

Rumo ao Big Data nas Ciências Ambientais



access2perspectives.com

Alexandre Camargo Martensen

4ntena Ambiental - 02/06/2022

Ciência 2.0

Novos paradigmas da ciência



access2perspectives.com

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2 dos maiores desafios da humanidade

Biodiversity



<https://www.safeworldhse.com/2020/04/biodiversity-types-importance-loss-conservation.html>



<https://www.usatoday.com/story/news/nation/2020/09/10/climate-change-covid-19-does-global-warming-fuel-pandemics/5749582002/>

O que é Ciência 2.0?

- **Nova forma de se fazer ciência, baseada na troca de informações e na colaboração**
 - Open research
 - Open science
 - Big data

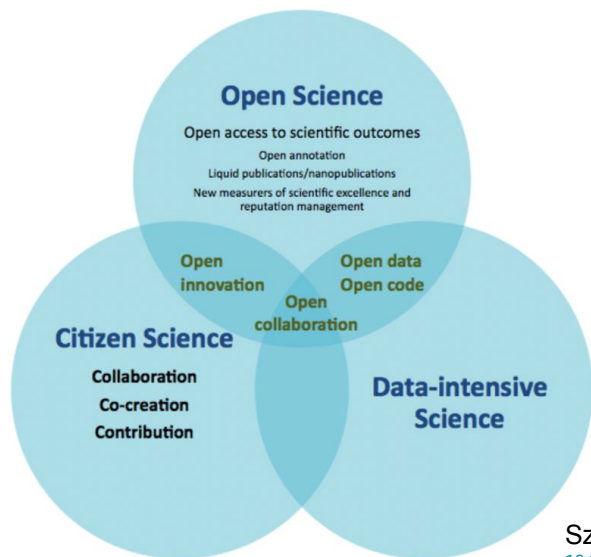
"Science happens not just because of people doing experiments,
but because they're discussing those experiments"

Christopher Surridge

<https://www.scientificamerican.com/article/science-2-point-0-great-new-tool-or-great-risk/>

O que é Ciência 2.0?

- Novas ferramentas de colaboração/comunicação como wikis, blogs, videos, open lab notebooks, gitHub, figShare, pré-prints, live figures, live code (ex. Shiny), data repositories, data-intensive, open reviews...



Data-intensive

Szkuta & Osimo (2012)
[10.13140/RG.2.2.35128.03842](https://doi.org/10.13140/RG.2.2.35128.03842)

Levantamento e monitoramento da biodiversidade 20 anos atrás...



Levantamento e monitoramento da biodiversidade

Métodos tradicionais (dificuldades)

- Espécies ainda não descritas
- Identificação de espécies crípticas
- Complexidade na identificação de jovens, etc
- Falta de especialistas/taxonomistas
- Amostragens não padronizadas (espacialmente, temporalmente, questões climáticas...)
- Técnicas e métodos de amostragens variáveis
- Amostragens invasivas
- Dificuldades cobertura amostral (espacialmente/temporalmente)
- Coleta > triagem > armazenamento > resgate da informação >> processo mecânico, passível de erros humanos
- ...

Sensing biodiversity

Sophisticated networks are required to make the best use of biodiversity data from satellites and in situ sensors

By **Woody Turner**

Global-regional coverage



Regional-local coverage



Citizen scientist with cell phone



Drone



Camera trap



Sound recorder



Wildlife officer with receiving antenna



Transmitting collar



Collecting environmental DNA



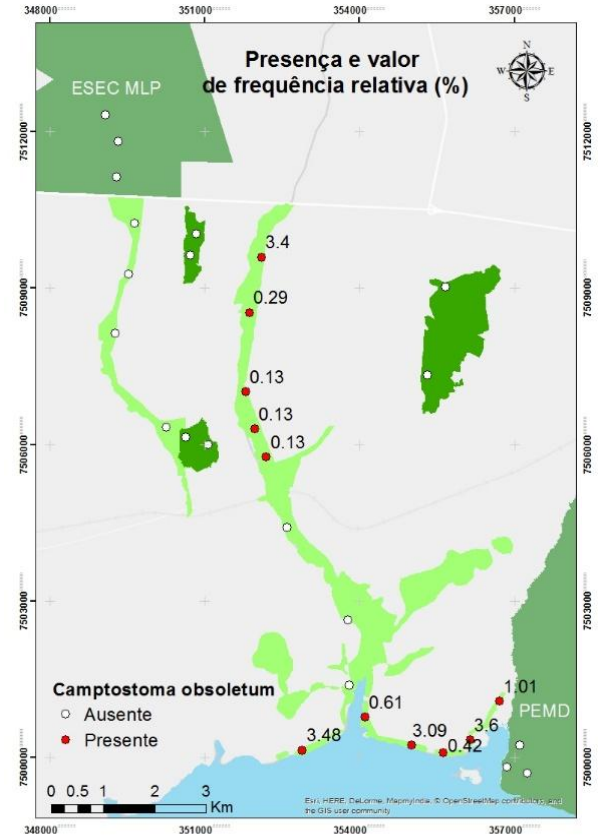
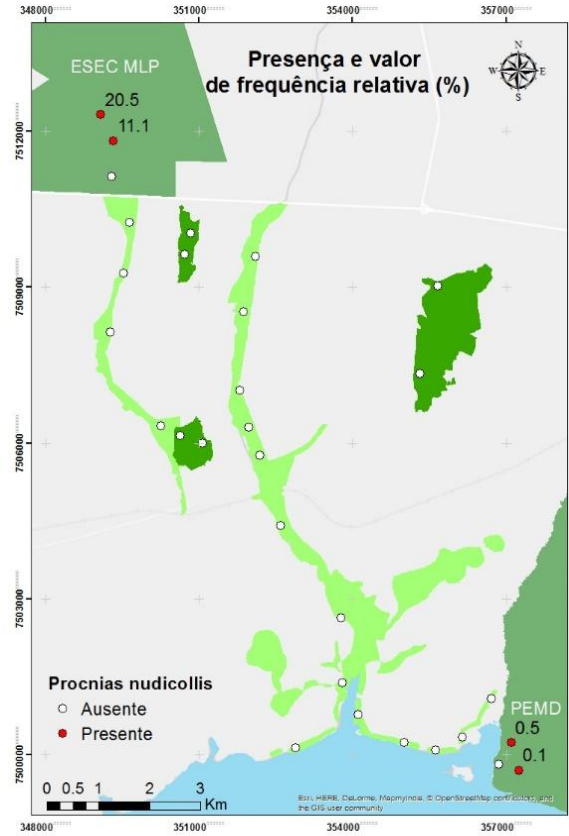
Turner (2014, DOI: 10.1126/science.1256014)



Monitoramento Sonoro



- Aves
- Anfíbios
- Morcegos
- Macacos

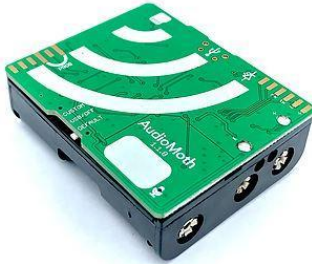




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Monitoramento Sonoro



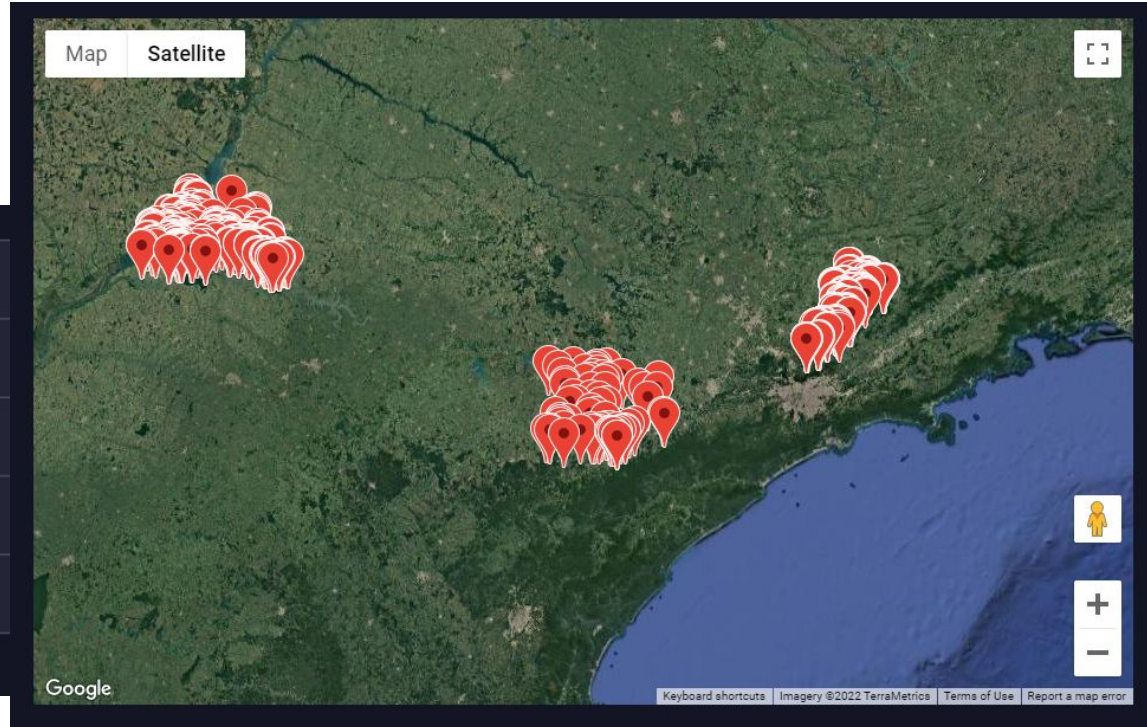
Sites: 604

Recordings: 2,006,027

Templates: 142

Pattern Matchings: 53

Validated species: 93



UFSCar Universidade Federal de São Carlos
Campus Lagoa do Sino

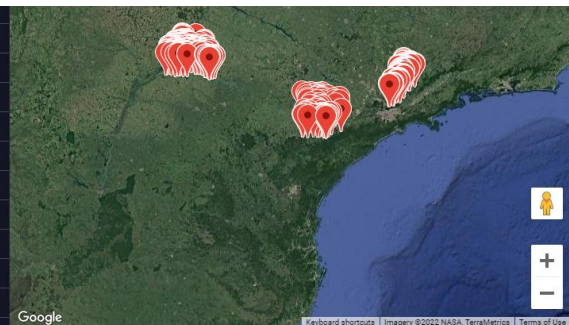


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Monitoramento Sonoro



ALPA_P3_35_45_MD	4675	-24.142	-48.559	812.00	May 10, 2022 3:15 PM
SC_B19P146GIPE12	6968	-22.855	-45.873	1,548.67	May 6, 2022 8:46 AM
SC_B06P107GIPE20	8149	-22.980	-46.041	856.18	May 4, 2022 4:26 PM
SC_B06P106GIPE36	8746	-22.985	-46.039	798.19	May 4, 2022 11:44 AM
ALPA_P2_45_55_MD	7151	-24.093	-48.246	770.00	May 4, 2022 11:02 AM
ALPA_P3_35_45_HD	7155	-24.079	-48.190	652.00	May 3, 2022 11:40 PM
ALPA_P3_55_65_LD	7159	-24.138	-48.273	837.00	May 3, 2022 5:24 PM
ALPA_P1_65_85_MD	7739	-24.091	-48.874	673.00	May 2, 2022 11:24 PM
ALPA_P1_15_25_HD	7753	-23.998	-48.927	652.00	May 2, 2022 4:53 PM
ALPA_P2_55_65_LD	7741	-24.139	-48.983	787.00	May 2, 2022 11:46 AM
ALPA_P2_45_55_HD	7734	-24.064	-48.882	701.00	May 2, 2022 12:49 AM
ALPA_P1_65_85_HD	3989	-24.119	-48.847	741.00	May 1, 2022 6:03 PM
SC_B09P090GIPE34	6492	-23.059	-46.163	982.59	Apr 15, 2022 4:05 PM
SC_B26P004GIPE02	4297	-23.215	-46.321	904.72	Apr 14, 2022 11:55 AM
SC_B15P012GIPE44	4623	-23.259	-46.294	759.80	Apr 14, 2022 7:57 AM
SC_B11P007GIPE67	8045	-23.135	-46.316	791.53	Apr 12, 2022 12:20 PM
SC_B31P153GIPE88	7161	-22.942	-46.165	1,066.37	Apr 12, 2022 7:55 AM
SC_B31P152GIPE15	6332	-22.947	-46.175	941.42	Apr 12, 2022 7:52 AM
SC_B31P154GIPE14	7161	-22.944	-46.172	968.76	Apr 11, 2022 2:00 PM
SC_B10P051GIPE58	5593	-23.113	-46.344	1,054.68	Apr 8, 2022 6:04 PM
SC_B10P046GIPE05	5592	-23.122	-46.341	1,047.72	Apr 8, 2022 3:58 PM
SC_B09P089GIPE73	3750	-23.057	-46.170	1,026.81	Apr 8, 2022 12:56 PM
SC_B09P088GIPE43	4154	-23.056	-46.163	1,021.52	Apr 7, 2022 7:12 PM
SC_B08P098GIPE45	4025	-23.061	-46.227	873.24	Apr 5, 2022 2:30 PM
SC_B17P106GIPE02	0	-23.225	-46.435	894.96	Mar 31, 2022 12:35 PM
SC_B29P180GIPE59	3300	-22.843	-46.10		

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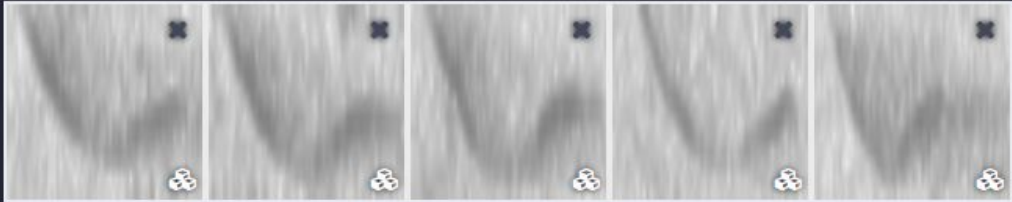
Monitoramento Sonoro



Turdleuco_nota3 info

Name	Turdleuco_nota3
Species sound	Turdus leucomelas - Common Song
	✓ present: 463 ✗ absent: 1004
ROI Count	5





Monitoramento Sonoro



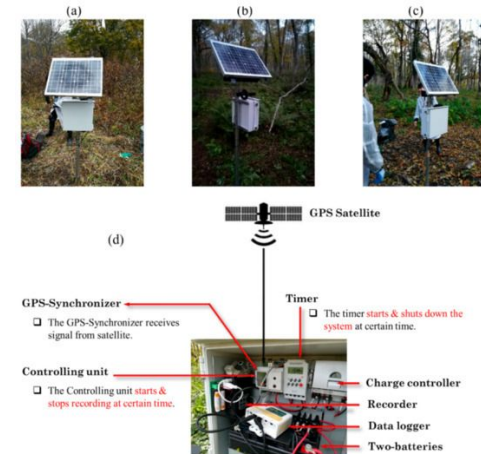
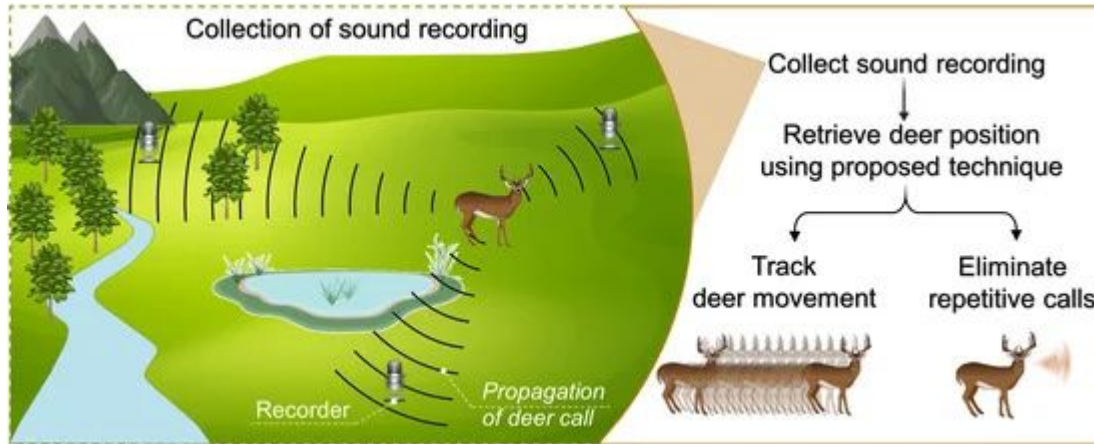
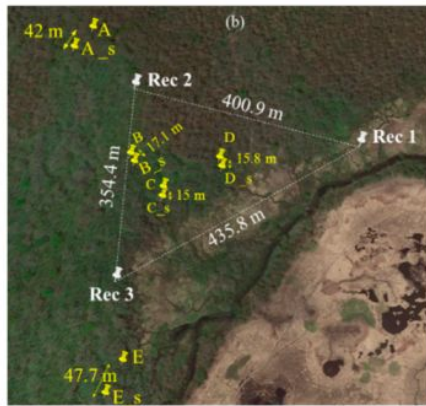
sensors



Article

Detecting and Tracking the Positions of Wild Ungulates Using Sound Recordings

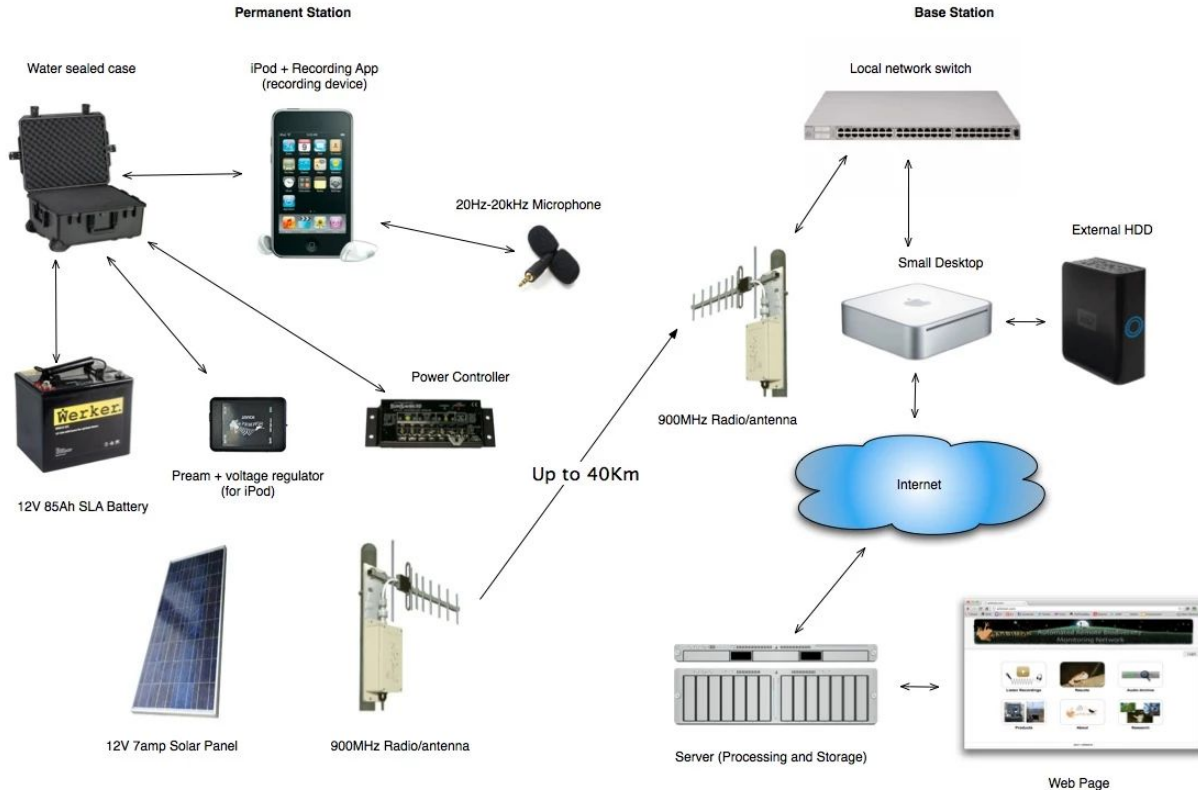
Salem Ibrahim Salem ^{1,2,*}, Kazuhiko Fujisao ^{3,4}, Masayasu Maki ⁵, Tadanobu Okumura ⁶ and Kazuo Oki ^{1,3}



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Monitoramento Sonoro em tempo real (Real Time)

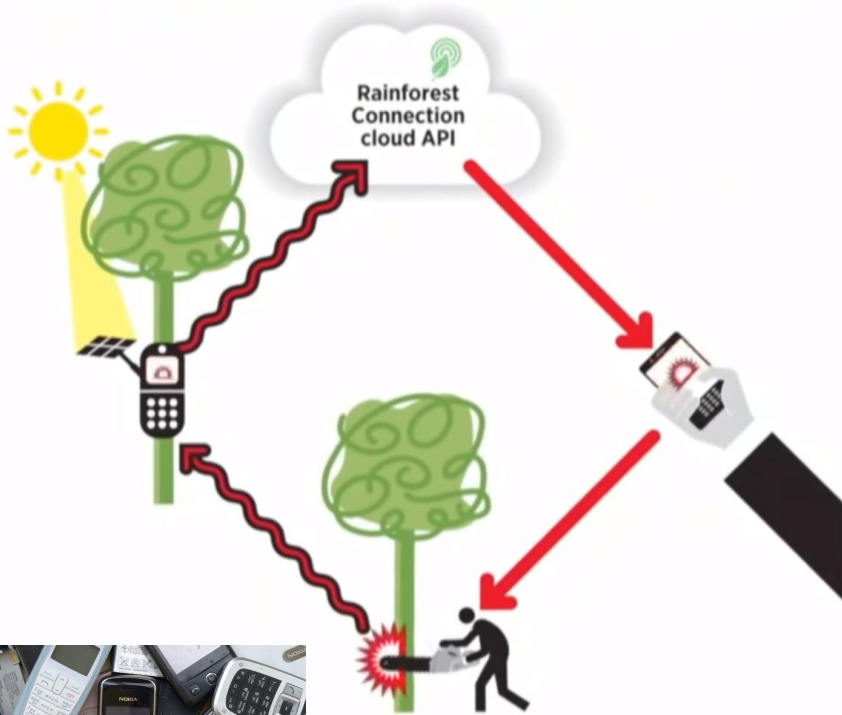


<https://newatlas.com/arbimon-wildlife-monitoring/28361>

Monitoramento Sonoro e desmatamento



Topher White



<https://youtu.be/xPK2Ch90xWo>



Monitoramento Sonoro e incêndio florestal em tempo real

Figure 2. Proposed system infrastructure.

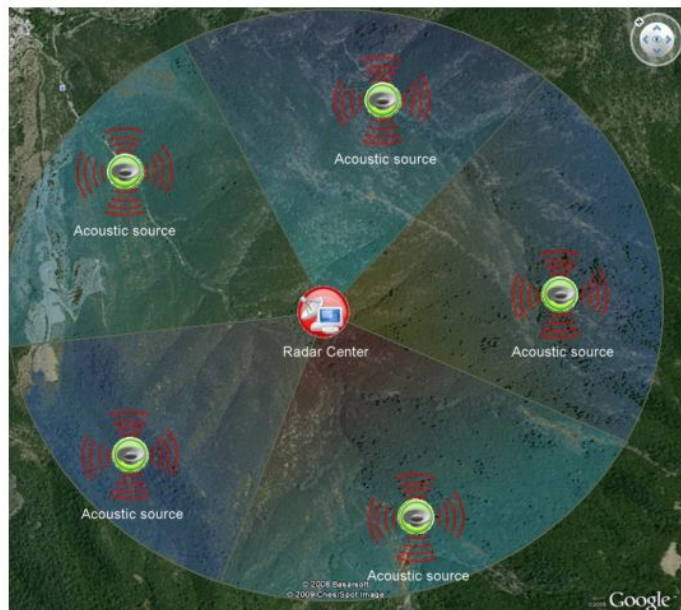
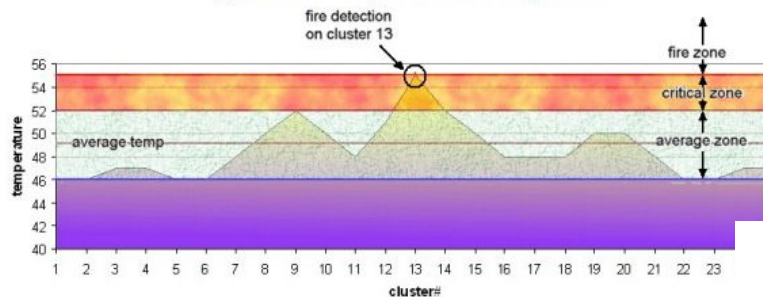


Figure 5. Warm region thermal data spectrum.



Sensors **2009**, *9*, 1485–1498; doi:10.3390/s90301485

Article

Early Forest Fire Detection Using Radio-Acoustic Sounding System

Yasar Guneri Sahin ^{1,*} and Turker Ince ²

OPEN ACCESS

sensors

ISSN 1424-8220

www.mdpi.com/journal/sensors

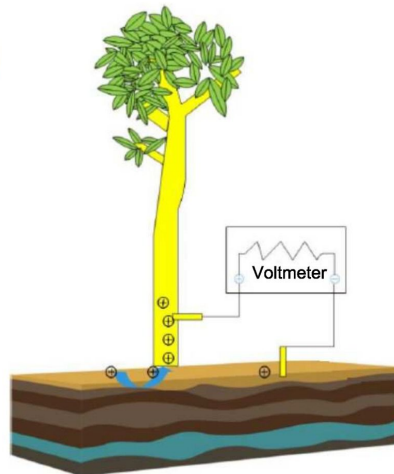
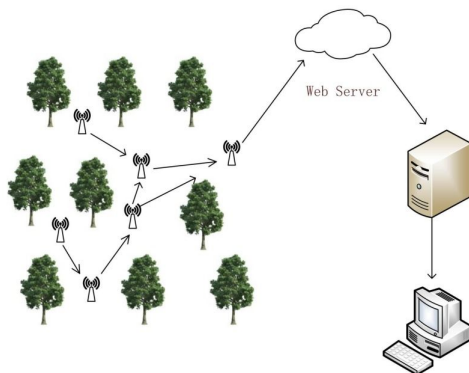
Monitoramento Sonoro e incêndio florestal em tempo real



Article

Wildfire Detection Using Sound Spectrum Analysis Based on the Internet of Things

Shuo Zhang [†] , Demin Gao ^{*,†}, Haifeng Lin [†] and Quan Sun [†]



3.1. The Principle of Energy Harvesting from Living Trees

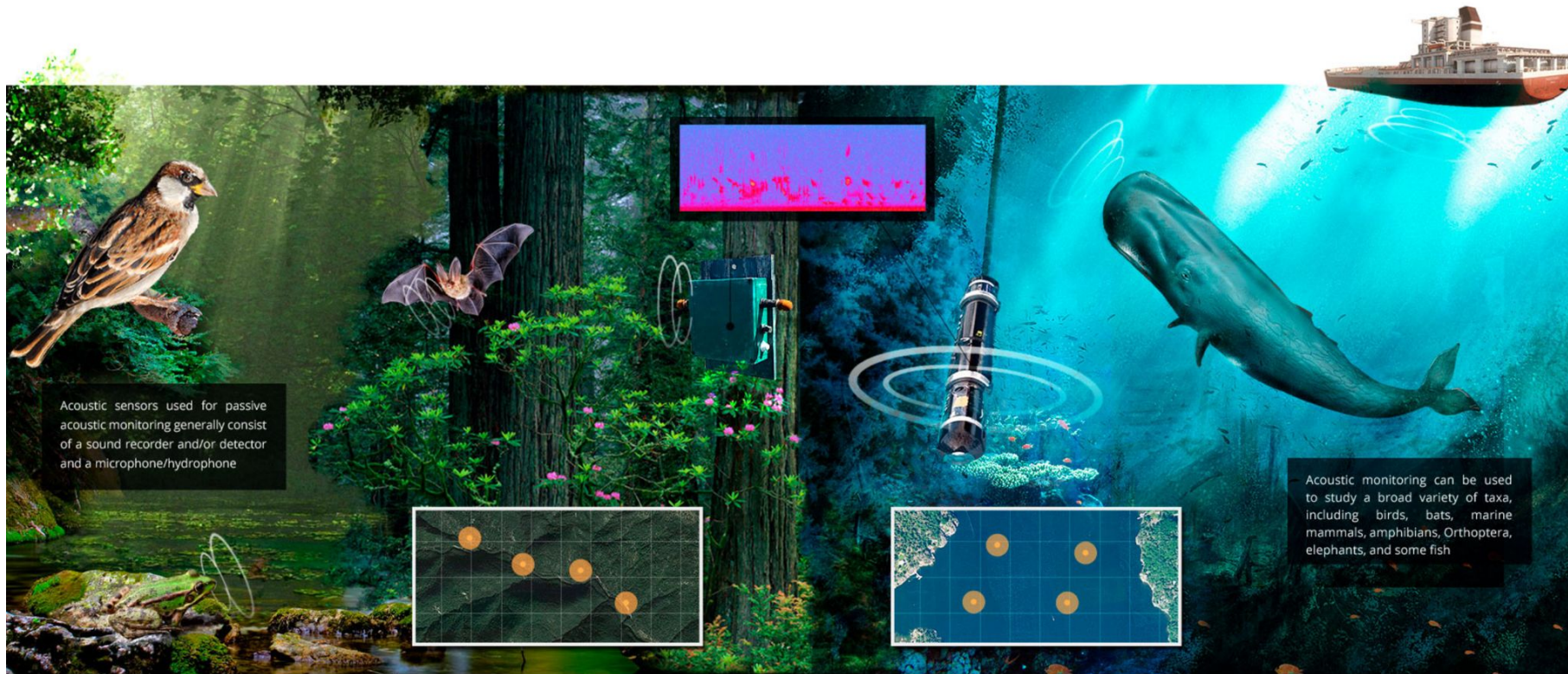
In the previous section, we discussed the energy supply issue of existing wildfire detection technologies, while the traditional solution is to use disposable chemical batteries with limited energy to provide power for conventional wireless sensor networks [40]. The reason why batteries are chosen to power nodes is that forested areas are generally in remote areas, and the terrain is rugged, which is unfavorable for supplying power to the sensors and to the data transmission of the sensors. It is universally acknowledged that it is inconvenient to replace disposable chemical batteries with limited energy in forested areas, and these batteries will cause severe pollution to the environment. To solve this issue, we did some related studies and found that we could harvest energy from living trees.

1.1. The Voltage Caused by Differences in the pH of the Xylem and Soil of Trees

In the process of measuring the voltage of eucalyptus, the Nernst equation generated from the potential voltage of the pH concentration is expressed as: $V = V' - \frac{RT}{nF} [\Delta pH] \sim 56mV [\Delta pH]$, where R is a general gas constant of $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$, T is the Kelvin temperature, and F is the electric charge mes Avogadro's constant, which is $9.648 \times 10^4 \text{ C mol}^{-1}$, and $[\Delta pH]$ is the difference between the two pH values [41]. This formula can be used to calculate the theoretical power that Eucalyptus can produce. From Figure 2, we can observe that under the effect of the tree's metabolism, it can produce a weak current.

doi: [10.3390/s19235093](https://doi.org/10.3390/s19235093)

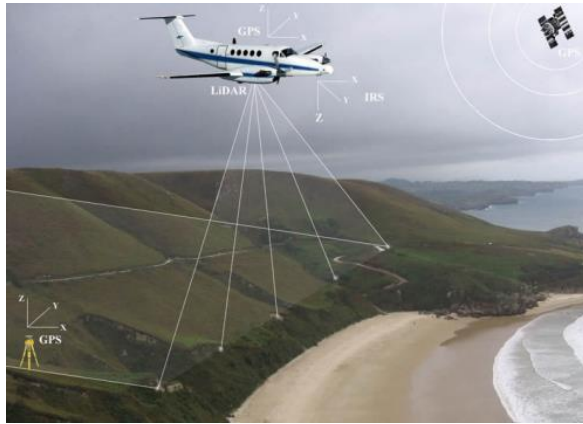
Monitoramento Sonoro



<https://www.wwf.org.uk/project/conservationtechnology>



Lidar - Light detection and ranging



<https://www.wwf.org.uk/project/conservationtechnology>

Lidar

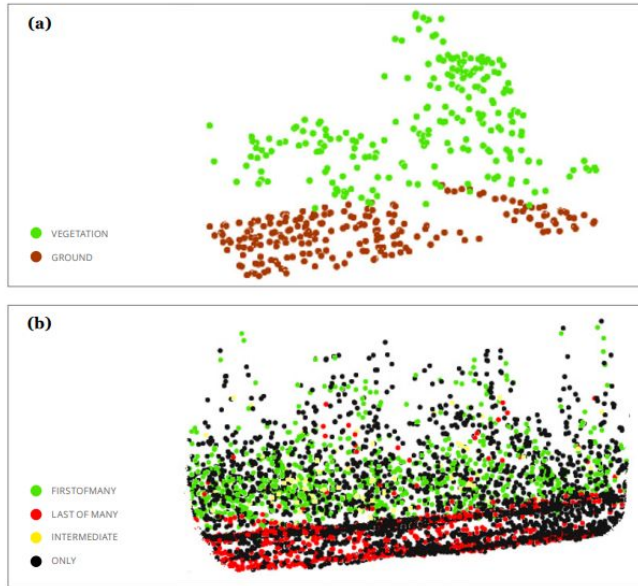
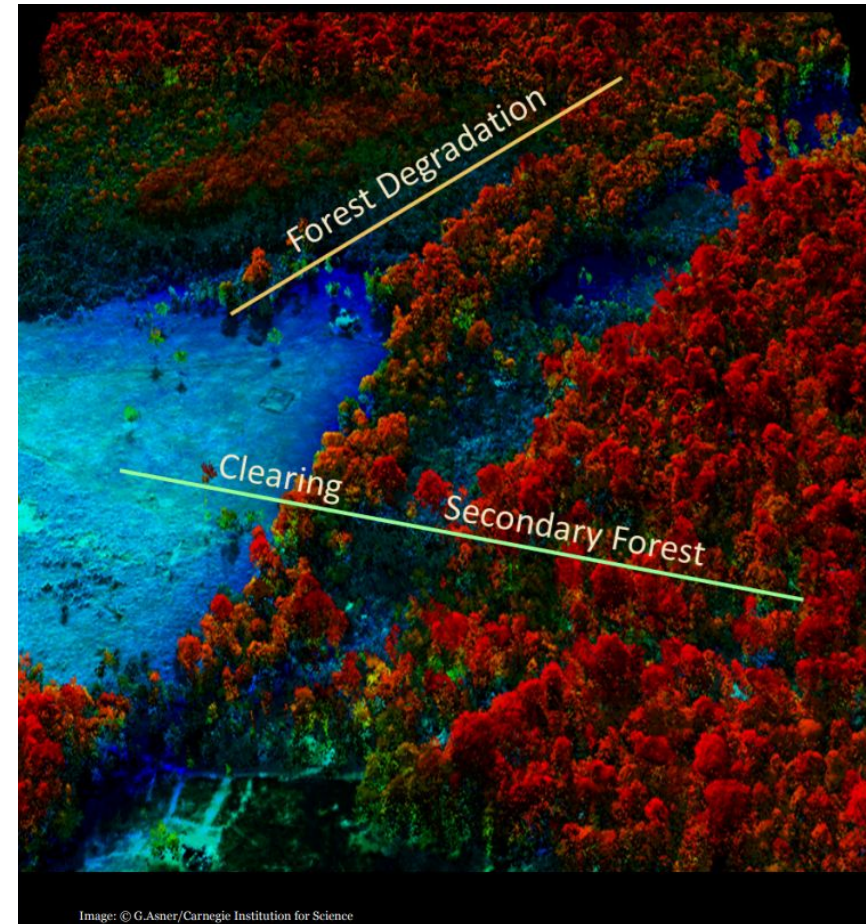
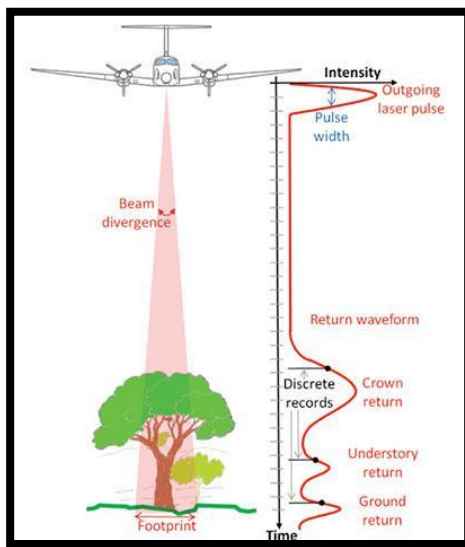


Figure 2.3 LiDAR echoes in point clouds categorized by target (a) or order of return of the echoes (b).

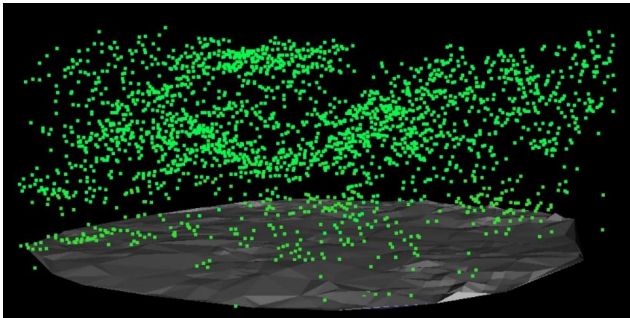
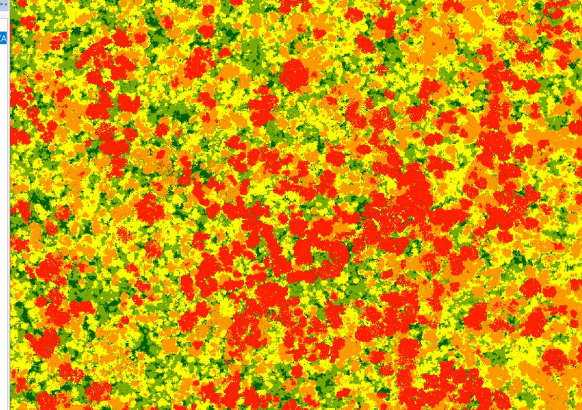
Melin, Shapiro Glover-Kapfer 2017



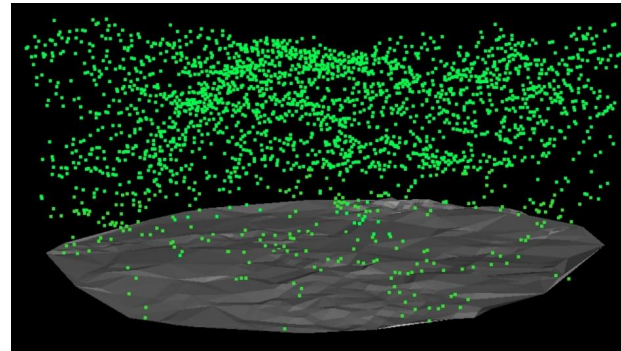


Corredor do Pontal

Table Of Contents
Layers
ECOR ECOLOGICO NORMALIZA
<VALUE>
0 - 1.783039138
1.783039139 - 5.0748037
5.074803701 - 9.052352546
9.052352547 - 15.77303853
15.77303854 - 34.97499847



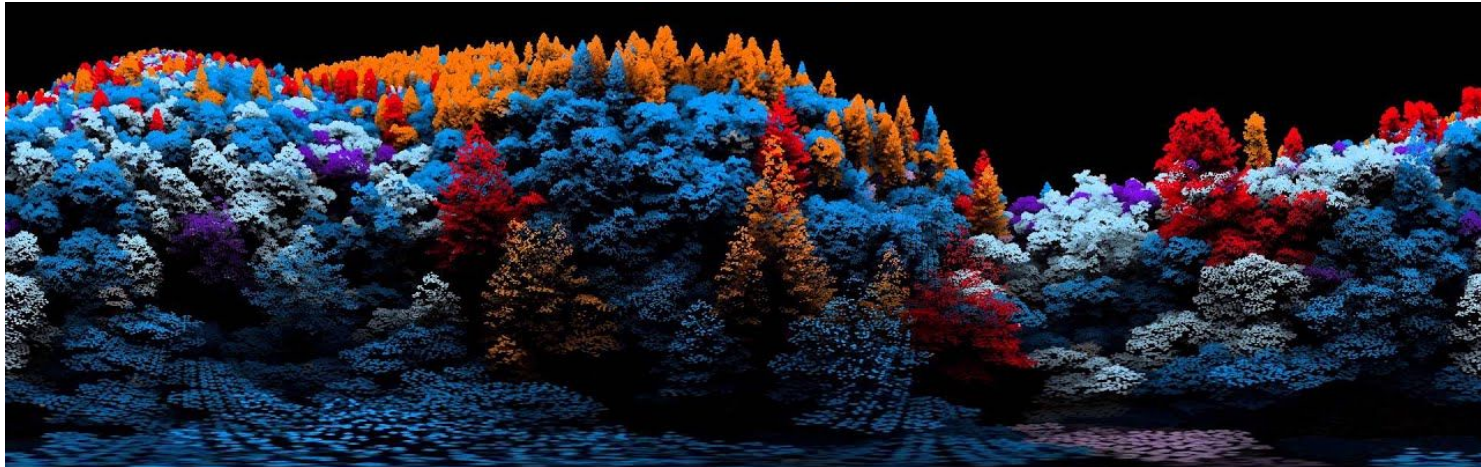
Parcela amostral 20 em Out/2015



Parcela amostral 20 em Nov/2016

Hiperespectral

- Identificação de espécies vegetais por imagens hiperespectrais



Tree Species Classification in a Highly Diverse Subtropical Forest Integrating UAV-Based Photogrammetric Point Cloud and Hyperspectral Data

Camile Sothe ^{1,*}, Michele Dalponte ², Cláudia Maria de Almeida ¹, Marcos Benedito Schimalski ³, Carla Luciane Lima ⁴, Veraldo Liesenberg ³, Gabriela Takahashi Miyoshi ⁵ and Antonio Maria Garcia Tommaselli ⁵

Remote Sens. 2019, 11, 1338; doi:10.3390/rs11111338

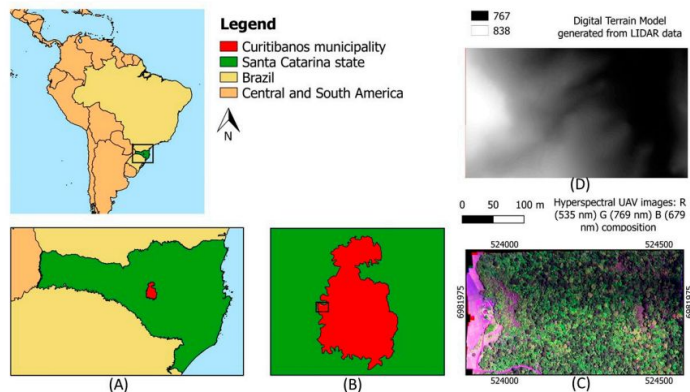


Figure 1. Study area location. (A) Santa Catarina State. (B) Curitibanos municipality. (C) Hyperspectral UAV image R (535 nm) G (769 nm) B (679 nm). (D) Digital Terrain Model.

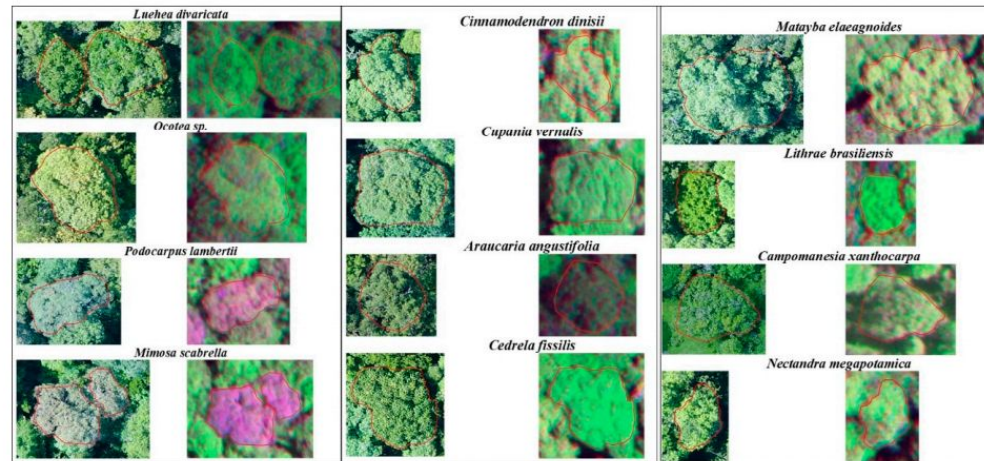
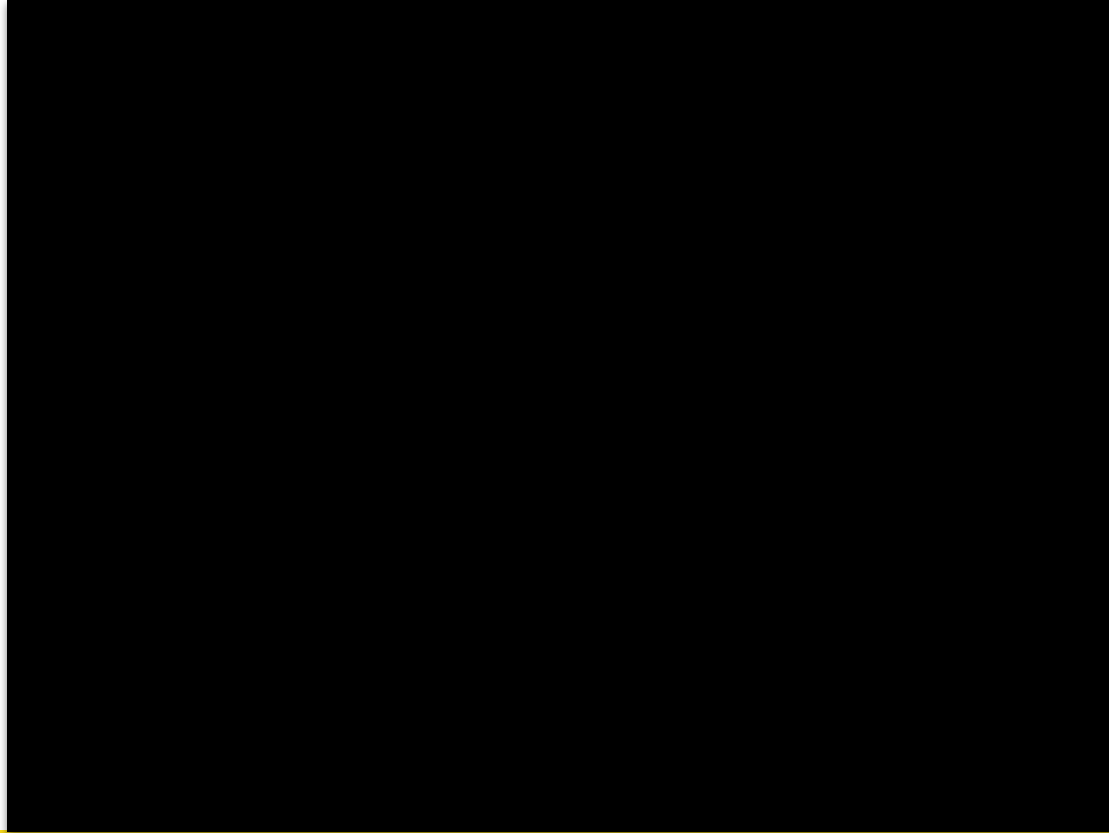


Figure 2. Tree species classes delimited in the unmanned aerial vehicle (UAV)-RGB image and the corresponding UAV-hyperspectral image.

Foi eficiente para a classificação das 12 espécies escolhidas

Drone térmico



F. Melo

eDNA/iDNA

Efficiency of eDNA and iDNA in assessing vertebrate diversity and its abundance

ENVIRONMENTAL DNA

INGESTED DNA

INVERTEBRATE-DERIVED DNA

METABARCODING

METANALYSIS

VERTEBRATE SURVEYS



Carolina Carvalho , **Marina Oliveira**, **Karen Rodriguez-Castro**, **Bruno Saranholi**,
Pedro Galetti Jr 

DOI: 10.22541/au.161777019.96557508/v1

“The metanalysis showed that, in general, there is no difference in the number of species detected or number of sites that a target species was detected when using eDNA/iDNA or conventional methods, suggesting that eDNA/iDNA and conventional methods were equally efficient in characterizing the biodiversity.”



eDNA/iDNA

Efficiency of eDNA and iDNA in assessing vertebrate diversity and its abundance

ENVIRONMENTAL DNA

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“The metanalysis showed that, in general, there is no difference in the number of species detected or number of sites that a target species was detected when using eDNA/iDNA or conventional methods, suggesting that eDNA/iDNA and conventional methods were equally efficient in characterizing the biodiversity.”

However, for water sampler and fish, separately, the risk of not finding a species was greater using conventional method than eDNA, suggesting that eDNA/iDNA was more efficient in finding the target species.



eDNA/iDNA

Efficiency of eDNA and iDNA in assessing vertebrate diversity and its abundance

ENVIRONMENTAL DNA

INGESTED DNA

INVERTEBRATE-DERIVED DNA

METABARCODING

METANALYSIS

VERTEBRATE SURVEYS



Carolina Carvalho , **Marina Oliveira**, **Karen Rodriguez-Castro**, **Bruno Saranholi**,
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DOI: 10.22541/au.161777019.96557508/v1

Abundance and biomass showed similar correlation patterns, and there was a positive correlation between eDNA/iDNA and abundance/biomass data, suggesting that eDNA/iDNA can be used as a proxy for abundance and biomass.





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Monitoramento biofísico



Datalogger
(a cada 10 min)

- ☐ Precipitação
- ☐ Temperatura
- ☐ Turbidez
- ☐ Nível
- ☐ Ph
- ☐ ...





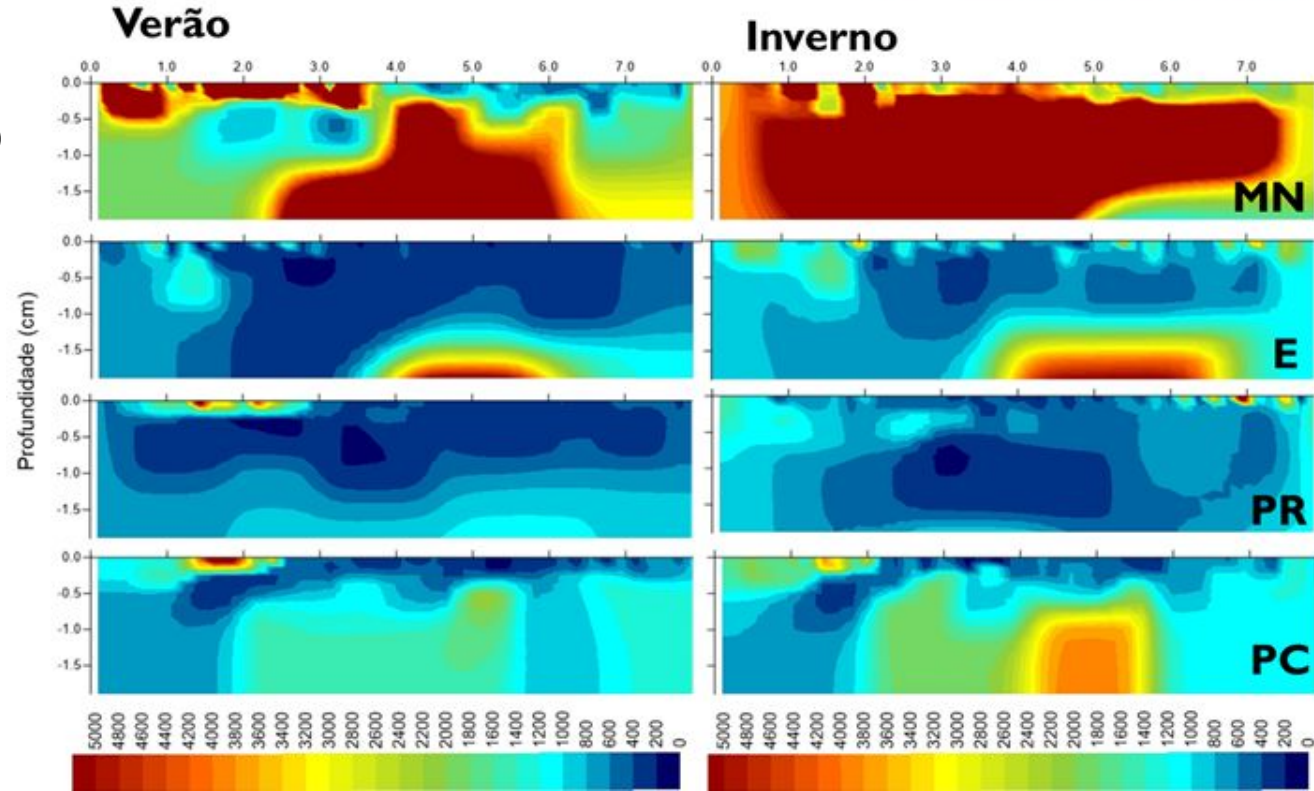
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da Natureza UFSCar

Monitoramento biofísico



Umidade do solo



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Campus Lagoa do Sino

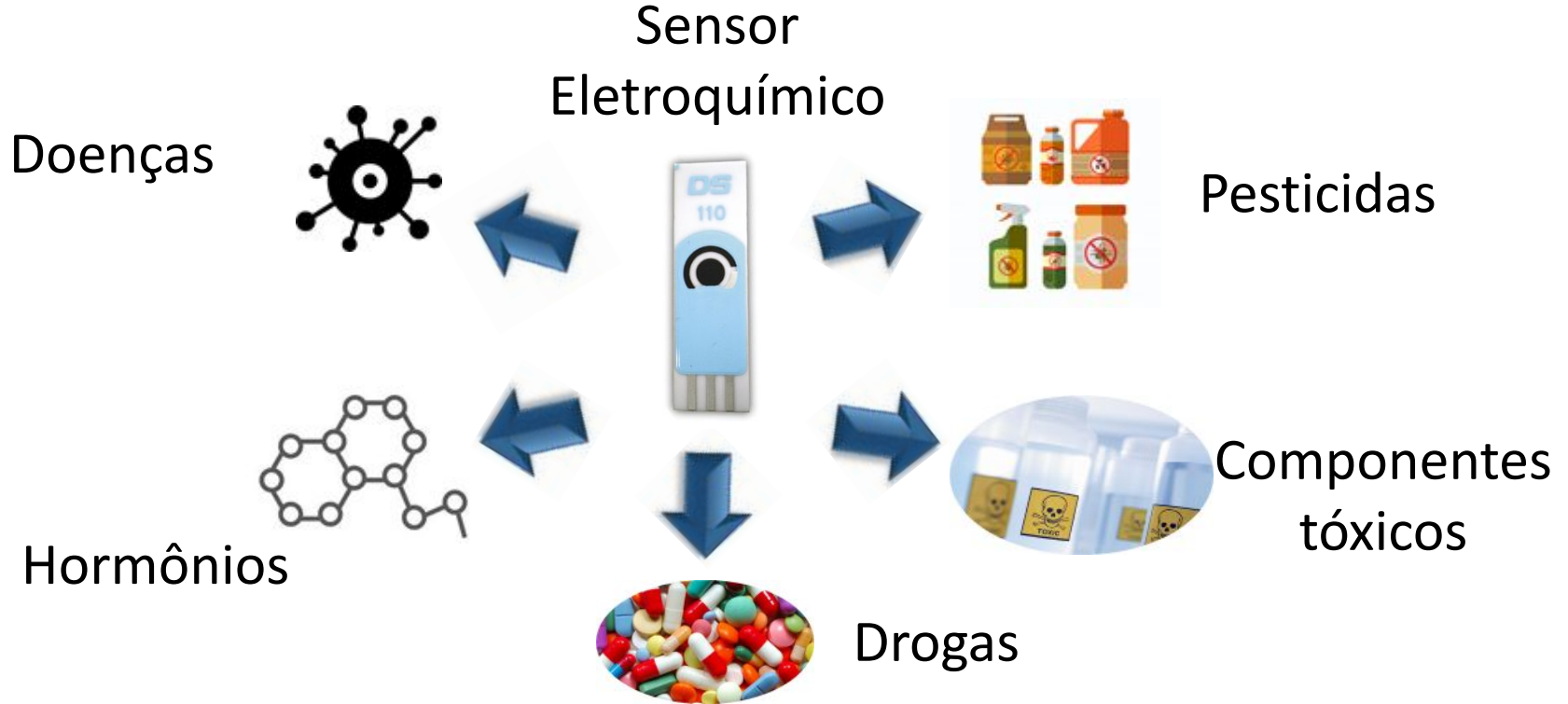




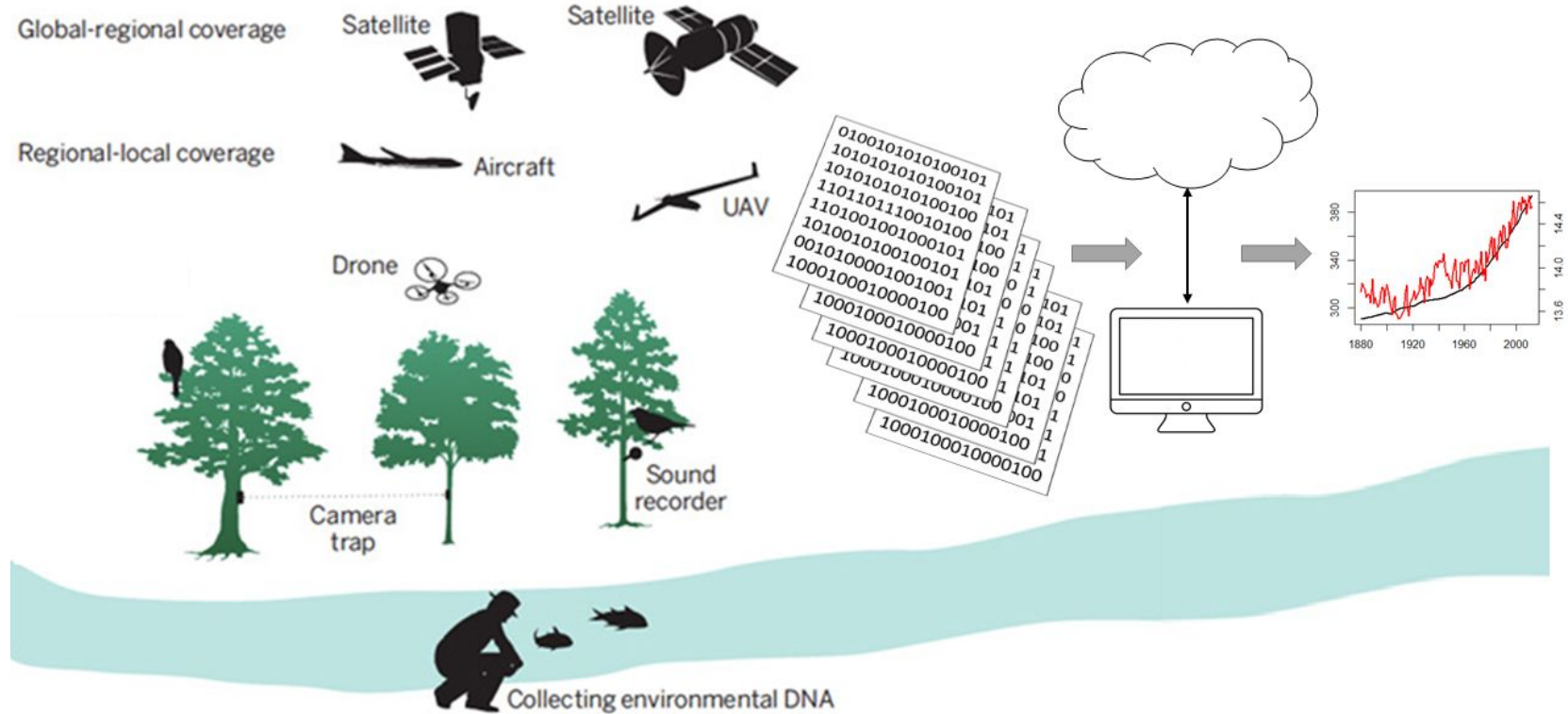
CCN

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Monitoramento biofísico



Coleta, publicação e análise de dados



Adaptado de: Turner, 2014 (Science)

Coleta, publicação e análise de dados

Data Papers

Ecology, 100(12), 2019, e02861

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FragSAD: A database of diversity and species abundance distributions from habitat fragments

JONATHAN M. CHASE ^{1,2,43} MARIO LIEBERGESELL,¹ ALBAN SAGOUIS,¹ FELIX MAY,³ SHANE A. BLOWES,¹
ÅKE BERG,⁴ ENRICO BERNARD ⁵ BERRY J. BROSI,⁶ MARC W. CADOTTE,⁷ LUIS CAYUELA,⁸
ADRIANO G. CHIARELLO ⁹ JEAN-FRANCOIS COSSON,¹⁰ WILL CRESSWELL,¹¹ FILIBUS DANJUMA DAMI,¹² JENS DAUBER,¹³
CHRIS R. DICKMAN,¹⁴ RAPHAEL K. DIDHAM,^{15,16} DAVID P. EDWARDS,¹⁷ FÁBIO Z. FARNEDA,^{18,19,20} YONI GAVISH ²¹
THIAGO GONÇALVES-SOUZA,²² DEMETRIO LUIS GUADAGNIN,²³ MICKAËL HENRY,²⁴ ADRIÀ LÓPEZ-BAUCELLS,^{19,20,25}
HEIKE KAPPES,¹³ RALPH MAC NALLY,^{26,27} SHIHWUA MANU,¹² ALEXANDRE CAMARGO MARTENSEN ²⁸
DUNCAN MCCOLLIN,²⁹ CHRISTOPH F. J. MEYER,^{19,20,30} SELVINO NECKEL-OLIVEIRA,³¹ ANDRÉ NOGUEIRA,³²
JEAN-MARC PONS,³³ DINARZARDE C. RAHEEM,³⁴ FLAVIO NUNES RAMOS ³⁵ RICARDO ROCHA,^{19,20,36} KATERINA SAM,³⁷
ELEANOR SLADE,³⁸ JOHN O. STIREMAN III,³⁹ MATTHEW J. STRUEBIG,⁴⁰ HERALDO VASCONCELOS,⁴¹ AND YARON ZIV⁴²

Análise de dados

Boettiger Group

Home Members Publications Teaching Lab Notebook

Boettiger Group, UC Berkeley

Dept of Environmental Science, Policy, and Management

Welcome to the research group of Carl Boettiger, Assistant Professor in the Department of Environmental Science, Policy and Management at UC Berkeley.

I work on problems in ecological forecasting and decision making under uncertainty, with applications for global change, conservation and natural resource management. I am particularly interested in how we can predict or manage ecological systems that may experience regime shifts: sudden and dramatic changes that challenge both our models and available data. The rapid expansion in both computational power and the available ecological and environmental data enables and requires new mathematical, statistical and computational approaches to these questions. Ecology has much to learn about what are and are not useful from advances in informatics & computer science, just as it has from statistics and mathematics. Traditional approaches to ecological modelling and resource management such as stochastic dynamic systems, Bayesian inference, and optimal control theory must be adapted both to take advantage of all available data while also dealing with its imperfections. My approach blends ecological theory with the synthesis of heterogeneous data and the development of software -- a combination now recognized as data science.

I am co-founder of the rOpenSci project, a senior fellow at BIDS, and a science adviser to NCEAS, reflecting my interests in open science, data science, and ecoinformatics.

Contact: cboettig@gmail.com
Office: 203 Wellman Hall
Address: ESPM Department,
University of California,
130 Mulford Hall #3114,
Berkeley, CA 94720-3114 USA
Orcid ID: 0000-0002-1642-628X



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News Article

NATURE | NATUREJOBS | Q&A

Turning point: Carl Boettiger

Virginia Gewin

Nature 493, 711 (2013) doi:10.1038/nj7434-711a

Published online 30 January 2013

This article was originally published in the journal *Nature*

Computational ecologist's online open notebook brings opportunities.

Subject terms: Careers • Media • Communication



Análise de dados

[illegible]

Model Comparisons

```
library(knitr)
library(nimble)
library(sde)
library(ggplot2)
library(tidyrr)

opts_chunk$set(dev = 'png',
  fig.width = 5,
  fig.height = 5,
  results = 'hide')
```

04 Jan 2015

« prev next »

History

Plotted in ecology
sigs: Really-merging, plotfile

All Rmd files
http://www.stat.columbia.edu/~fdr500/ModelComparisons/

Stick with SDE example as a reference point:

```
set.seed(123)
d <- expression(0.5 * (10-x))
s <- expression(1)
data <- as.data.frame(sde.sim(X0=d, drift=d, sigma=s, T=20, N=100))
```

sigma.x not provided, attempting symbolic derivation.

```
ggplot(data) + geom_line(aes(seq_along(x), x))
N <- length(data$x)
```



LSN version

Modify the LSN model to explicitly model the changing parameter as a hidden, stochastic variable

```
lsn <- nimbleCode({
  theta ~ dnmif(1e-10, 100.0)
  sigma_x ~ dnmif(1e-10, 100.0)
  sigma_y ~ dnmif(1e-10, 100.0)
  m ~ dnmif(-1e2, 1e2)
  x[1] ~ dnmif(0, 100)
  y[1] ~ dnmif(0, 100)
```

boettig / earlywarning

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earlywarning / R / get_replicates.R

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boettig

earlywarning manuscript data file included

8681874 on 16 Feb 2012

1 contributor

27 lines (22 sloc)

686 Bytes

Raw

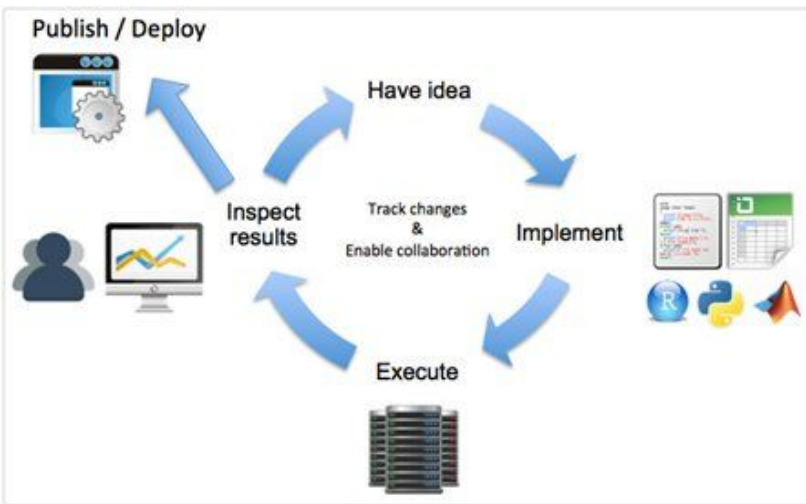
Blame

History

```
1 # extract the replicates simulations by model
2 #@param reps a list of outputs from compare()
3 # @return a data.frame listing the "time", "rep" id number,
4 # "value" observed at that time, and the "model" producing the
5 # simulated data
6 # @examples link(compare), link("roc_data")
7 # @import reshape2
8 # @export
9
10 get_replicates <- function(reps){
11   out <- sapply(reps, function(rep){
12     if(resModel=="OU")
13       reps[[1]]
14   })
15   lens <- sapply(reps, function(rep){
16     if(resModel=="LW")
17       reps[[1]]
18   })
19   out <- melt(list(OU=out, LW=lens))
20   names(out) <- c("time", "rep", "value", "model")
21   out$time <- reps[[1]][out$time, 1]
22   out
23 }
24
25 }
```

Análise de dados

- gitHub
- Workflow
- Código



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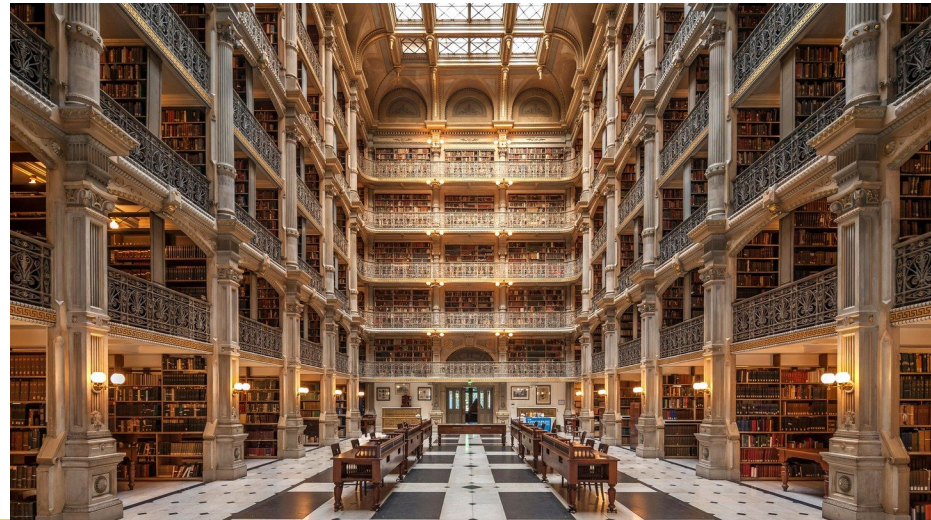
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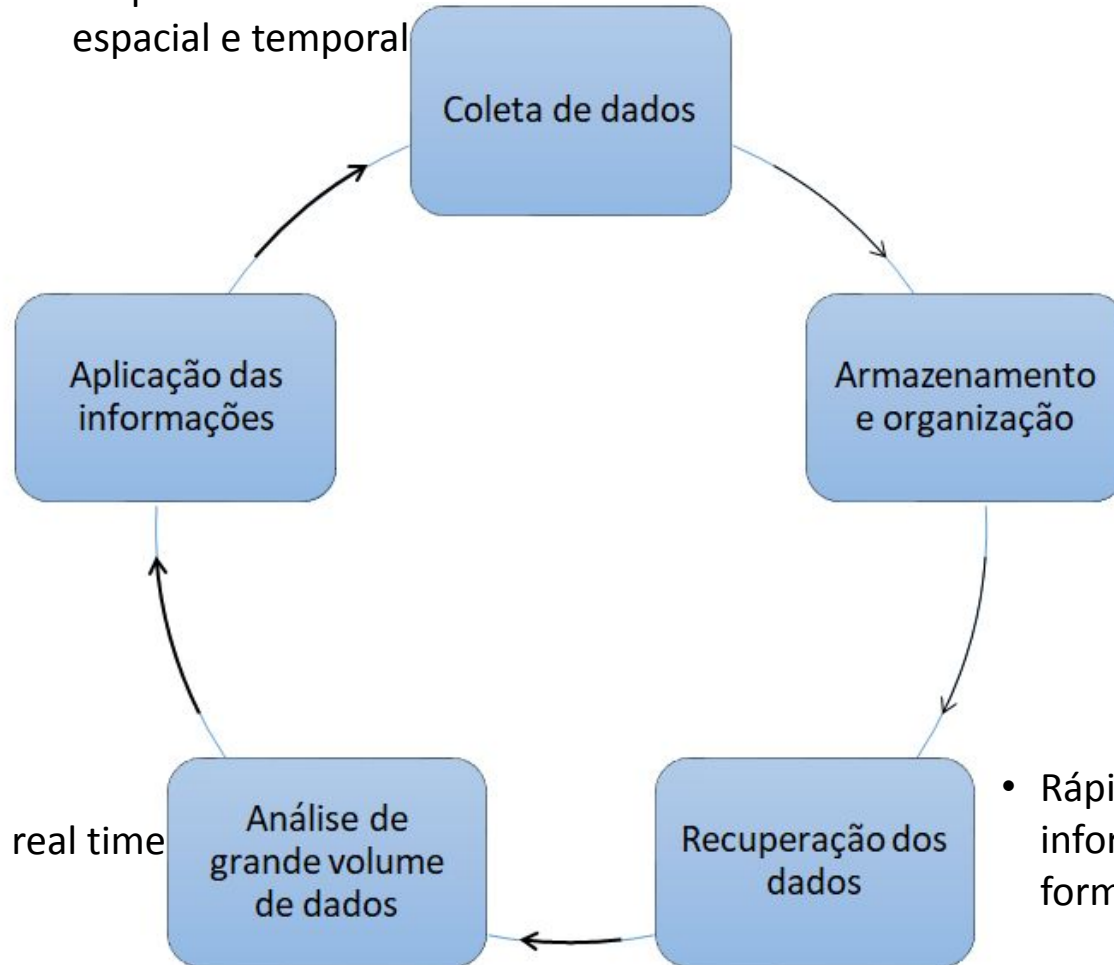
Duncan Hull^{1,2*}, Steve R. Pettifer^{2,3}, Douglas B. Kell^{1,2}

¹ School of Chemistry, The University of Manchester, Manchester, United Kingdom, ² The Manchester Interdisciplinary Biocentre, The University of Manchester, Manchester, United Kingdom, ³ School of Computer Science, The University of Manchester, Manchester, United Kingdom

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