The remote island solving the world's most serious diseases

By Jacqui Thornton
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The pristine, deserted, white sandy beaches go on for miles as palm trees tower over lush forests, birds sing softly, and dolphins greet the local fishing boats.

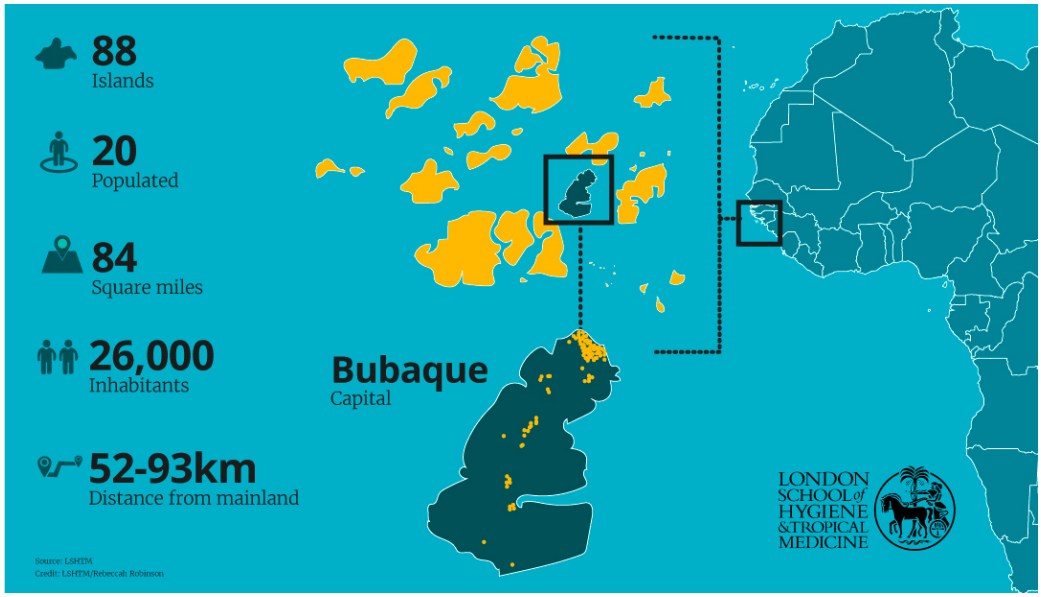
Truly unspoilt, the remote Bijagós, a collection of 88 islands two hours by speedboat off the West African coast would effortlessly fit into any travel guide.

Life across the archipelago is quiet and isolated. While locals rely on perilous canoes, the wealthy can use the main island's tiny airstrip.

The town of Bubaque, the capital of the main island of the same name, has the greatest connection to the outside world. Here, a ferry arrives every Friday from the mainland of Guinea-Bissau – a journey that can take up to eight hours.

Many of the smaller islands and islets have no infrastructure at all. Being so cut off, the Bijagós people have been able to maintain strong cultural traditions, including striking costumes and animal masks used for events. The archipelago also has its own unique language.

Bijagós islands



Society here is matriarchal where women choose their menfolk and they can force divorce on their husbands if they so choose. Most are animists – with the religious belief that objects, places and creatures all possess a distinct spiritual essence.

The high diversity of ecosystems – mangroves, palm forests, dry and semi-dry forests, coastal savanna – led to the islands being designated a UNESCO biosphere reserve in 1996.

The main outsiders to date have been Portuguese colonisers, some German settlers, missionaries from Brazil, a few adventurous fishermen from Senegal and tourists.

As a result, young children on the islands have to be taught that other people exist in the world with different coloured skin to them – 'brancos' as they call people with white skin.

But amid the beauty and serenity – and female empowerment - the local people face many dangers: deadly and distressing diseases, such as trachoma, the leading cause of infectious blindness globally; soil-transmitted helminths such as intestinal worms; and lymphatic filariasis, a disturbing parasitic disease where a person's legs or intimate body parts become so swollen that patients cannot walk – also known as elephantiasis.

These infections are just a few examples from a group of conditions known globally as neglected tropical diseases.

With only one health centre on the island and limited medical supplies due to the inaccessibility and lack of vehicular transport, provision of healthcare has been difficult -- despite the best efforts of the Guinea-Bissau ministry of health.

A living laboratory

Today, this archipelago is acting as a 'living laboratory' that could hold the secret to eliminating these neglected tropical diseases for good – not just here, but potentially across the world.

The fact that these Atlantic islands are so untouched, and that they house many similar but contained environments due to minimal migration within the islands, makes them a unique study location for scientists, who can compare the success of different interventions on some islands against other islands acting as a control group.

Seizing on this opportunity are researchers from the London School of Hygiene & Tropical Medicine who have been visiting the islands for the last six years, focusing on trachoma – where it is being transmitted, how it could be controlled and the impact of mass treatment with antibiotics.

These islands could be used as a disease and treatment model for the wider world, according to Dr Anna Last, Associate Professor of Infectious Diseases at the School.

Dr Last, a medical doctor specialising in infectious diseases, is now bringing together an expert team from the School for an ambitious new two-year project, called 'Studies towards infectious disease elimination on the Bijagós Archipelago of Guinea Bissau',

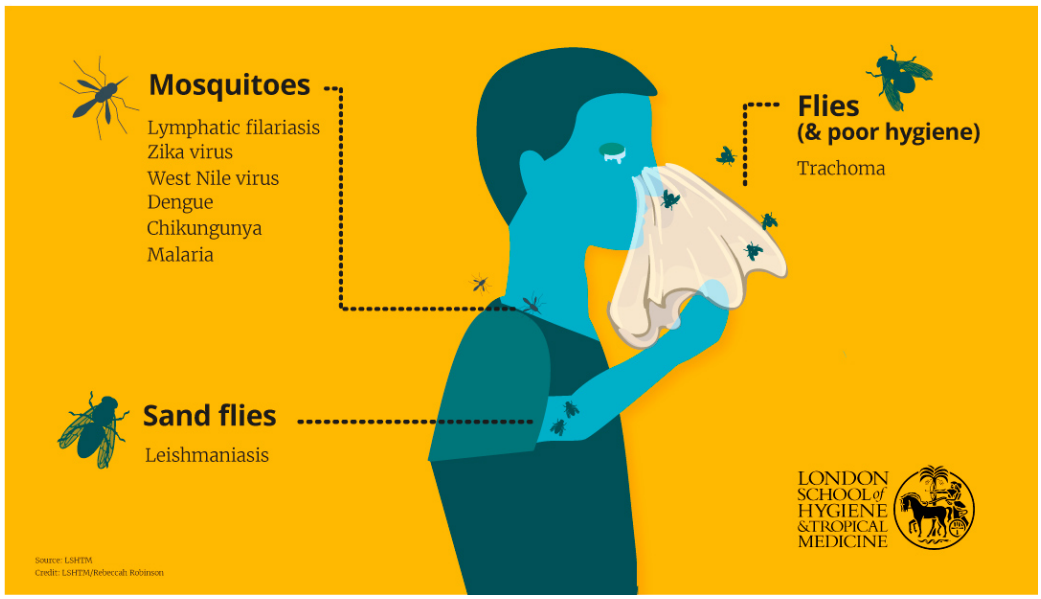
The £607,000 project, funded by Research Councils UK, will eventually add schistosomiasis – a worm infection transmitted by snails -- soil transmitted helminths, yaws and lymphatic filariasis to the diseases being studied. Researchers will also map the epidemiology and social determinants of malaria.

"The islands are geographically remote, culturally isolated, with communities living in forests, with no roads and vehicles – it's challenging to work here," she said.

Even so, Dr Last and her team – which includes a small field staff of islanders - believe they have won their first battle against endemic disease: eliminating trachoma from the archipelago.

Thy did so by repeated visits to identify and map the high-risk areas, then treating entire communities at risk with a single dose antibiotic of azithromycin in tablet or syrup form.

Vectors and associated diseases in the Bijagós



A unique experiment

The newly funded project has three benefits: increasing scientific knowledge about disease transmission for a global audience; helping the local community by offering healthcare for these terrible illnesses as part of interventions; and building capacity on the island by training local people in scientific techniques.

The team plans to set up its own laboratory and insectary of mosquitoes, reared from larvae, and fed blood to produce eggs, to start colonies for experiments related to the vector-borne malaria and lymphatic filariasis, led by Professor James Logan.

It's an extraordinary venture given the geography, and demography, of the islands.

The Bijagós cover 1,184 square miles, but only 20 of the 88 islands are populated, housing just 26,000 people in villages with no grid electricity or piped water. Homes are made of mud with palm leaf roofs and open eaves giving little protection from mosquitoes transmitting malaria. Bubaque residents have only recently been provided with bed nets, in May 2017, by the public health department of Guinea-Bissau.

Most villages are reached by a network of small paths deep within the palm forest, intentionally designed to protect themselves from invaders, said Dr Last. She and her team got around by boat and on mopeds and bicycles, as well as by hiking through forest.

Dr Last began coming to the Bijagós islands for her PhD at the School in 2011 to study trachoma, with the Guinea-Bissau Ministry of Health National Trachoma programme, and has since visited all of the 20 inhabited islands.

Before then, very limited research had been done on the islands and there was little information about what kind of diseases existed - and the burden they caused.

She has since carried out surveys on maternal health and sexual health, malaria and soil-transmitted helminths.

Local acceptance and building capacity

This summer there were five additions from the School, with a group of MSc students who spent a two-month study period on the islands. One of them, Scott Tytheridge, said it was touching how welcoming and inviting the community had been. One thing he did not expect was the extent – and value – of small talk. Local culture insists a third of any conversation is small talk before you get to the nitty gritty.

"They ask about your family, your body, how you slept the night before. In the UK, we don't partake in that, but it seals a lot of social bonds," said Tytheridge. But sensitising the local community to their work in the early days was effective.

"We've had a lot of success. We have a very low dropout rate from studies, people are very enthusiastic to be involved," said Dr Last.

Dr Last learned the local language (Bijago) to help her get by, and was also helped to develop relationships by people like nurse Eunice Da Silva, brought up in Bijagós, who now specialises in ophthalmology and is a health advisor to the Bissau-Guinean government.

But finding others to help was no easy feat.

The secondary school on Bubaque faces huge staffing problems and according to Dr Last is often not functional. There are only one or two other secondary schools in the archipelago along with a number of primary schools. Children often travel between islands to go to the nearest school, staying with relatives, while others go to the mainland, said Dr Last.

But from this population over the last six years, the team at the School has trained 25 locals, educated to secondary school level, who have learnt to enter electronic data and take photos for the projects. Some are healthcare professionals, such as Eunice, who then get consent from the locals to take part in studies and help with field surveys.

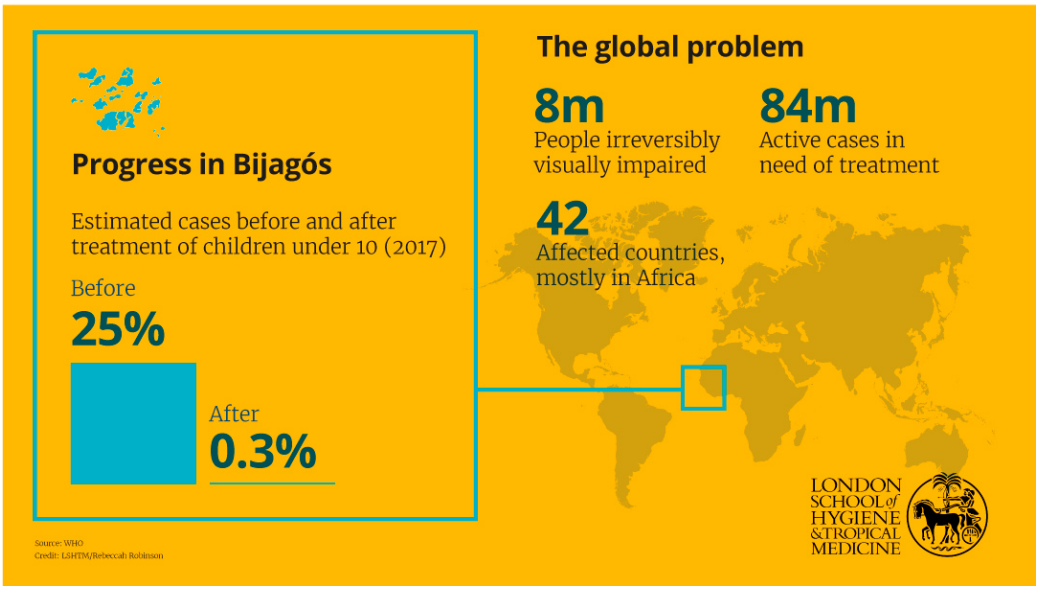
Together they have set out on a multi-pronged mission to improve health across the islands.

First mission: Ending trachoma

Trachoma is an infectious disease where the bacterium *Chlamydia trachomatis* is spread through discharge from the eyes or nose of an infected person. Hands, clothing, and insects can all be routes of transmission if they pick up the discharge.

The disease thrives in crowded living conditions where there are shortages of water and inadequate sanitation. Flies are a common means of transmission – coming into contact with people's eyes.

Trachoma treatment in Bijagós and the global potential



The first stage of the disease is follicular trachoma, which can be treated topically, but with repeated infections and inflammation over many years, the upper eyelid can turn inwards, so that the eyelashes rub on the eyeball, resulting in intense pain and scarring, known as trachomatous trichiasis.

Without surgery this leads to irreversible blindness.

When Dr Last started screening for clinical signs of trachoma using magnifiers or loupes, initial surveys of the local population found that in clusters among children under 10 years of age, there was a prevalence of active (infectious) disease of 25%.

In some villages ALL children had the disease.

“If you can imagine any disease in the UK being that prevalent in children, it’s a startling figure,” said Dr Last.

In conjunction with the national programme for visual health in Guinea-Bissau, her team was able to deliver treatment to the whole population of the archipelago. “Encouragingly, most recently, at the beginning of this year, an impact survey shows that we have most likely eliminated trachoma as a public health problem on these islands,” she said.

“Of course, there’s still more work to do, and that will come into the next phase of projects that we’re undertaking there, but it’s very encouraging news indeed.”

Their study published in 2017 found that after mass drug administration, the estimated prevalence of follicular trachoma in children aged 1–9 was 0.3% and that of unoperated trachomatous trichiasis in people older than 14 was between 0.1 and 0.4%. These rates were under the World Health Organization (WHO) threshold for elimination.

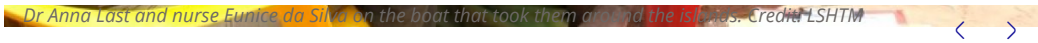
“We’re not treating individual infections; we’re trying to cut the transmission cycle. By treating everybody at the same time we aim to reduce the burden of infection in a community so that it can’t transmit.”

Now her team will undertake monitoring and surveillance to prevent its re-emergence, including looking at behavioural interventions and improved sanitation to ensure sustained elimination.

The battle to beat trachoma is important worldwide - it’s a public health problem in 41 countries globally, and is responsible for the blindness or visual impairment of about 1.9 million people.

There has been a global concerted effort to eliminate the disease and Morocco has been the most recent country to do so through the SAFE intervention of surgery, antibiotics, facial cleanliness and environmental improvement, following eight others.

Where the work on the Bijagós islands would benefit the wider world, she believes, is in the monitoring and surveillance after elimination of trachoma. “Using some of the molecular diagnostic techniques that we use during these studies, and some of the genome sequencing techniques that we’ve used on the infection, we can understand what happens after elimination and do detailed monitoring and surveillance which will inform programmatic activities generally,” said Dr Last.



Dr Anna Last and nurse Eunice da Silva on the boat that took them around the islands. Credit: LSHTM *Dr Anna Last*

Next target: malaria

While trachoma is among the most serious public health conditions in Bijagós, the islands are also endemic for malaria.

An early pilot project estimated malaria rates to be 10-15% during the dry season and 25% in the rainy season, which runs from June to November – similar to the mainland.

Prof James Logan, Professor of Medical Entomology, the study of insects that spread diseases, and the Head of the Department of Disease Control at the School, travelled to the islands as part of the project earlier this year.

He believes the beauty of the site is that each island could have its own study taking place looking, for example, at how a disease is transmitted or how it responds to a particular treatment. This could be monitored very carefully, with another island acting as a control and, if successful, the intervention being studied could be scaled up for international malaria control.

Interestingly, this could include the study of genetically modified mosquitoes as an intervention.

Scientists have been genetically altering the insects in a number of ways in an attempt to beat malaria, such as making them produce 95% males, to 'crash' the population.

In another example, male mosquitoes, which do not bite, have been manipulated to carry a gene that prevents their offspring from reaching adulthood. These have been released in Brazil to mate with wild females to undercut the population of Aedes aegypti mosquitoes, which spread Zika.

Prof Logan says working on the islands gives us more control over the studies, and minimises influence from surrounding areas. "On the mainland, you have issues with movement of mosquitoes and people into the study sites, but on an island, you are surrounded by water.

"Because we are able to look at the entire mosquito and human population on the islands, we can carefully and accurately measure the impact of the interventions and use this information to scale up on the mainland."

Student Scott Tytheridge has prepared the path for Prof Logan by mapping mosquito larvae sites on the islands.

Prof Logan will now collect larvae from their water pools and catch adult mosquitoes in traps in an effort to determine how many mosquitoes' species exist there, what they are and where they are found.

Once the researchers know that, they can start to design the correct method of control as each species has different life cycles and biting behaviours.

Early indications show that one of the main species responsible for malaria transmission, *Anopheles gambiae,* is present, but within this species there are different types.

Prof Logan said a combination of interventions including tools to control the mosquito, a vaccine, antimalarials and community educational campaigns could make a real 'dent' in malaria both here and worldwide.

"It's very exciting. We're going into the unknown, and we're discovering new things, and trying to piece together a very complicated puzzle to try and solve a problem in this niche area," he said.

Prof Logan will also be training around 20 local field staff. "We want to build capacity so that local scientists have the ability to perform their own research, to get their own research funding, and hopefully we would continue to collaborate with them going forward," he explained.

Final target: multiple diseases

There is also a wider global perspective to this research – and not just in terms of controlling malaria.

There are also implications for the control of other diseases transmitted by mosquitoes such as zika, dengue, yellow fever, filariasis and by other insects, like sand flies that transmit leishmaniasis.

The World Health Organization (WHO) estimates there are 390 million dengue infections globally each year. The disease is spreading globally and certain countries have seen devastating outbreaks this past year, such as Sri Lanka.

There are an estimated 700 000–1 million new cases of leishmaniasis, caused by Leishmania parasites, each year and 20 000 to 30 000 deaths occur annually, mostly among the poorest populations on earth.

Multiple diseases, spread by a select range of insects, could be controlled with more insight on how to control their vectors, perhaps stemming from this work on the islands.

Dr Ricardo Thompson, the acting chair of the WHO programme review group of neglected tropical diseases in the Africa region, went to the islands for the first time in August and is excited about the School's work there.

He is particularly keen on the work they will be doing to prevent and help treat lymphatic filariasis, as he has met many patients infected with the parasite. In advanced stages it causes hydroceles - sacs filled with fluid that form around a testicle, which is physically disabling and stigmatising.

An estimated 120 million people in tropical and subtropical areas of the world are infected with lymphatic filariasis, among which almost 25 million men have genital disease.

During a survey of 480 people Dr Thompson carried out in August, he found a prevalence of 18% on the main island of Bubaque. Although this was lower than previous estimates of 24% in 2005, he thought that in fact there were similar levels of disease.

The villagers made it very clear to him how the disease was ruining their lives.

"About seven men aged 29-60 asked to see me in private. They took me into a hut and pulled down their pants to show me their swollen testicles.

"The most striking case was this young man about 20-years-old, a handsome, big man. He said: 'you are the first person I have talked to about this, it is embarrassing for me, I'm young I should be socialising normally but I have this issue – what can you do for me?'"

"These people are confused and don't know what to do. It's extremely difficult to deal with," said Dr Thompson.

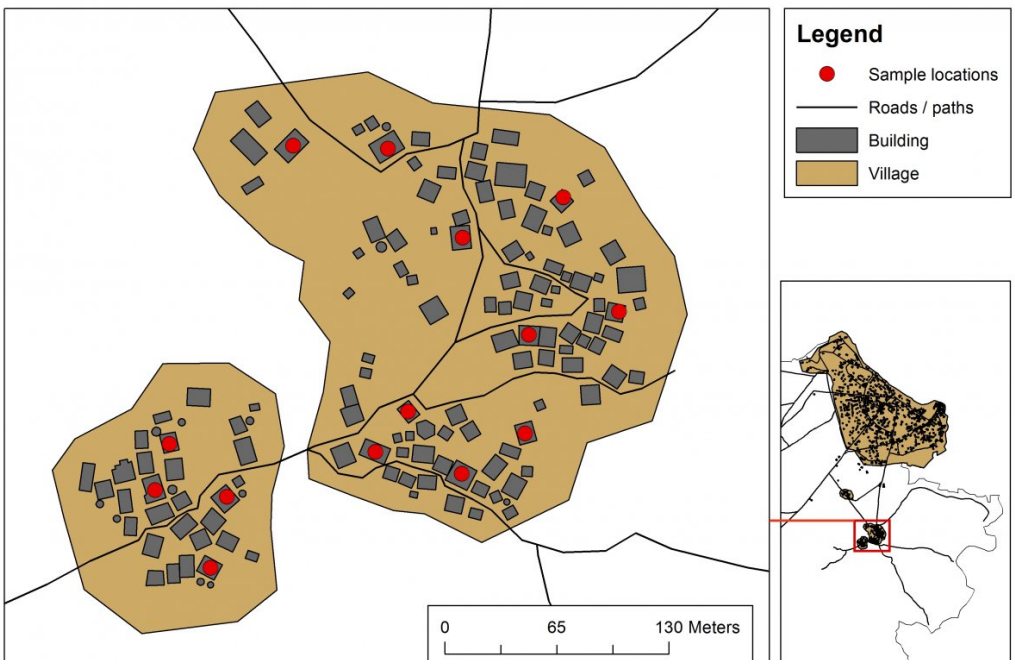
He forwarded the names of the men to the health authorities to be referred for surgery on the mainland. But the ultimate aim is to treat illnesses like this much earlier, or to eliminate them entirely.

To do so, means finding them.

A crucial map to lead the way

The extensive scale of research being made possible in Bijagós needs one crucial detail for any of it to happen: the ability to know where to target. Providing this is the School's Chris Grundy, an expert in computer mapping known as Geographic Information Systems (GIS) - computer software used to map and analyse spatial or geographic data.

Mr Grundy is creating maps for the researchers – both local and international – to know where to go.



Bijagos Islands map. Credit: OpenStreetMap

Bijagos sampl

Throughout the world, OpenStreetMap is increasingly being used as an alternative to Google maps, as it is both open-source and crowd-sourced, meaning anyone can use and add data.

When Mr Grundy looked up the islands on OpenStreetMap, he was intrigued to see that while there were satellite images of the Bijagós available, they were unmapped.

Pre-mapping the islands – doing mapping before research starts, not as part of the work itself - would give the researchers a tremendous advantage, he reasoned, making them able to plan their work much more efficiently by having information on population size and population location in advance. He then offered this resource to Prof Logan.

Mr Grundy knew about the subgroup of OpenStreetMap called the Humanitarian OpenStreetMap Team (HOT), who respond to emergencies and natural disasters. For example, after the Haiti earthquake, the roads and buildings – and damage to them – was mapped in just 2-3 days after thousands of mapping enthusiasts volunteered to help from their own homes using satellite images.

HOT is now routinely called upon to map locations affected by an emergency, such as the recent Hurricane Maria, which affected countries in the Caribbean, and the part of Mexico hit by the recent earthquake.

“HOT can do in days what it would take months to do on the ground,” said Mr Grundy.

Another newer joint project that Mr Grundy is involved with is Missing Maps – founded by the British and American Red Cross, by HOT and Médecins Sans Frontières - to map unmapped vulnerable areas before disasters happen.

Missing Maps took the standard HOT mapping methods and added a simple mobile phone app called MapSwipe which records if there is a building or a road on a small square in the satellite image.

The app works in a similar way to a dating app - the “Tinder for mapping” – as people cycle through a number of images and tap when they see a building or road to mark it on the map. Three or four people are then served the same image to verify its location.

The results from MapSwipe are then used to target mapping to areas with human development, saving even more time and allowing larger areas to be covered.

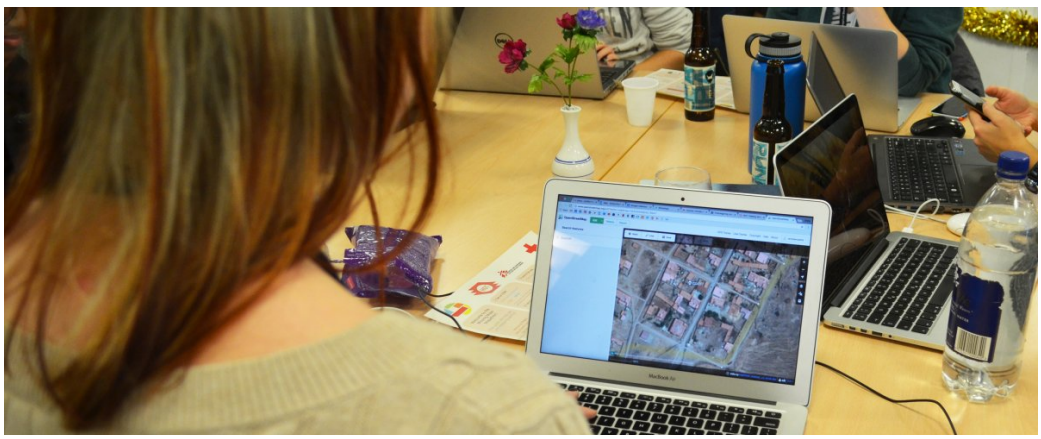
More than 70 projects have been completed so far. For example, in South Sudan, these techniques have been used in Aweil County to map homes and better deliver medical services to the very vulnerable population.

Mr Grundy approached Missing Maps, who agreed to include the Bijagós Islands as a pilot, to see whether the same system to map unmapped areas for humanitarian purposes could be used to help researchers at the School.

The first stage was to use MapSwipe to identify areas with buildings or roads. This took just a few hours by a volunteer mapping community.

For the second stage, a mapping party was held in June where 40 of the School’s MSc students mapped the buildings and roads identified in MapSwipe into OpenStreetMap. Two students, Olivia Farrant and Scott Tytheridge who were going to be working in Bijagós on their Msc projects, helped to validate the data before it went live into the OpenStreetMap dataset for anyone in the world to see - including Dr Last and Prof Logan.

The goal was to show them how map data is used in research.



Students mapping the buildings they had identified in Mapswipe into OpenStreetMap. Credit: Joanne Last

Maps, calculations and revelations

Mr Grundy could work out population estimates for the islands, by counting the number of buildings in the OSM dataset and multiplying by 5.6 – which from ground surveys has been shown to be the average number of people per building in this region.

When the MSc students on Bubaque collected the actual data in household surveys, the figures were amazingly accurate: The ground survey found 575 buildings compared with the 580 mapped remotely, and found the total population to be 3,157 compared with the 3,248 estimated by Mr Grundy, an error of less than 3%.

Having validated the figures on one island, the population on the other islands could be estimated for the first time by counting the number of houses and multiplying by 5.6.

This information will be useful when teams are carrying out an intervention and want to select a number of villages more than, say 2km apart. “We have all the buildings, all the roads, where the mangrove swamps are, and the village names all marked,” said Mr Grundy. “The researchers don’t have to map the islands, they can concentrate on collection the information about health of the population.”

Once again, there are wider global implications.

Mr Grundy said doing this kind of pre-mapping with OpenStreetMap would save other researchers time and money and would contribute to getting the whole world mapped -- and keeping that map up to date.

“As researchers we should be adopting methodologies that improve our work and make the spatial data we collect available to all. The locations the School works are often the same as Médecins Sans Frontières, the International Federation of Red Cross and Red Crescent Societies and other NGOs, so data produced by researchers and made available to OpenStreetMap benefits everyone.”

The World Health Organization’s Health and Environment Linkages Initiative has noted the strength of maps and GIS, particularly their immediate impact, while the WHO’s liaison with Guinea-Bissau Dr Thompson said that concerted partnership working in remote areas like the Bijagós can make a huge difference.

WHO’s Dr Thompson returned to the islands in October 2017 to meet Dr Last and her colleagues to discuss the work. He said concerted efforts such as these will be a ‘big benefit’ to the community on the islands and to the wider world.

“What’s important about the work of the School is that it can work as a proof of concept of the problem to eliminate or control these diseases in a given geographical area,” he said.

“If successful, they can show that we *can* do it, that we can do it *fast*, and that we can do it sustainably.” For the people of the Bijagós, and in turn many developing settings worldwide, that proof cannot come soon enough.

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