MakeSense: DustDuino
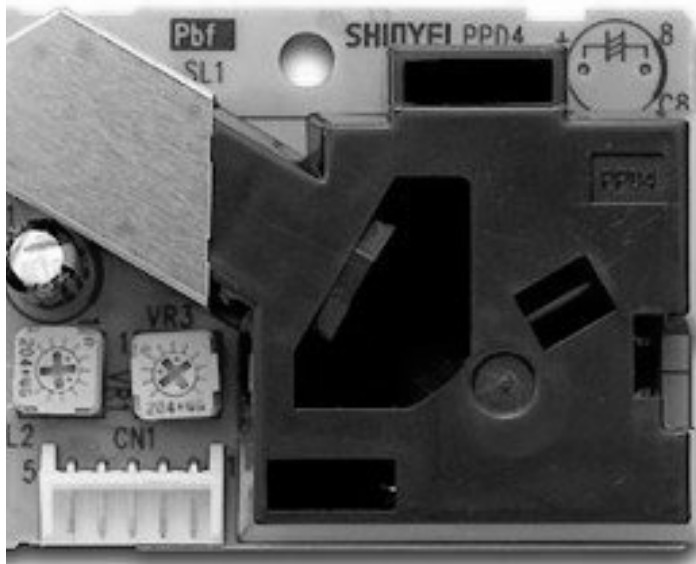

The history of a networked sensor pilot project for improving understanding about the air we breathe.

by Erica Hagen

MakeSense: DustDuino

Background and Purpose

Hypothesis: *Citizen-led sensor monitoring of environmental factors will strengthen feedback loops by providing structured, accurate, and reliable data to compare against government measurements and news stories in the Amazon basin.*

The MakeSense project began in early 2014 with a proposal to the Feedback Labs experiment fund, seeking to test the above hypothesis.

The funding amount of $60,000 was initially meant to support the following:

- **Research** to determine which pollutants to measure by GroundTruth Initiative, InfoAmazonia and Internews in partnership with communities and researchers
- **Design and construction** of several low-cost sensors by Internews and its academic partners
- **Creation** of the technical back end in FrontlineCloud by SIMLab to interpret incoming data, and create APIs useful for InfoAmazonia
- **Support** from InfoAmazonia to GroundTruth to connect its platform to FrontlineCloud
- **Formalization** of the standing informal partnership between GroundTruth Initiative, InfoAmazonia, Internews, and Social Impact Lab

The initial concept, drafted by FrontlineSMS (later SIMLab, its nonprofit institutional home), was meant to lay the groundwork for a further estimated $500,000 consortium project to build and expand on this sensor pilot. So, this small pilot was also envisioned as the beginning of a fund raising campaign and preparation for donor engagement that would grow substantially.

In the one and a half years that followed, the project made several detours from the initial plan, which explains its current dormant status. At the same time, however, it also made headway in certain key areas. This evaluation reviews this trajectory, and draws several lessons learned.

An image of a forest fire in the Amazon taken from the International Space Station
Photo source:
NASA Earth Observatory

It is our hope that this open evaluation will be useful to others as they deploy similar projects, and fulfills our commitment to be as transparent as possible in our work

The report was written by Erica Hagen of GroundTruth Initiative, and is based on her knowledge of the project as a participant as well as interviews with each consortium member and reviews of project documents.

Project Timeline
FEBRUARY 2014: Initial conversation occurs between FrontlineSMS and Internews around the possibilities of the project
APRIL 2014: Funding is approved by Feedback Labs for the MakeSense project
JULY 2014: Decision made to reduce geographic scope to São Paulo
AUGUST 2014: MoUs signed among each member with SIMLab, to create an official consortium
MARCH 2015: SEEED Studio agreement is signed to manufacture the sensor prototype (known as DustDuino)
APRIL 2015: Sensors are shipped to Brazil
MAY 2015: The website DustDuino.org is up and running
JUNE 2015: Consignment agreement signed with SEEED Studio
JUNE 2015: The website OpenDustMap goes live with wifi sensor data
AUGUST 2015: Codigo Urbano holds sensor building party in São Paulo
JANUARY 2016: Video about the project is completed

Theory of Change
Under the initial theory of change, community members and groups in the Brazilian Amazon basin, who were highly impacted by environmental degradations, would operate simple sensors whose data would then be used by Brazilian members of the Earth Journalism Network (EJN) to report on key issues. By comparing readings to official sources they would be able to counter incorrect, unknown or ignored information, increasing accountability. InfoAmazonia (based in São Paulo) would provide the required networks and contacts in these communities and serve as local base, while Internews would supply the technical know-how for the devices. FrontlineSMS would develop a pipeline to transmit the sensor data via SMS through its platform. GroundTruth Initiative would design and test the engagement with local communities who would manage the sensors

The MakeSense project's conceptual framework built upon research and case studies in the nascent field of SENSOR JOURNALISM. Emerging sensor technologies could be used by citizens themselves to provide missing environmental monitoring in order to help hold governments and the private sector accountable, especially in cases where official measurements were not available, fully trusted, or reliable. It was envisioned that environmental journalists could help mediate this process.

SENSOR JOURNALISM
A white paper on this topic, informed by participants of a workshop held from June 1 to 2, 2013, was published by the Tow Center at Columbia University's Graduate School of Journalism.

Project Narrative
Inception

A meeting between FrontlineSMS and Internews was held in Washington, DC to discuss deployment of a GSM-BASED SENSOR NETWORK as a continuation of prototype development funded by the Internews Center for Innovation and Learning. GroundTruth Initiative was brought on to help design and test a citizen engagement process around the sensors. InfoAmazonia, an organization based in São Paulo, Brazil, provided the local context and capacity for piloting (Internews and its Earth Journalism Network (EJN) were already working closely with InfoAmazonia).

Following the submission and acceptance of a brief proposal to Feedback Labs, the consortium convened its first meeting for project start up in **APRIL 2014**. The purpose of early meetings was to reach a common understanding of prioritization and execution of the project.

During these early discussions it became clear that Internews already had a strong preference for working with air quality sensors as a result of prior research and development of 10 prototypes, called DustDuinos, that were tested with journalists in 2013. The gap in data quality for low-cost dust sensors was shrinking, and deploying low-cost sensors as a complement to high-cost monitors had real potential to expand monitoring networks and increase opportunities for citizen contributions. Other types of environmental sensors, such as water quality sensors, were still comparatively difficult to develop at low cost.

Previously, the DustDuino sensors – designed by Matthew Schroyer, an Instructional Technologist at Oklahoma City Community College – had been set up individually, with parts coming from several different manufacturers. A GSM version had not yet been tested.

GSM
A globally available standard for connecting to cellular networks. Sensor devices connected to GSM networks transmit data using text (SMS) messages .
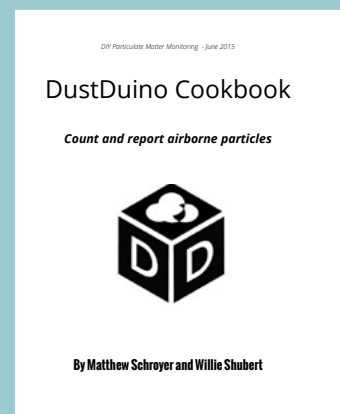
SENSOR NETWORK
A wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental condition.

Research: Air Quality and Sensors

The health effects attributed to outdoor fine particulate matter (PM2.5) rank it among the risk factors with the highest health impacts in the world, accounting for over 5.5 million premature deaths annually. More than 85 percent of the global population lives in areas where the World Health Organization Air Quality Guideline is exceeded.

DustDuino was initially developed as a low-cost means for individuals with limited resources monitor particulate matter concentrations. It uses the SHINYEI PPD42NS, and an ARDUINO development board and transmit sensor data to the internet.

DIY Particulate Matter Monitoring - June 2015

DustDuino Cookbook

Count and report airborne particles

By Matthew Schroyer and Willie Shubert

For more information on the health issues of air pollution and sensor specifications visit Publiclab.org/wiki/dustduino or the documentation listed in the outputs section

It may not have been clear at this point to all partners or to Feedback Labs that **production of mass-produced sensor hardware device is in itself a highly challenging and time-consuming process** – or, the extent to which the mass-produced version of the device and its data systems were still in a very early stage of development. The initial hypothesis had assumed that there was a working prototype, or that one could be easily produced.

Changing hardware parameters, new partners

The budget allotted to the pilot turned out to be not nearly enough to cover the objectives of the team. Discussion centered around what constituted a minimal viable product, and there was some disagreement on project direction. Should the pilot set the stage for further fundraising based on a limited product and research, or should time be spent actually developing and field testing more thoroughly – which would ultimately leave less partner time for outreach and business development?

There were several cost considerations. First of all, sensor components themselves are priced based on their quantity. A cost analysis conducted in **MAY 2014** projected the following costs per unit (organized by connectivity type) without mass production:

- GSM: $174.22 per unit
- WI-FI: $97.95
- XBEE MESH NETWORK: $206.69

If sensor kits could be mass-produced, it would lower the cost per unit and reduce the logistical complexity needed to acquire parts from multiple sources. However, reducing per-unit costs required increasing the quantity of sensors ordered beyond the needs of this pilot. Internews offered to provide co-financing for the cost of additional units to be used in their broader sensor work.

But, that also meant possibly reducing orders of GSM sensors, since they were more costly to produce and would additionally require substantial budget allocation to cellular charges. Each individual data transmission incurred SMS charges unless donated by mobile network providers. For example, a network of 30 devices sending 24 messages a day (hourly) for 90 days at $0.05 cents per message would cost $3,240.

Another emerging consideration was that the number of sensors required for accurate measurement needed to be large enough to function as a "network." A reprioritization toward a more scientifically valid proof of concept would mean deploying a larger number of sensors than first envisioned.

Two issues that were previously not well considered arose at this point, which would redirect the course and alter the goals of the project.

- Internews' suggestion that a fairly large number of sensors would be required in order to attempt to create reliable data worthy of comparison with official sources.

ARDUINO
An open-source hardware development platform that includes a software programming environment for supporting a diversity of hardware configurations.

These prices are based on retail rates for component parts in May 2014 . These do not include shipping, tax, or customs costs.

Sources for parts included Adafruit, DFRobot, DigiKey, Fastenal, HobbyKing, and SeeedStudio

XBEE MESH NETWORK
XBee networks enable devices to connect to private networks with greater outdoor range by forming an interconnected mesh.

- Related interest in mass production meant ordering sensors that could be used beyond the scope of this pilot, and therefore GSM-based sensors would not be mass produced at this stage.

At the same time, after breaking down the travel costs both within and to Brazil, it became clear that this travel would potentially be cost prohibitive. InfoAmazonia is based in São Paulo, and the locations proposed for deployment were in the Amazon basin, requiring local travel expenditure. GroundTruth was originally meant to assist with deployment and community engagement planning with the selected civil society organizations, which also required international travel.

Rural testing may still have been achievable within the initial budget, but now there was a growing concern among some team members that a user interface for configuring the sensor and an attractive front-end site for displaying the data were missing from the project plans.

The initial idea was that InfoAmazonia.org would be the hub where the sensor data would appear and be mapped. InfoAmazonia already had a geographic component and a network of environmental journalists. The data would be sent to Xively to be captured and managed, but this too ran into cost barriers - there was concern over being locked into the Xively fee-based platform indefinitely. Feedback from the initial Internews pilot also indicated that simplifying the process for connecting the device to an online database was important.
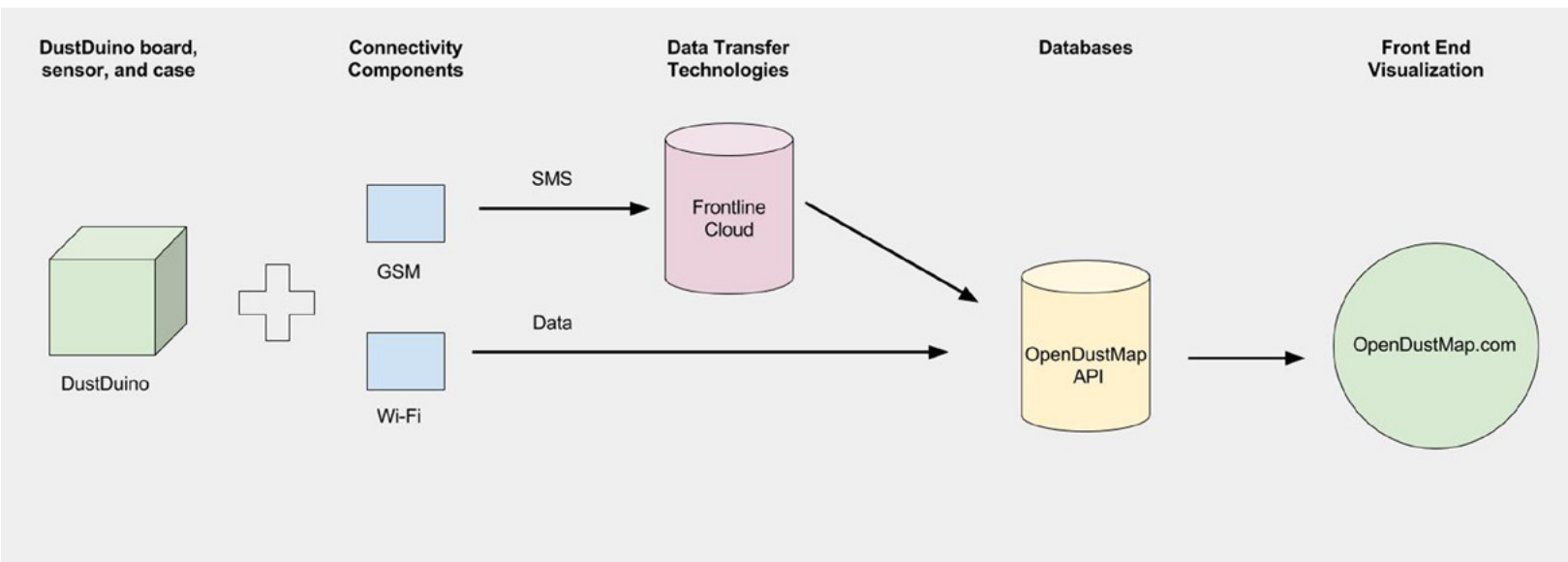
For these reasons, a decision was made to create the Open Dust Map site to contain and display the data, and for individuals to connect their sensor easily to the web. Development Seed would come in as a new partner as InfoAmazonia lacked the ability to display streaming data without investment. They would house the incoming data from the sensors in a simple database on their servers and display it geographically on the site.

In order to save money and reallocate some to the new partner, as well as to establish a longer term manufacturing and distribution partnership for the devices with SEEEDStudio, a China-based manufacturer, Internews proposed that the

A diagram of the data pipeline for streaming, storing, and visualizing the sensor data created for this project. The software developed to transmit data from the sensor to the internetconfigured according to the connectivity technology.

team rely on mass-produced sensors and pay for 35 sensors out of a bulk order of 100 (the rest of the 100 would be paid for by Internews for their own use).

The majority of these sensors would be wifi-based, without the GSM shield. The wifi-enabled sensor was priced at approximately $50.80 USD per unit in the bulk order (a GSM-enabled sensor from SEEED would have cost approximately $110.70 per unit).

So, the decision was made to produce the wifi sensor in bulk, and to separately purchase a set of GSM shields that could be tested on a few of the devices

From Community Engagement, to Civic Spaces

Aside from the cost savings potential in removing transportation to rural Brazil, the project now had to make the wifi sensors work - which meant limiting much of the project to urban centers. So, the team decided to reevaluate the location of the sensor project deployment. They considered first whether measuring air quality during the World Cup, taking place in JUNE 2014 in Rio, was feasible within the time frame. But this would require very rapid production of the sensors. While some sensors already existed, they weren't in Brazil and would need to be sent or carried there in time. The time was too short for this idea to succeed.

UNBOXING: Each Dust-Duino kit arrived with parts needed to put together a sensor. They were not pre-assembled for both shipping and cost reasons.

Alternatively, InfoAmazonia proposed testing sensors within São Paulo itself in public spaces. Air quality could be measured in micro-environments such as individual bus stops on the streets of the city. Individuals could borrow a sensor from InfoAmazonia and test their homes, schools, and other places where there may be concern about air quality. This was the final model of deployment that was selected. GroundTruth Initiative was reassigned to work with InfoAmazonia on the plan for deployment and engagement around a variety of São Paulo communities, with both wifi and GSM sensors.

Shifting project goals and allocations

This set of interrelated decisions—ordering the wifi sensor, designing a new user interface and front end with a new partner and mass producing the sensors—reallocated the budget from the initial plan, which had relied heavily on two partners for much of the pre-deployment work.

GroundTruth and InfoAmazonia were to collaborate closely with local organizations to conduct early research around sensor data demand and citizen engagement. Emphasis shifted from pre-deployment research around sensor data demand and citizen engagement, to setting up technical systems and working on hardware, data pipelines and web design.

This decision **acknowledged on the one hand the sheer difficulty of setting up a new and functional piece of hardware in bulk**, and the failure to build in appropriate funding and timelines in the initial proposal for this development.

It seems the assumption was made that hardware development was already covered by Internews and InfoAmazonia for other projects, so it would not need to be figured into the planning as extensively as was needed. Many of the challenges and time delays that arose later came out of the manufacturing and data pipeline processes.

However, it also indicated **a move towards spending on development time over determining field needs and demand in-person**, relying instead on an individualistic "MAKER" MODEL. By this model, community access comes only after a device is developed and validated within a hacker/technologist setting. Or, journalists and other data literate individuals exclusively work with technology and mediate the information to the general public.

This can allow for all the bugs to be worked out before devices are introduced to less technical groups and communities, but it **may risk failure to develop for the needs of such communities without their participation**, leaving them with hardware and software that has already been built to suit a particular social subset (usually wealthier, more urban, and highly technically skilled groups). In some ways this goes against the "Maker" ethos itself, which might prioritize tinkering in-situ whether in the Amazon basin or an urban hackerspace. Ultimately, environmental sensors will need to reach locations that are more remote and challenging.

A clear **tension between the desire to have statistically valid data and systems, and to have input from the potential user community in a high-need field context** arose due to the limited budget.

MAKER MODEL:
An approach that focus on individuals familiar with do-it-yourself (DIY) techniques to develop unique technologies. This model pre-supposes participants embedded within communities of knowledgeable peers that can access tools at low cost.

The goal was always to get a working prototype of the technology and research the needs of the remote community. But, as the technical/logistical challenges grew and the timeline slipped, the ambitions of the project were forced to contract. Without a working prototype to show, raising follow-on funding also became more difficult.

In technology and development projects, there is often a question to be answered about exactly how and when to integrate user feedback directly—a question of what happens when, and how often during the overall design process.

In the case of this project, there may have been different, shifting, or poorly communicated understandings within the team of who the most critical "users" were for this pilot (and whose feedback was necessary at each juncture): the initial proposed target of the Amazon basin communities, or the urban "hackers" who were already familiar with Arduino boards and could more easily manage the devices.

Sensors Arrive

By the end of 2014, five sensors with GSM shields had been sent to Brazil and assembled by the project team. FrontlineSMS developed the API to channel their SMS messages to the website in development by Development Seed. However, there was another problem: the code on the devices themselves wasn't working

An assembled DustDuino prior to installation in an apartment window.

correctly to allow the GSM shield to operate. The team would have to re-code the devices to even begin to transmit any data. Since this was also not budgeted for, a Brazilian developer had to commit volunteer time to get them working. This was not completed until March of 2015, and bugs in the code plagued the project throughout.
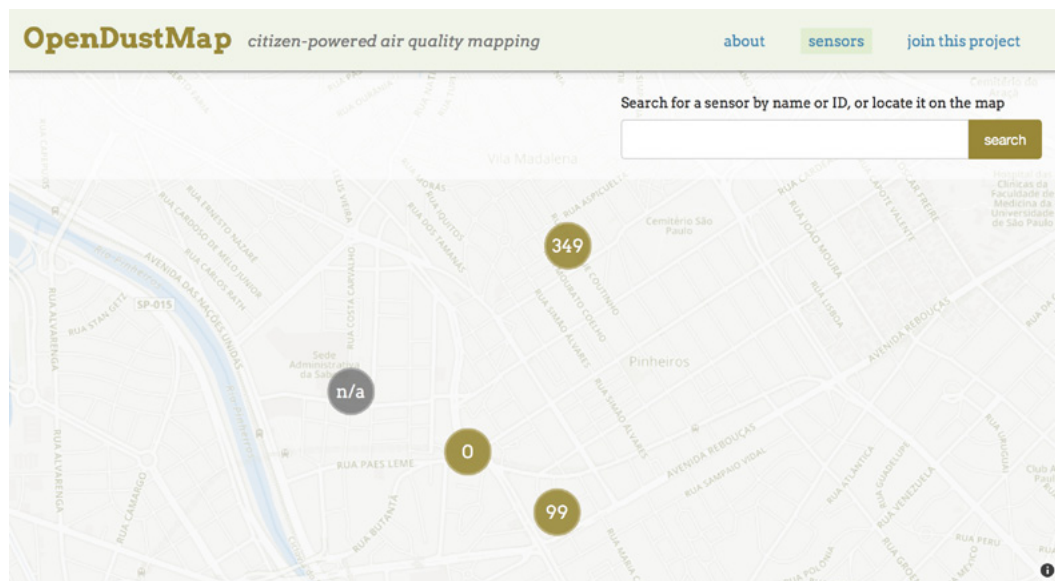
Three of these GSM sensors were then set up for testing: one at a bus stop, one at a local "hackerspace", and one at the InfoAmazonia office. Each began to send SMS messages to FrontlineSMS (which were paid for by the project); however there was an issue between the Frontline API and OpenDustMap so initially they could not be displayed on the map. These messages were eventually taken down until this could be resolved.

Meanwhile, the full shipment of sensors had been delayed while Internews developed the manufacturing agreements and documentation with SEEED studios, the manufacturer. It also turned out that CUSTOMS EXPENSES in Brazil were going to fully triple the cost of each sensor, an unforeseen budgetary challenge. For 35 sensors, the costs to import came to nearly $2,900 USD. Internews covered that expense.

CUSTOMS EXPENSES
Customs tariffs are determined based on products harmonized system (HS) codes set by the World Customs Organization. A large shipment without a recognized product code was subject to arbitrary fees.

The Bus Stop:

To help the data reach the general public in São Paulo, the InfoAmazonia team decided to deploy one sensor at a news kiosk in a large public bus station. A large color-coded LED sign was hooked up to the Arduino processor to alert the public to high dust levels. They also put up posters to help people understand the LED warnings and issues around air quality.

DustDuino em SP: sensores independentes de qualidade do ar

This GSM enabled air quality monitor used an LED strip as an indicator. It was placed above a news stand in a bus terminal in São Paulo. A poster was made to share with neighbors who adopted a sensor.

In **APRIL 2015**, the full sensor shipment arrived in São Paulo. In August, an event was held to start to share the devices within the hacker community for testing, and an online form was developed and shared to invite residents to "adopt" a sensor, or take one home or to their office on loan. Five devices were adopted by attendees during the hacker event

Created (UTC)	PM10 µg/m³	PM10 Count pt/cf	PM2.5 µg/m³	PM2.5 Count pt/cf
01:00 23/09/15	44.96	140.84	1.51	1254.65
00:00 23/09/15	35.89	112.38	0.81	838.03
23:00 22/09/15	21.93	68.78	0.34	494.08
22:00 22/09/15	22.83	72.09	0.19	467.21
20:00 22/09/15	90.16	281.11	1.54	1255.41
19:00 22/09/15	206.59	642.79	2.08	1596.92
18:00 22/09/15	4.17	13	0	60.17
15:00 19/09/15	26	82.17	0	141

The statistical view of the air quality data on Open-DustMap shows PM10 and PM2.5 patterns at hourly intervals.

In **SEPTEMBER 2015**, the bus stop GSM sensor was re-deployed and began sending signals via SMS to Frontline, and from Frontline to OpenDustMap successfully.

However, other technical issues became apparent immediately. The sensors were getting incorrect readings. Some appeared to have actually negative numbers. Others were clearly too high. It turned out that the casing was the wrong size for the sensors and was obstructing the airflow; meanwhile the wifi component's power demands were also impacting the readings . The casing was resized locally but funding for reordering all the cases from SEEED Studio was not available.

A poster was designed to accompany a public sensor deployment and highlight air pollution issues, causes, and what the device is.
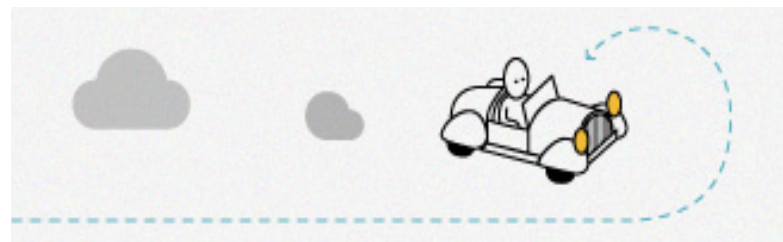
Overall, several bugs were reported in the wifi sensors in **LATE 2015** – complex combinations of hardware and software with multiple points of failure, meaning that troubleshooting them was time-consuming, and not budgeted for. Some of these additional issues were not resolved when the casing was fixed.

By November, so few sensors had been deployed that information was very patchy. Once a sensor went offline, its historic data remained with no way to remove or mark it as old. Again, funds to permit even this relatively small fix were not available.

The consortium decided to archive the site for the time being and turn it into a record of the pilot's learning, foregrounding this report and resources that might allow others to take forward this work. GroundTruth committed to document this learning and evaluate the project.

Conclusion:

Ultimately, this project has not sufficiently demonstrated proof of concept or fully tested its hypothesis: Citizen-led sensor monitoring of environmental factors will strengthen feedback loops by providing structured, accurate, and reliable data to compare against government measurements and news stories in the Amazon basin.

The project has made some progress toward creating a reliable DustDuino air quality sensor prototype; ironing out mass-production, software and hardware issues; and building FrontlineSMS integration, API, and a back-end user integration and front-end data display on Open Dust Map. The project has also made headway toward getting reliable and accurate structured data from the sensors, and produced extensive documentation that will allow for further experimentation.

In the end, however, the consortium was not able to successfully test the potential of sensor technology for monitoring by people and communities most affected by environmental degradation.

This is where the project stands as of this review. Internews does plan to carry forward efforts to increase data quality through new casing and other improvements, and to continue to develop DustDuino in 2016 in combination with several other related projects -- such as OpenAQ, a site monitoring official government air quality data. The formal consortium established for this pilot does not have plans to move forward.

MakeSense : DustDuino | *INPUTS*

Codigo Urbano organized local deployments and coding
- Organized meet-ups at São Paulo hackerspaces
- Led GSM hardware development
- Led local sensor assembly and configuration

Development Seed led the software development and design initiatives
- Produced opendustmap.com and api.opendustmap.com

DustDuino lead developer Matthew Schroyer:
- Led engineering of the DustDuino board
- Led wifi code development
- Provided materials for product documentation

Feedback Labs provided financial support for the pilot
- 60,000 USD

FrontlineSMS (later SIMLab), produced the proposal and led development of the GSM data pipeline
- Coordinated project schedule and task management
- Development of SMS pipeline to OpenDustMap via FrontlineCloud API

GroundTruth Initiative contributed research and learning components of the project
- Advised InfoAmazonia on deployment strategy
- Produced the learning report

*InfoAmazonia* led the production of local media and deployment of
- Coordinated local deployment of sensors
- Produced video and poster materials

*Internews Earth Journalism Network*, led hardware development and documentation
- Research and development of sensor technology
- Coordinated development and iterative testing of sensor technology
- Formalized manufacturing relationship and managed logistics
- Led production of users tutorials and documentation

MakeSense : DustDunio | OUTPUTS

TECHNOLOGY
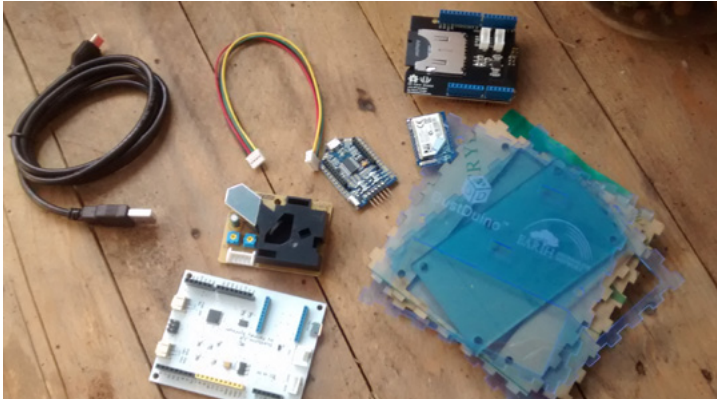
DustDuino Kits
DIY air quality monitoring kits . 100 sensors produced by SEEED Studio (40 sensors in Brazil: 5 GSM and 35 Wifi based) under a manufacture, distribution, and pricing agreement.
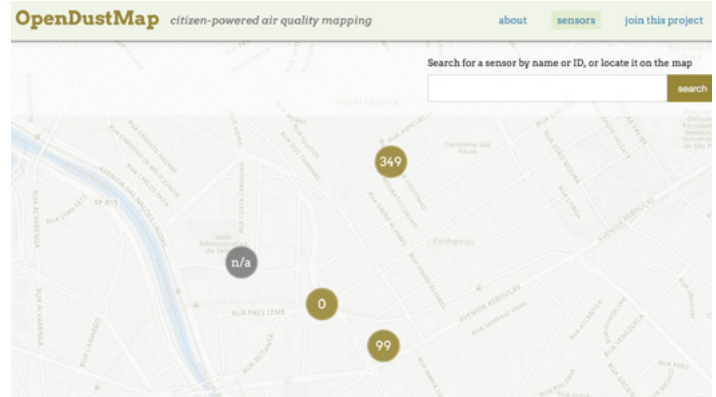
opendustmap.com
The front end website for displaying the data generated by the sensors.

DOCUMENTATION

DIY Particulate Matter Monitoring - June 2015

DustDuino Cookbook

Count and report airborne particles

By Matthew Schroyer and Willie Shubert

https://brazil-sensor.herokuapp.com

Deployment Poster
Designed to accompany public displays of the sensor

DustDuino Cookbook
Detailed documentation for configuring, assembling, and deploying DIY sensors.
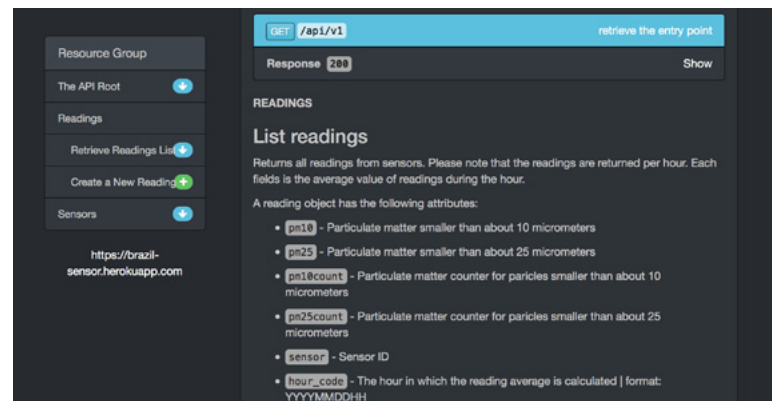
api.opendustmap.com
An open-by-default online database for sensor readings.

MEDIA

Scientific American *Dust in the Wind: How Data Visualization Can Help The Environment*, published July 15 2015

Nature *Environmental Science Pollution Patrol*, January 15, 2015

Development Seed *Opening Up Air Quality Data,* June 3, 2015

Codigo Urbano - *Primeiro sensor independente para monitorar poluição é instalado em SP,* March 25,2015

OpenDustMap Project Video - March 2016

Lessons for future projects

Technical Challenges

1. TECHNICAL DIFFICULTIES ARE TO BE EXPECTED. Setting up a new hardware is not like setting up software: when something goes wrong, the entire device may have to go back to the drawing board. Delays are common and costly. This should be expected and understood, and even built into the project design, with adequate developer time to work out bugs in the software as well as hardware. At the same time, software problems also require attention and resources to work out which became an issue for this project as well, which often relied upon volunteer backup technical assistance.

2. REDUCE TECHNICAL KNOW-HOW REQUIRED FOR YOUR DEVICE: SIMPLIFY. The project demonstrated that it's important to aim for the everyday potential user as soon as possible. The prototype, while mass-produced, still required assembly and a slight learning curve for those not familiar with its components, and also needed some systems maintenance in each location. Internews plans for the DustDuino's next stage to be more "Plug-and-play" - most people don't have the ability to build or troubleshoot a device themselves.

3. CONSIDER DATA SYSTEMS IN DEPTH . This project suffered from a less well-thought-out data and pipeline system, which required much more investment than initially considered. For instance, the sensor was intended to send signals over either wifi or GSM, but the required code for the device itself, and the destination of the data shifted throughout the project. Having a working data pipeline and display online consumed a great deal of project budget and ultimately stalled.

4. PRIORITIZE DATA QUALITY. The production of reliable data, and scientifically

While setting up a deployment at a news stand, Gustavo Faleiros of InfoAmazonia, used the poster to explain the aims of the project.

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valid data, also needs to be well planned for. This pilot showed how challenging it can be to get enough data, and to correct issues in hardware that may interfere with readings. Without this very strong data, it is nearly impossible to success-fully promote the prototype, much less provide journalists and the general pub-lic with a tool for accountability

Implementation Challenges

BE INTENTIONAL: DON'T UNDERESTIMATE THE NEED FOR IMPLEMENTATION FUNDING. It is often the case that software and hardware development use up the majority of a grant budget, while programmatic and implementation or field-based design "with" processes get short shrift in the inception phase. De-cision making about whether to front-load the technology development or to develop quick but rough in order to get prototypes to the field quickly, as ref-erenced in the narrative, should be made intentionally and consciously. Non-technical partners or team members should be aware of the incentives present for technical team members to instinctively emphasize technical development over equally critical local engagement and field testing processes.

FUNDING PARALYSIS. The anticipation of a need for future funding dominated early conversations, and led to a typical problem with pilots: funding available tends to skew to piloting with no follow up funding opportunities for successful pilots, leading to the conundrum that before the pilot even produces its results, organizations must begin to source other funds. That means they must allocate resources to business development as well, which can be difficult if not impos-sible, and face pressure to create marketing materials and other PR pieces. This can also in some cases (although not with this pilot) lead to very premature claims of success and lack of transparency. During this project, there was some disagreement among team members about how much to use this pilot fund to support the search for further investment, almost as a proposal development fund, and how much to spend on the actual proof of concept through hardware/software development and field testing.

This is a lesson for donors especially: when looking for innovative and experi-mental work, include opportunities for scale-up and growth funding or have a plan in mind for supporting your most successful pilots.

TEAMWORK. A consortium project is never easy. A great deal of time is required simply to bring everyone to the same basic understanding of the project. This time should be adequately budgeted for from the start. Managing such a team is a challenge, and experienced and very highly organized leadership helps the process. FrontlineSMS (which received and managed the funding from Feedback Labs) specifically indicated they did not sufficiently anticipate this extensive re-quirement. Also, implementing a flat structure to decision making was a huge challenge for this team. Though it was in the collective interest to achieve major goals, like follow-on funding, community engagement, and a working prototype, there were no resources devoted to coordinating the consortium nor any spe-cial authority to make decisions, sometimes leading to members operating at

cross purposes. Consistent leadership was lacking, while decision-making and operational coordination were very hard given quite divergent expectations for the project and kinds of skills and experience. This is not to say that consortium projects are a poor model or teams should not use a flat structure, but that leading or guiding such a team is a specialty role which should be well considered and resourced.

Part of the challenge in this case was that the lead grantee role in the consortium actually shifted in 2015 from FrontlineSMS to SIMLab, its parent company, when the FrontlineSMS team were spun out with their software at the end of 2014. The consortium members were largely autonomous, without regular meetings and coordination until July 2015, when SIMLab instituted monthly meetings and more consistent use of Basecamp.

COMMUNICATIONS. Set up clear communications frameworks in advance, including bug reporting mechanisms as well as correction responsibilities. Delays in reporting bugs with Development Seed and FrontlineSMS APIs contributed significantly to the instability of the sensors in the field. Strong information flow about problems, and speedy remote decision-making, was never really achieved. At the same time, efficiency in such consortia is paramount, so that time isn't taken from operational matters with coordination meetings - so a balance must be struck. This project eventually incorporated the use of BaseCamp.

Implications for Innovation Funding

While it might have been too ambitious to try for a hardware prototype with two types of connectivity, a documenting website, actual community engagement AND business development, all for $60k, not to mention the coordination required, it is also true that typical funds available for innovation lend themselves to this kind of overreach. Indeed, a more realistic proposal would have merely stated that the team would work out software and hardware bugs and establish key relationships and processes, clearly only a first step - though a critical one - toward a "feedback loop". However, such a proposal would not be as exciting to donors.

At the same time, for projects which have already come this far - which have a viable product and need to take the next several implementation and development steps - funding is not as easily available. Instead, funders may support a different team to start over from scratch with a similar concept rather than support the crucial yet less "exciting" growth phase of a project. If they do support a growth phase, they may expect the project to generate revenue prematurely.

Consortium projects are another trend that require more consideration. Rather than simply expect a new team to know how to work well together, in spite of differences ranging from subject area expertise, geographical base, to business models to even basic assumptions about development, funders should instead consider direct support (financial and/or capacity) to consortium leadership alongside or as part of project funding. Our analysis of this project highlights the key role played by communication and teamwork, yet hardly ever does a

funder request management plans or demonstrated experience in consortium leadership, nor give special attention and resources to support the collaborative process. The more partners are included, the more difficult the process becomes to the point where there may be a lack of buy-in and ownership of the project overall.

Good practice would be to support innovators throughout the process, including (reasonable) investment in team process (while still requiring real-life testing and results), and opportunities for further fundraising based on "lessons" and redesign from a first phase. As well, an expectation that the team be reconfigured, perhaps losing some members and gaining others between stages, plus defining a clear leadership process. Supportive and intensive incubation, with honest assessment built in through funding for evaluations such as this one would go a long way toward better innovation results.

Funders should also require transparency and honest evaluation throughout. If a sponsored project or product cannot find any problems or obstacles to share about publicly, they're simply not being honest. Funders could go a long way toward making this kind of transparency the norm instead of the exception. In spite of an apparent "fail fair"-influenced acculturation toward embracing failure and learning, the vast majority of projects still do not subject themselves to any public discussion that goes beyond salesmanship.