

Big data, health and university development cooperation

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Illustrator: [Hansel Obando](#)

The threat of new variants of the SARS-CoV-2 virus has reminded us that Africa exists. It is very likely that there the pandemic has been and still is as devastating as anywhere else in the world; however, the official incidence levels - and also the vaccination rates - reported are very low. Everyone talks about the lack of vaccines, but the real problem in many African countries is the lack of an effective health service (with human resources, cold chain, etc.) close to the population (Availability, Accessibility, Acceptability, Quality). In development cooperation, one of the priorities must be to bolster the health systems of countries with low and very low development indexes. This in turn requires strengthening international health-related institutions, such as WHO, which should be endowed with a real capacity to significantly influence health systems worldwide.

In a small country like ours, neither the magnitude of our work nor the quantity of resources can be expected to have a transformative impact on development cooperation. Catalonia's development cooperation must be based on quality, innovation, on projects and programmes that generate sustainable changes and can multiply autonomously. In the health sphere, this type of project should be implemented particularly in primary care. Another priority should be to improve education, from primary and secondary school to university, with the goal of training quality health professionals (doctors, nurses, nursing assistants, health agents, etc.). Without trained professionals (human resources), there can be no health care.

In Catalonia, universities are underrated players in development cooperation. Fortunately, today, Catalan universities are ranked among some of the world's best, with teachers and researchers who work with a high level of excellence. Development cooperation would surely benefit from having access to their knowledge. University development cooperation (UDC) should be a strategic factor within the framework of Catalan cooperation.

In this paper, we present the work carried out jointly by three research groups affiliated with the Universitat Politècnica de Catalunya, in partnership with the Hospital Vall d'Hebron and the Probitas Foundation, with the goal of improving the standard of care provided to people with malaria, tuberculosis and neglected tropical diseases (NTD). The Germans Trias i Pujol Research Institute (IGTP) and two Brazilian Universities (Federal

Rural University of Pernambuco, UFRP, and Federal University of Rio Grande do Norte, UFRN) also took part.

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The UPC created the Development Cooperation Centre (CCD) in 1992, with responsibility for promoting UDC. The CCD provided the support for starting the three projects we present here and has also financed part of their cost. The work done is the result of years of cooperation between the CCD-UPC and the people at the World Health Organization (WHO) responsible for the control programmes for Chagas disease, Pere Albajar-Viñas, and leishmaniasis, José Postigo, two Catalans who are deeply committed to human development within the Neglected Tropical Diseases Department (NTD-WHO). The cooperation between NTD-WHO and CCD-UPC is an excellent example of good practices in university development cooperation and, as such, is worth considering when reflecting on and defining development cooperation for addressing the challenges of the 21st century.

Challenges

In countries with low or very low human development indexes, deaths and days lost due to disease are mostly attributable to difficulties in accessing medical care (in the health promotion, disease prevention and health care dimensions). The projects presented here do not pretend to provide a complete solution for these problems but they do contribute to advancing toward their solution.

It will probably not be possible to control malaria, tuberculosis or NTDs with technological contributions alone, such as rapid diagnostic tests or vaccines. The epidemiological silence (due to lack of case detection, reporting and surveillance) is so great that increasing the number of diagnoses will, in all likelihood, require integrating technological contributions with classic and simple methods that do not depend on external resources. Vaccines have been a highly effective solution for many infectious diseases, but they are unlikely to be effective for those diseases where lasting immunity is not gained by catching the disease; for example, vaccines are rarely effective in combatting complex pathogens that have co-evolved with the human species. In such cases, the best strategy would probably be to avoid risk situations, diagnose early and give appropriate treatment. That is why many diseases (including malaria) that are still prevalent in places where there is poverty are not endemic in places like Catalonia. The project has set itself the following goals: (1) facilitate early diagnosis of malaria, tuberculosis and NTDs, (2) improve knowledge of NTDs' epidemiological status, and (3) develop tools for reflecting on the potential of the different control strategies that can be used.

IMAGING: Diagnòstic automatitzat mitjançant microscòpia de baix cost

Today, many diseases, such as malaria, continue to be diagnosed mostly with a light microscope. In the case of malaria, a drop of blood and an appropriate stain for examining biological samples are enough. One of the challenges is the availability of microscopists (in numerical regression around the world) who have learned to identify images of parasites and have time to analyse samples under the microscope. It is a time-consuming task which, when it becomes routine (without systematic quality controls) or when there is a large backlog of patients, may give rise to multiple errors. To facilitate the diagnosis process, the possibility was seen of digitising the images (to request a second opinion, to monitor the patient, to insert the image in the patient's medical record, to train new microscopists) and automating the diagnosis [1].

The project has progressed and we now have a low-cost microscope equipped with an Arduino computer controlled via a mobile phone. Arduino is an open-source, low-cost digital platform that allows implementation of different types of microprocessor. Following the instructions received through the mobile phone, the Arduino moves the slide so that the phone can take photos of the different fields (selected areas of the slide). Malaria parasites are detected automatically using artificial intelligence techniques based on deep neural networks. The detection made from the sample images is complemented with statistical models to assure the diagnosis. The system is expected to be very cheap; the total cost has not yet been calculated definitively but it will probably run to a few hundred euros per installed device. In addition, the quality of the diagnoses made has been found to be very high. Thus, the medical centres who use microscopes for diagnosis will be able to continue doing so with guaranteed sustained quality while enormously reducing the use of human, financial and time resources.

With the work in an advanced phase, it is expected to be able to use it to diagnose malaria within a few months. Subsequently, it will be possible to adapt the system to any other disease that can be diagnosed by microscope, such as a percentage of tuberculosis cases (those that can be diagnosed from the sputum) or NTDs [2].

If the centre where the diagnosis is made has access to Internet, the image, diagnosis and case report can be sent to referral hospitals, surveillance systems and/or system managers. It will also be possible to gather epidemiological information in real time, without requiring additional resources. In health management, up-to-date knowledge of the epidemiological situation (in time and space) is essential for making the best possible decisions.

This is a cross-disciplinary project, involving computer engineers, telecommunication engineers, biomedical engineers, physicians, nurses, biologists and physicists. Pooling technological effort, biomedical knowledge and knowledge about development cooperation has proved to be a formula that has given good results in previous projects. For example, the IMAGING project was conceived, to a great degree, from the learning gained in an earlier project we took part in [3].

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The present project has been possible thanks to the resources provided mostly through the Probitas Foundation's Global Laboratory Initiative. They quickly understood its significance and are providing technical and financial support for the work. Hospital Vall d'Hebron and the UPC have also provided substantial support in terms of funding, personnel and infrastructures. WHO's NTD Control Department is also providing technical support for the project, as it considers that the concurrent detection of different parasites in the blood (differential diagnosis of blood parasites) is an example of the strategy called opportunity of systematic integration, for increasing efficiency and effectiveness in the early detection of parasite infections. The project is also an excellent example of cooperation between public and private sector, working together for a better future.

WISCENTD: Dades per a fer possible conèixer la realitat

There are forgotten tropical diseases, neglected diseases, in which there has been negligence in their monitoring and control. Some of these are NTDs. The main reason for this negligence is that they mostly affect low-income segments of the population, who have little political and economic influence. The lack of epidemiological information (epidemiological silence) is one of the reasons why this negligence has continued for so long. In order to effectively solve the problem, it is vital to have quality information. With this goal in mind, ten years ago, WHO's NTD Department and the UPC's Database Technologies and Information Management Group started working together to create a database management tool capable of collecting all the information available about NTDs. A tool that would gather together in one place reliable information provided by health ministries, non-governmental organisations, research groups, pharmacovigilance systems, etc.

In order to build a more complete epidemiological image of NTDs, it is vital to support the collection of data, integrate all the data available, and do so using open-source software. Breaking these diseases' epidemiological silence must be the first step to making good decisions about their control and elimination. It is crucial to uncover the true situation through open data.

The project is in an advanced stage of development. In fact, the initial focus was solely on Chagas disease, with the idea of progressively expanding it to include all the other NTDs. At present, the system is being adapted so that it can also collect and process images, as they too are data; by this means, it will also be possible to include in the WISCENTD system the information generated in the IMAGING project explained in the previous section. This is a good example of a UDC project giving support to an international organisation and its multilateralism, necessary for successfully addressing a global challenge that particularly

afflicts poor, neglected populations.

Mathematical epidemiology: From data to understanding

Data are the 21st century's oil and gold. Among other things, data enable companies to improve their profits, scientists to advance their knowledge, and they should also enable politicians and managers to make better decisions. To maximise the benefit gained from data, analysis tools and prior experience are necessary in order to ensure that the strategies to be used are assessed rationally using the best evidence available. Data, in an unprocessed state, are the raw material but extracting the information they contain is not an easy task.

The UPC's Computational Biology and Complex Systems Research Group (BIOCOM-SC) has been working for a number of years on mathematical epidemiology related with tuberculosis, malaria and NTDs. Mathematical epidemiology's greatest contribution is that it helps us understand reality by objectively showing what the data are telling us. The following example illustrates just how valuable it is. It was found that the epidemiological status of tuberculosis in Nigeria had not improved since 1990. A study was undertaken, which revealed the problem's underlying cause: epidemiological silence. It was calculated that over 80% of the cases were never diagnosed. These conclusions form part of the study performed by a Nigerian mathematician [4] as part of his PhD thesis at the UPC.

Curiously enough, the knowledge generated by the BIOCOM-SC group in its study of tuberculosis, malaria and NTDs has provided vital input for the management of COVID-19. Since March 2020, the group has been working with the European Commission and the Government of Catalonia's Ministry of Health; working with diseases that have little current impact in our society has been essential for helping us face the impact of the pandemic.

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The data collected in WISCENTD, and the data generated in IMAGING, will help improve our understanding of reality within a cooperative project between experts, such as the people responsible for these diseases' control at WHO, or between specialists in laboratories, medical centres or hospitals, together with experts in mathematical epidemiology such as the BIOCOM-SC group. Analysing the data should enable us to reflect on what actions should be undertaken to move human development forward. Data and mathematical models will help us extract the best possible knowledge within the framework of a valuable experience in development cooperation.

Conclusions

UDC carried out in the field is essential for addressing the challenges of the 21st century, but non-governmental organisations (NGOs) and foundations should also be encouraged to intensify their cooperation with universities, research institutes and hospitals, which should become leading players in Catalan development cooperation. For this to be possible, scientific and technological research must be included as a priority in cooperation policies, as illustrated by the three success stories presented here. Their most valuable contribution should not be long-term actions on the ground but the development of knowledge and tools that can bring about sustainable improvements. UDC is vital for addressing the challenges of the 21st century.

But not just that; scientific and technological training in the Global South is absolutely indispensable for bringing about meaningful, sustainable change. Support must be provided for teaching science and mathematics in secondary and pre-university education in the countries with a low or very low HDI, as well as establishing cooperation projects between Catalan universities and universities in the Global South to improve the training of their bachelor's and master's degree graduates. It is very important to cooperate in research and supervise doctoral theses undertaken by students from the Global South, as we have seen in the case of mathematical epidemiology in Nigeria.

Support must be given to the international organisations that are working for human development from a multilateral perspective. However, it is also important to take this work to the local level, and now we have the means to do this. Support should be given specifically to the Catalans who are working for human development in organisations such as WHO. The experience gained at the UPC provides ample evidence of the potential and the mutual interest in undertaking such cooperation activities. The support given to international organisations by Catalonia needs to be reviewed, with the aim of enhancing its value and developing its full potential at both international and local level, in Catalonia.

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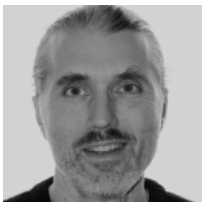
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**Daniel López**

Daniel López Codina holds a PhD in Physical Sciences from the Universitat de Barcelona. He is currently a full professor at the UPC where he teaches Biophysics and Mathematical Modeling of Biological Systems. He has been director of the Higher School of Agriculture and Delegate of the Rector at the Baix Llobregat Campus. He is a member of the UPC's Computational Biology and Complex Systems research group. For thirty years he has been involved in development cooperation, at the UPC he is part of the Center for Cooperation for Development of which he was director for three years, and at the local level he is president of the NGO Caldes Solidaria. He has managed to focus his research work on human development, developing mathematical models in tuberculosis, malaria, Chagas disease and other neglected diseases. He has recently received the City of Barcelona Prize for Experimental Sciences and Technology for his work monitoring the COVID-19 pandemic.

**Elisa Sayrol**

Elisa Sayrol Cloles received her doctorate in Telecommunications Engineering from the Polytechnic University of Catalonia (UPC), where she received the special prize 1994-1995. She carried out predoctoral stays at Northeastern University and the University of Southern California between 1990 and 1993. She has been Deputy Director and Director of the Barcelona School of Telecommunications Engineering, as well as Vice-Rector for Institutional Relations at UPC. She is currently a Full Professor at the UPC and a member of the Image and Video Processing Research Group, associated with the IDEAI-UPC Research Center. She has been a representative of the UPC in the EIT Urban Mobility, period in which she has also coordinated the Master in Urban Mobility of the UPC. She is part of the CARNET Academic Committee, a knowledge hub founded by the UPC together with SEAT and VW Research. Her research focuses on the study of machine learning and deep learning techniques with computer vision, especially in urban mobility and medical imaging applications. In this regard, at the initiative of the Center for Development Cooperation, she agreed to work with biomedical images of malaria, leishmaniasis and tuberculosis, directing the development of tools for the identification of parasites.

**Alberto Abelló**

Albert Abelló holds a PhD in Computer Science and a professor in the Department of Services and Information Systems Engineering at the UPC, an expert in Big Data and Business Intelligence. He is a member of the DTIM group (Database Technologies and Information Management Group). He carried out research stays at the University of Granada (Spain), the Technische Universität Darmstadt (Germany), the Université Claude Bernard Lió 1 (France), the Universidad de la República (Uruguay) and the University of Edinburgh (Scotland). He has participated in 24 national and international research projects or networks of excellence, and has signed R&D agreements with companies such as Hewlett Packard or SABE. At the request of the UPC Center for Development Cooperation, he accepted the challenge of collaborating with the WHO Department of Neglected Diseases. He has led the project to create the database for this department.