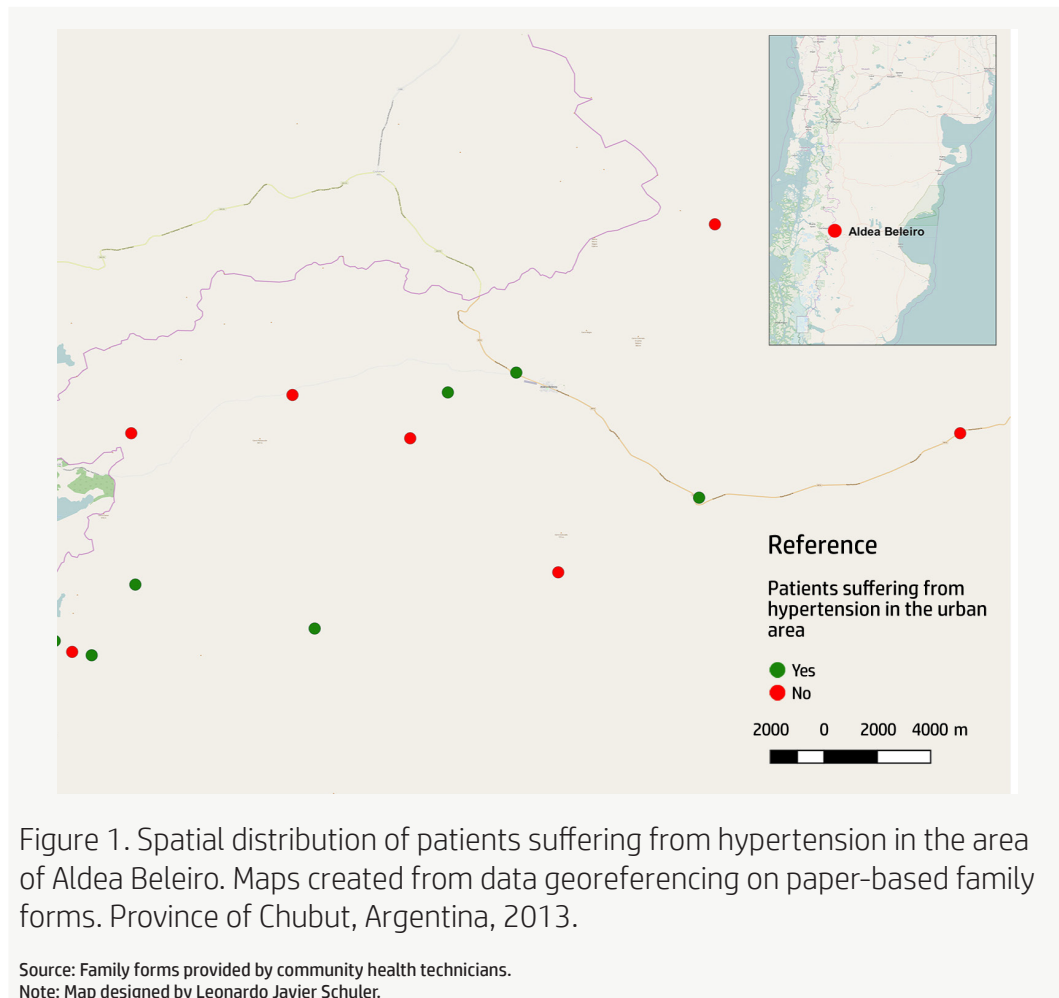


Figure 1. Spatial distribution of patients suffering from hypertension in the area of Aldea Beileiro. Maps created from data georeferencing on paper-based family forms. Province of Chubut, Argentina, 2013.

Source: Family forms provided by community health technicians.  
Note: Map designed by Leonardo Javier Schuler.

information, using a free-license QGIS program, in order to copy the *family forms* and to later systematize and cross the information. The process of georeferencing *family forms* was carried out with the aid of a satellite image, a topographic map from Argentina's National Geographic Institute and the visual recognition by a health worker, a so-called *baqueano* [a road expert] and an ambulance driver.

The georeferencing of *family forms* gave as a result the maps in Figures 1 and 2, as a pilot sampling of the work carried out, for the purpose of evaluating the benefits of

Finally, the work done in Social Cartography workshops was systematized into tables showing results, which facilitated a critical analysis of health care accessibility in rural areas. This social mapping became the first translation of the process of constructing Social

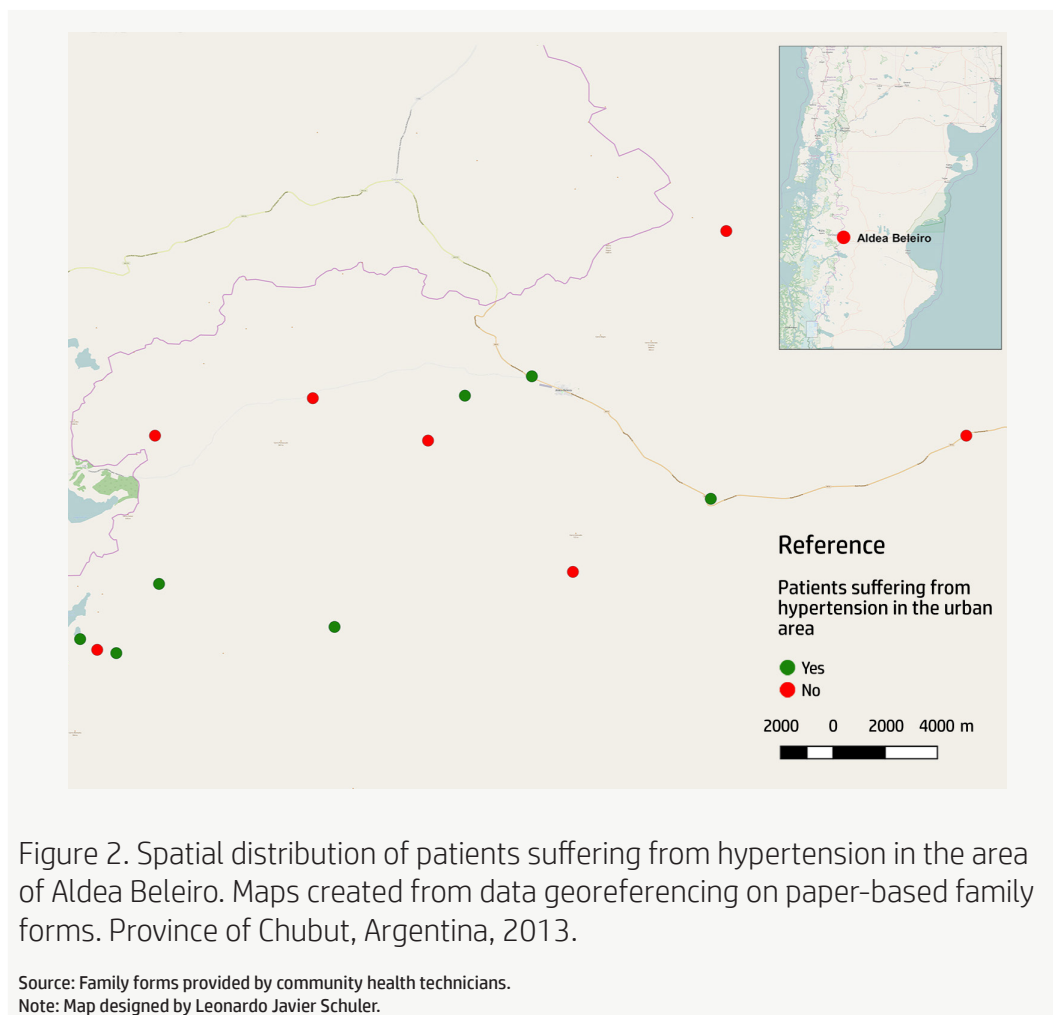


Table 1. Contribution of social cartography, the systematization and georeferencing of information, and the understanding of methodologies to the development of App+Health.

Contribution of social cartography	Contribution of data systematization and georeferencing
<ul style="list-style-type: none"> <li>▪ Recovery of the spatial social fabric, based on the problems and strategies developed by the local population.</li> <li>▪ Possibility of a local dialogue about health issues, with a territorial, intergenerational and network-based approach.</li> <li>▪ Comparison of strategies in different time periods that promote the intergenerational dialogue (birth practices and spaces where they took place, for example.)</li> <li>▪ Redesign of territorial limits, borders and centers, based on social practices.</li> <li>▪ Dialogue about the shapes and contents of space, based on new collective mappings.</li> <li>▪ Addition of new contents into formal methodologies (such as inaccessible areas due to snow, rivers covering paths in certain times of the year, and so on.)</li> <li>▪ Drawing of new projection maps and social-scale maps.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Digitization of data currently available only on paper</li> <li>▪ Possibility of handling, linking, relating, crossing and analyzing data to create new information.</li> <li>▪ Translation of paper maps and charts to GIS with the assistance of baqueanos [road experts]<sup>(27)</sup>.</li> <li>▪ Georeferencing of data and unification of storage devices and visualization, as contributors of the management of community health on the ground.</li> <li>▪ Possibility of overlapping public health and geographic data to analyze local and regional problems.</li> <li>▪ Possibility of making historical and systematic monitoring.</li> <li>▪ The training of health workers to handle GIS and address potential differences on the criteria of use in each locality was considered an obstacle.</li> </ul>
Contributions after uniting methodologies	
<ul style="list-style-type: none"> <li>▪ Update of base maps, specially through the platform <a href="https://www.openstreetmap.org">https://www.openstreetmap.org</a></li> <li>▪ Addition of data collected from Social Cartography in the platform <a href="https://www.openstreetmap.org">https://www.openstreetmap.org</a> as base map (informal garbage dumps, swelling of temporary streams, polluted areas, among others).</li> <li>▪ Creation of a shape with the data collected in the family form.</li> <li>▪ Overlapping of layers and comprehensive analysis of the information obtained from both methodological processes.</li> </ul>	
Source: : Project App+Health	

Cartography and its development to visualize the mapping results shown by the QGIS program.

The development of a series of maps made it possible to add information based on knowledge from the local social experience of spatial objects (garbage dumps, fords, flooded areas, and so on) on the open, collaborative platform *openstreet-maps*. The addition of data was of great importance for sharing the geographic information within the community, and to come up with critical approaches to assist the local community.

The process explained so far accounts for the contributions to the development of App+Health, whose results are summarized in Table 1.

### Raising awareness and deepening of experiences in the fieldwork toward the development of App + Health

After completing the process outlined above, participants from LabUrb, from the Universidade Federal de Pelotas, a new stage of sharing their experiences began, which gave rise to a binational project that received financial aid from the Conselho Nacional de Desenvolvimento Científico e Tecnológico of Brazil, in 2014, and from the Secretary of University Policies of Argentina in 2015. Then, a research-intervention work through sensitization workshops began, with community health workers and civil servants (within the Ministry of Health of the Province of Chubut, and the locality of Comodoro Rivadavia in Argentina, and within the Ministerio da



Saúde of the State of Rio Grande do Sul and the prefecture of Pelotas, in Brazil). This work had two purposes: (a) to test and socialize the current system of family visits and data collection with research groups in both Argentina and Brazil; and (b) to set up the criteria for translating paper-based data into digital and georeferenced information so as to avoid missing the social fabric of the information.

Two different workshops were held in Argentina, one at Comodoro Rivadavia and the other at Rio Mayo, about auto-analysis of working practices on the ground, with the participation of fifteen community health workers on the ground and civil servants from the province. These workshops were organized with the participation of researchers and students from Argentina and Brazil, and the following critical results were obtained: (a) overlapping of social workers on family visits, with duplicated information; (b) criticisms and suggestions to the structure of *family forms* (the main tool used by community health workers for recording and collecting regular data); and (c) analysis of the different georeferencing and mapping models used by health workers.

Regarding the *overlapping of social workers*, this result was obtained after the creation of a *sociodrama*<sup>(28)</sup> that consisted in simulations of *family visits*, where social workers use *family forms* and define multiple social relationships with the visited families, which gives place to the practice of social intervention.<sup>(29)</sup> *Family forms*, as monitoring “objects,” are structured into another instrument that becomes occasionally useless in a context in which the symbolic meaning of social health practices are registered and monitored through different means. We therefore agree with Carballada’s position regarding the practice of intervention:

...the influence of medical and biological thinking also leads social intervention to normalizing, moralizing, punitive and pedagogical practices that go against

the historical social aspects that cross the process of social intervention, and especially, the demand. Thus, the idea of social intervention as a protocol entails a dialogue covering different perspectives of visibility, enunciation, lines of power and, especially, ways of creating subjectivity related to social intervention. A way of approaching this issue may be from the perspective of linguistics and the theory of construction of subjectivity.<sup>(30)</sup> [Own translation]

*Sociodrama* was conceived as a way to know and experience *practice* as a content with which it is possible not only to simulate visits and represent its complexities, but also to create a scenario of intervention that may be adapted to the development of App+ Health (an online adaptation that includes approaching methods in which normalization does not eclipse the social aspects affecting social intervention.)

Regarding the *criticisms and suggestions to the structure of family forms*, the interviews on the ground with supervisors and community health workers that participated actively in different changes of *family forms* in the last few years led to the revision of the different *family forms* used as tools for the historical collection of sociosanitary variables. These variables were considered valuable to be studied on the ground and regarded as an essential resource for the practice of community work. Given their historicity, these *family forms* were gradually modified to include variables as the perception and framing of health issues and approaching priorities changed. As a response to the need of sorting out stacked data and a uniform management, the Administration of Promotion and Prevention, within the province of Chubut, published the Provincial Standards of Labor on the ground to regulate different aspects of the field work, including the contents in the *family form*, which became generically referred to as “F1”, a mandatory reference for its analysis. The

2015 version of that form was the object that the GIGAT along with LabUrb, community health workers and authorities within the Ministry of Health validated in connection with a series of variables with the same content as in “F1” forms, but occasionally recategorized, in order to adapt them to the future digital version for mobile devices. Within the restructuring of the form, the relevance and benefits of repetitive and redundant variables were analyzed. As a result, *family forms* were refined in order to advance toward a digitized format.

After these participation works, at an awareness raising, revision and comparison stage the *local mappings* drawn by the community health workers on the ground were investigated, both in rural sanitary facilities and district health centers. In every health center and/or facility visited, we found different and original types of maps used to make a collective georeferencing of the families that were assisted in the area. Those maps, which are part of the photographic archive of the binational research group, were analyzed and compared to identify

the recurrence and differences in its existence. As a distinctive feature, maps are usually drawn by hand (Figure 3), sometimes by copying cadastral maps and including relevant local references such as rivers, garbage dumps, and difficult-to-reach areas, among others. At the same time, maps have the reference of family houses – usually with a unique identifying number – and the specific elements that define them (color of the walls, name or nickname of any of the habitants, the phrase “neighbor of” and so forth). Through the identification number, each map is linked to the data on a *family form*, although this information is generally for internal use, limited to health workers and occasionally to a restricted work group.

This stage of awareness raising was essential to start the work along with the Information Technology programmer of LabUrb, who had to undertake a complex task of “translating” the results obtained so far and the demands by community health workers for the base development of App+ Health.



Figure 3. Typical map drawn in a rural health facility, linked to Family Forms. Province of Chubut, Argentina, 2014.

Photo: Juan Manuel Diez Tetamanti.

## Structuring and adaptation of data collection forms

The initial development of App+Health required three meetings between the teams from Argentina and Brazil along with the Information Technology programmer. As a previous step before designing the basic structure of App+Health, the forms used by health workers were analyzed in the province of Chubut as well as in the locality of Comodoro Rivadavia, the prefecture of Pelotas and the State of Río Grande do Sul. In order to integrate the different forms, LabUrb also had to organize meetings and interviews with governmental departments, program leaders and directors of the area of health from the prefecture of Pelotas and the state of Río Grande do Sul, with a methodology similar to the one applied in Argentina but with the idea of importing the proposal originally formulated in Chubut.

After the analysis of the types of forms used in Argentina (family forms) and Brazil (Sistema Único de Saúde - Atenção Básica, Programa Nacional de Controle da Dengue, Programa de Controle da Doença de Chagas, and municipal programs) a table was created, including the contents of the forms and its singularities, and possible types of integration and structuring. After that, a first scheme was designed, containing 210 questions on different topics such as *environment, household, social programs and personal, and family aspects*. This first scheme included the singularities of the inquiries made by the work group both in Argentina and Brazil, therefore merging the types of forms recently mentioned into one single questionnaire.

## RESULTS

### Development of the App+Health (App+Saúde) and incorporation of openstreetmaps

After designing the first scheme of 210 questions, a new stage began to refine and simplify the questionnaire. In this stage, *critical workshops*<sup>(31)</sup> were held with community health workers in Argentina and Brazil so as to improve the quality of the questionnaire.

The result of this cleansing stage was a new scheme of 177 questions that included all the thematic aspects from the different sheets and forms and the georeferencing of every set of information from the input of a "household visit," which is the task of every community health worker consisting in accessing the designated household. Due to the adaptation of the many forms included in the binational interrelation of its genesis, the App+Health is designed to register a household visit, from which a healthcare worker can input data, environmental aspects and a list of individuals living in the house. Equally, for each gender or age group there is a set of different questions referring to the particularity of the input of each new individual. This way, there are, for example, questions intended for pregnant women that are different from those intended for non-pregnant women. Nevertheless, this type of data is stored in the "historical background" of the individual, serving as original information.

The information introduced in the application is synchronized with the web server and, then, from a browser it is possible to cross different data to analyze the correlation between information and its georeferenced position. Consequently,

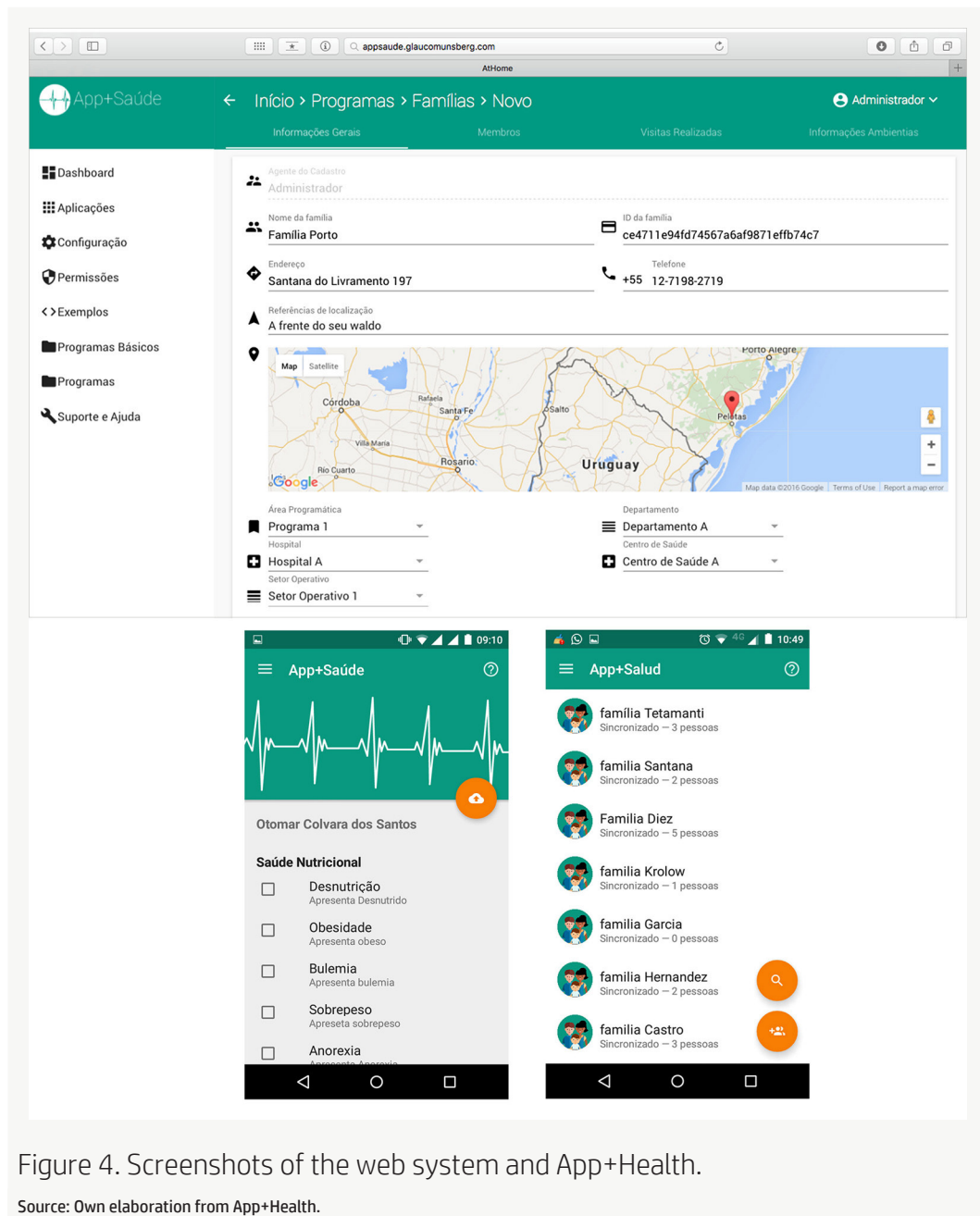


Figure 4. Screenshots of the web system and App+Health.

Source: Own elaboration from App+Health.

we can analyze, for instance, the existence of a recurrent disease in a certain geographic area, by crossing its record with environmental data, which may be useful to gather new conclusions and act accordingly.

At the time of drafting this article, there is a “pilot” version of App + Health, available to any user at <http://www.appsalud>.

unp.edu.ar made up of: (a) an application for *Android* 5.0 operating system, or higher; and (b) a *web server* (Figure 4). Currently, there are different ongoing tests of usability and stability of the concept-test online, both in Argentina and Brazil.

Both the collector and display screen (Android application) and the persistence system (webserver) were developed with

frameworks that facilitate a fast maintenance so as to adapt the needs of the project resulting from the tests conducted, and also for the next stage of “pilot implementation.” Through the application for Android cell phones or tablets it is possible to collect data about the family, individual and household to later synchronize it with the web server where this information is stored. The system is developed to assist the pilot project. However, the development of the application for other operating systems such as iPhone’s is still pending, as well as the correction of current errors and tests done in the present time period, based on the assessment done.

With the web server it is possible to see all the data collected through the app but it is still necessary to develop internal programs to cross, from the current server’s interface, specific data of the mapping of OpenStreetMap. By so doing, it will be possible to understand the correlation between the information stored and mapping updates.

In this sense, the development of App+Health provides a revolutionary structure regarding the cooperation of phenomenological and analytical approaches in the field of geography. The integration of an API (Application Programming Interface) from OpenStreetMap gives the possibility to modify the initial mapping by including data (polygons, lines and dots) with the addition of the content from the social fabric. This fact makes the proposal innovative as the application does not exactly adjust to the parameters of expertise when loading georeferenced data to the map; instead, it opens the door to a process of constant data translation from social mappings based on social cartography and the aid of the local population involved in the process. In this way, for instance, we suggest as the next stage of pilot implementation holding a series of workshops of social cartography in different localities to translate the data collected on

OpenStreetMap, which is in turn a simplified platform to load data. Thus, new objects with the signature of social content can be included, so that *form* and *contents* are not fixed but dynamic elements just like the space of interaction with experiences of health workers itself. This correlation between *form* and local *content* in the map, added to the public health information provided by the protocol, will, to our understanding, enhance considerably the work of community health workers on the ground; and at the same time, based on the level of visualization and analysis, strengthen the possibilities of prevention and reaction of the public health system.

## DISCUSSION

The data analysis of the health-diseases process has been enhanced in the last few years due to the introduction of the term territory as a variable to further understand the needs concerning health issues and its distribution in groups of people. Progressively, the concepts of health and geography migrated from software packages that facilitated the integration of data into maps, to the usage of data with which, if contextualized in geographic areas, it is possible to identify “patterns of risks distribution,” an inevitable step toward the search for clusters of inequality and, therefore, a powerful tool to define the distribution of social resources of health.<sup>(32,33)</sup> Several changes in knowledge as well as technological advances refined these improvements by developing a mixture of methodologies that connect qualitative and quantitative approaches and give place, from that perspective, to an essential, unique and dynamic advance on the knowledge of public health phenomena and its occurrence with a specific group and in a specific territory.

However, these advances on technology and knowledge could not disregard the hegemonic approach of health policies that, despite having leading

diagnoses toward a positive social change, in practice they implemented a type of mechanical and divided rationality that strengthens the hegemonic nature of health care institutions. These institutions have been historically ineffective regarding the social health care needs of a population, and more oriented toward social control (clearly, an unfulfilled goal).<sup>(34)</sup>

However, the development of systems of geographic information and techniques of geographic analysis (sometimes contrasting or complementing the ideas of critical epidemiology that endorse critical geography and phenomenology) was such that it modified the concept of territory itself, refining its meaning to a multidimensional idea which, unlike other popular concepts in public health, was conceptualized and then operationalized, rather than first operationalized and later conceptualized. Geo-semantic is, then, a result of the possibility of handling massive data, which must be given sense and reference in terms of geographic spaces. Therefore, this perspective has fewer chances of being useful to maintain current institutional agreements; it is rather oriented to showing the differences in social groups just the way they are. These types of projects redirect forces to a balance between the growing interest in the management of health systems (a dimension with particular emphasis in biopolitical aspects of health organizations) and a wider openness to find coherence in the health needs of a population and the actions to solve them.<sup>(35,36)</sup>

This way, the widespread use of smartphones and more frequent use of *mHealth* offer the possibility of implementing geographic information systems in mobile devices on the ground. Similarly, another advantage of these systems is the possibility of incorporating different layers of information to both visualize and analyze phenomena on the ground.

The case of App+Health is presented as an initial alternative to the integration of social, dynamic information

with historical sociosanitary data of each household and its members. This feature will lead to a deeper and more integrated analysis of the relationship between environment, society and health, both in rural and urban areas, as suggested by critical epidemiology, where raw data is not split between the singularity of the subject and the group.

The possibility of having nominalized and georeferenced data is additional progress toward the effective implementation of universal health care. Knowing the individuals, their surroundings and relevant sociosanitary information and placing them in a geographical context is an advance toward the visibility of subjects under unequal socioeconomic conditions and, therefore, one more step to the construction of citizens, subjects of law. The complexity of the information collected, and its considerable volume made it difficult to use it toward the achievement of this objective. Crossing this technological barrier will also lead to further challenges. One of these challenges will be deciphering how the different disciplines will coordinate to achieve a comprehensive and conducive knowledge, necessary to address the social problems resistant to mechanical interventions that only have a disciplinary approach. Another challenge will be knowing how the health system will leverage the great benefits of handling a great volume of data of a complexity level never seen so far. This challenge, at a macro level, is defining which measures will be designed based on the information gathered and, at a micro level, how will health workers develop skills related to the community while taking advantage of systematized data that exempts them from creating consolidated paper reports by hand, which is time consuming.

This latter point (the development of skills and protocols intended to enhance the work of health workers) is not a minor detail. Evidence shows that not all

interventions done by community health workers were effective and that their contributions to a better level of health in a community is related to the way they direct their efforts toward vulnerable populations with several issues and the role they play in well constituted health care teams.<sup>(37,38)</sup> That is to say, when it concerns directing or redirecting the dynamic of their actions, tools such as social cartography and mobile devices applications to systematize data are a promising combination.

## CONCLUSIONS

Both the development of a system of georeferenced and comprehensive monitoring that facilitates the management of community health, and the task of constant prevention and investigation regarding health care open up the possibilities of assistance and coverage in health, especially in rural areas and for vulnerable populations. The creation of maps with social contents and crossed data collected by community health workers will also enable them to act more efficiently; for instance, in weather emergencies, by visiting first those individuals suffering from health problems or, concerning investments on infrastructure, by identifying recurrent health issues related to environmental causes.

The development of the project App+Health becomes a multidisciplinary binational tool that gives birth to a socially innovative product, since it uses the most updated technology and, at the same time, is characterized by its availability at a low cost while providing

solutions to a problem claimed by the public health community: data systematization, integration and georeferencing.

At the time of this article's publication, the work team has finished the trial stage of App+Health, originally planned for late 2016, along with community health workers in Argentina and Brazil in different facilities and health centers. The next anticipated step is to carry out the "pilot implementation," which is part of the project in order to launch the system in a limited geographic area, in order to assess possibilities and problems, while making constant adjustments. In this framework, relevant actions for reaching an agreement between the Ministries of Health of Chubut, Argentina, and Río Grande do Sul, Brazil, in which the municipalities of Comodoro Rivadavia (Argentina) and Pelotas (Brazil) are already well underway.

Finally, we would like to highlight the enriching benefits of the perspectives provided by this approach. From the multidisciplinary field it was possible to move toward a phenomenological perspective, by building the methodology in the process itself<sup>(39)</sup> without excluding the logics of new paradigms of geotechnology.<sup>(40)</sup> The long journey undertaken reinforces the conviction that, based on multiplicity, it is more likely to advance toward complex solutions, delving into the experience of sharing knowledge and manners of doing, for the purpose of getting solutions from the subjects themselves that every day, on the field, create the supportive road toward community health.

## ACKNOWLEDGMENTS

The projects on which this article is based are called "App+Saúde: Sistema georreferenciado e comunitário para a gestão, mobilidade e acessibilidade a saúde" financed by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (2014-2016), and "Accessibility to public services and social policies in Patagonia Central" [Accesibilidad a servicios públicos y políticas sociales en Patagonia Central] financed by the Secretary's Office of Science and Technique within the Universidad Nacional de la Patagonia San Juan Bosco (2015-2018); in addition to other contributions to projects and grants funded by the Secretary's Office of University Policies within the Ministry of Education from Argentina and CONICET. Additionally, this project received financial aid for the carrying out of different exchange activities, field and mobility works from the Secretary's Office of Extension from the Universidad Nacional de la Patagonia San Juan Bosco (Argentina) and the Faculdade de Arquitetura from the Universidade Federal de Pelotas (Brazil). We would also like to thank the contributions by Beatriz Escudero, director of GIGAT; Susana Muñoz, director of the Associate's Degree in Community Health at Comodoro Rivadavia; Luis Avilés from the Rural Hospital Río Mayo; María Ancaleo from the Public Health Facility at Aldea Beleiro; and Graciela Oliva from the Hospital Rural from Río Senguer. Finally, we are grateful for the contributions regarding methodology by Magali Chanampa, Alberto Vázquez and the participation of Maria de Los Angeles Jaimes, Pamela Gómez and Nadia Martínez regarding social cartography.

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#### CITATION

Diez Tetamanti JM, Rocha E, Munsberg G, Castro JHP, Neutzling ADS, Jaime SF, Schuler LJ. Development of a georeferenced system for the management, mobility and monitoring of primary care in community health. *Salud Colectiva*. 2018;14(1):121-137. doi: 10.18294/sc.2018.1210

Received: 31 Oct 2016 | Modified: 26 Jun 2017 | Approved: 10 Aug 2017



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<https://doi.org/10.18294/sc.2018.1210>

The translation of this article is part of an inter-departmental and inter-institutional collaboration including the Undergraduate Program in Sworn Translation Studies (English < > Spanish) and the Institute of Collective Health at the Universidad Nacional de Lanús and the Health Disparities Research Laboratory at the University of Denver. This article was translated by Ingrid Julia Martinez under the guidance of Mariela Santoro, reviewed by Anna Edelman under the guidance of Julia Roncoroni, and prepared for publication by Candelaria Alonso under the guidance of Vanessa Di Cecco. The final version was approved by the article author(s).