

Approche Paysagère, Big Earth Data et Intelligence Artificielle pour aborder la complexité des Territoires

Laurent Durieux – UMR ESPACE-DEV



Photo credits: Ludovic Bernaudat

Lancement du CES Paysage
Montpellier 28-29 Mars 2019

LANCEMENT

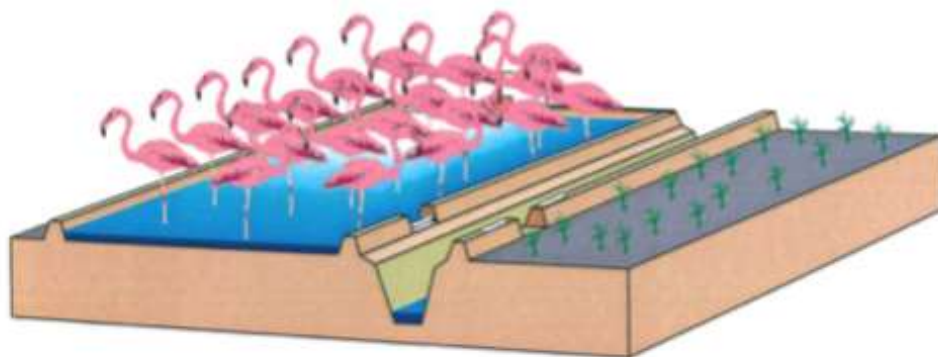
Compte-rendu du stage

ESPACE ET NATURE

par

Laurent Durieux

DEA "Structures et Dynamiques Spatiales"



Stage réalisé à l'Université d'Avignon

Responsable du stage: Pierre Dérizoz

1998



Développement et optimisation d'un modèle de gestion durable pour la maîtrise des incursions de Flamants roses dans les rizières de Camargue

Rapport d'activités 2009



Arnaud Béchet
Régis Vianet
Philippe Isenmann
Pascal Gaubert
Jean-Baptiste Audibert
Aurélien Laget



Région
Provence-Alpes-Côte d'Azur
Partenaire principal



BILAN FINANCIER DES DOMMAGES de FLAMANTS ROSES DANS LES RIZIÈRES

Dépenses par dégradation

- Surfaces dégradées par les incursions
- Coût de la dégradation par hectare
- Coût pour le resemis par hectare

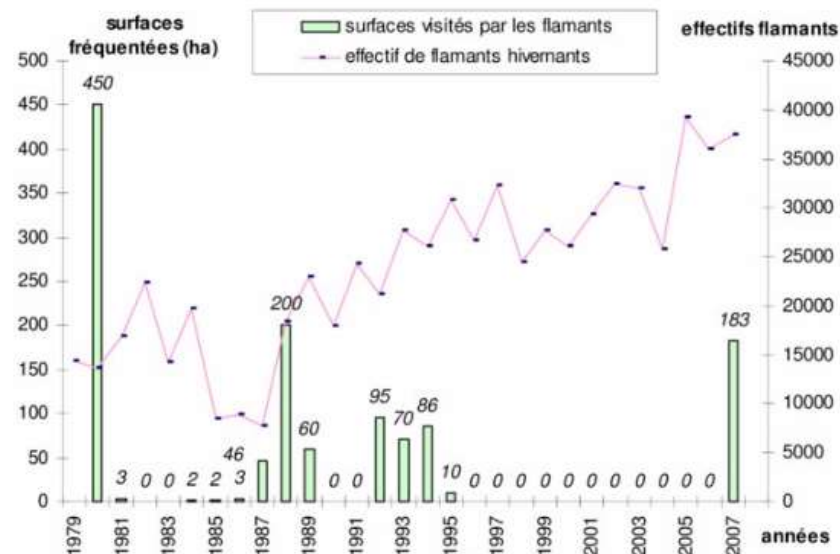
	250 ha
	1400 €
	800 €
Total	550 000 €

Dépenses pour l'effarouchement

- Coût de l'effarouchement actif
- Coût du matériel

	75 000 €
	25 000 €
Total	100 000 €

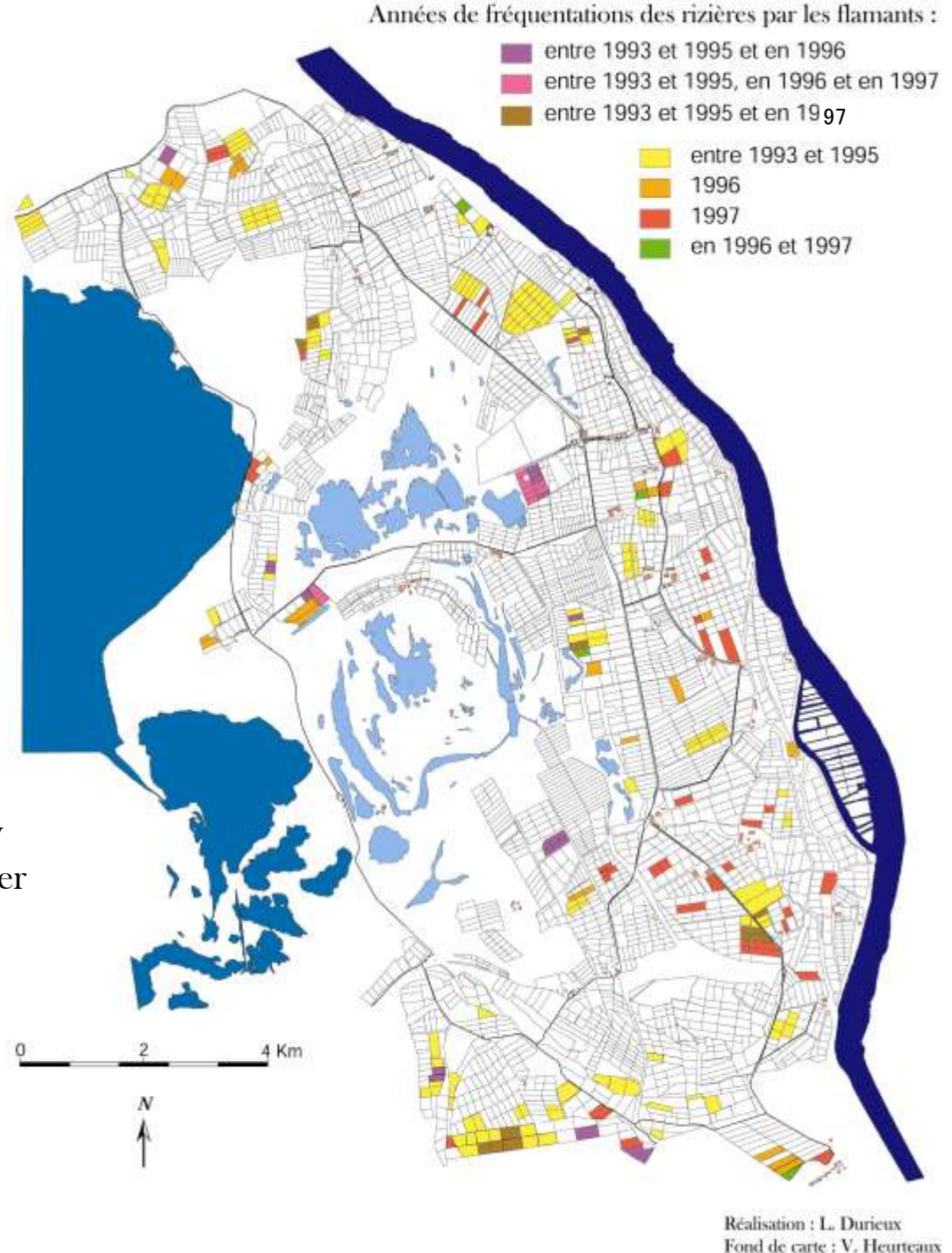
Total 650 000 €





**Gestion intégrée d'une contrainte patrimoniale:
exemple du flamant dans le système rizicole Camarguais**

Localisation of incursions between 1993 and 1997



13% of the fields frequented one year by the flamingo are frequented the year after

2% des parcelles non-fréquentées une année le deviennent par la suite

Gestion directe individuelle

● Actions

- ★ Utilisation de canons détonants
- ★ Utilisation de fusées éclairantes
- ★ Pression sur les écologistes pour limiter les flamants
- ★ Action en justice contre l'État ➤ dédommagements
- ★ Utilisation sporadique d'armes de chasse

● Conséquences

- ★ Effarouchement efficace contre les incursions
- ★ Coût de l'effarouchement élevé
- ★ Surcoût de travail pour les riziculteurs
- ★ Détonations nocturnes dérangent habitants
- ★ Détonations dérangent gibier et espèces protégées
- ★ Augmentation des tensions agriculteurs- écologistes

Gestion intégrée

● Directions d'étude

- ★ Les priorités de recherche vont vers une action sur les milieux plutôt qu'une action directe envers la population de flamants.
- ★ L'action sur les milieux ouvre deux voies:
 - Agir sur les lieux de gagnages « naturels » (lieux d'alimentation) pour concentrer les flamants dans ces zones.
 - Agir sur le géosystème rizicole pour le rendre moins attractif pour les flamants.

● Hypothèse de recherche

- ★ La distribution des rizières fréquentées par les flamants peut être expliquée par des critères paysagers

Study Area : Fumemorte bassin



Les principales rizières de Camargue en 1999

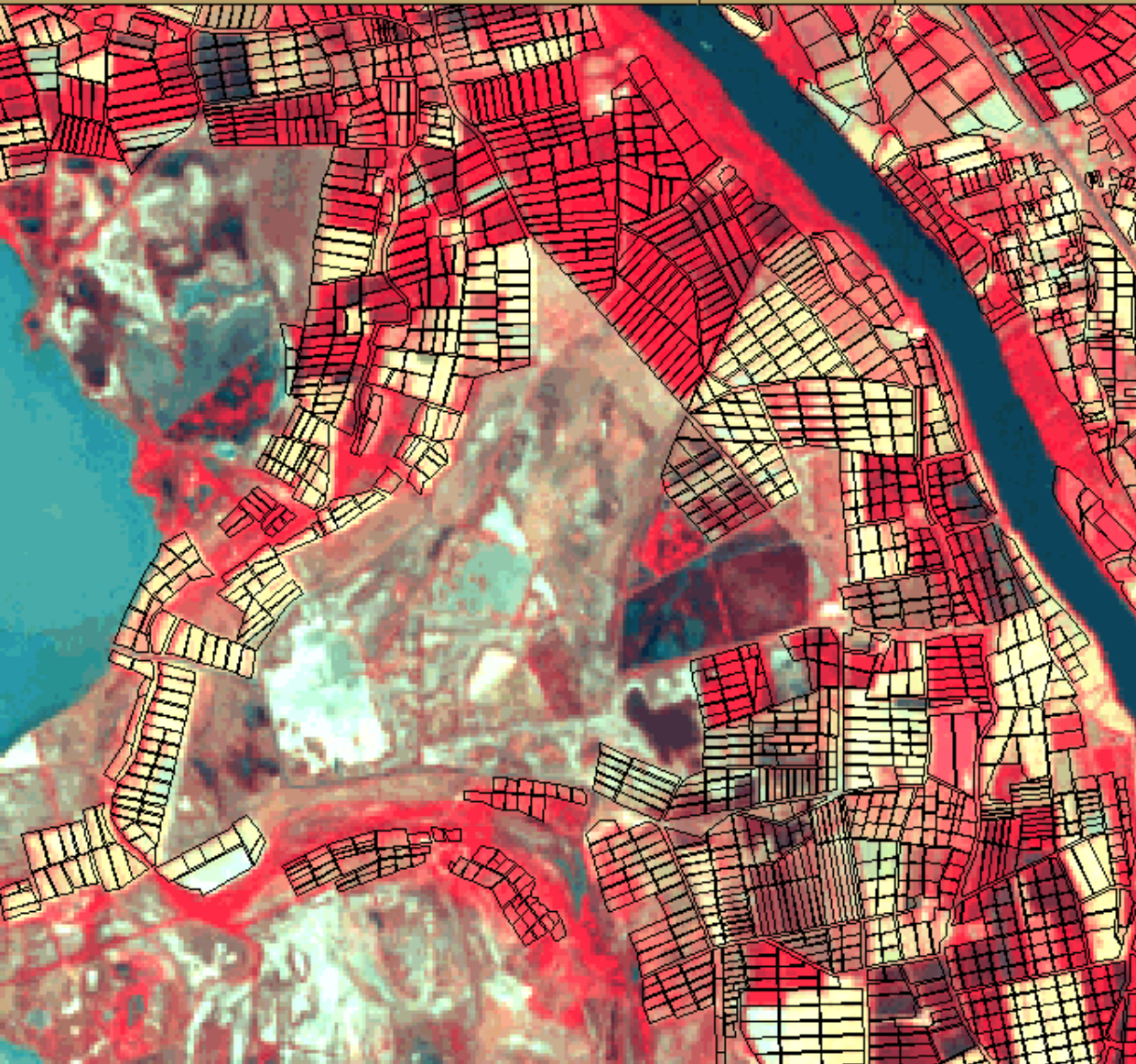
riz



00

10 km

Classification obtenue à partir d'une image Landsat TM,



Infos

PARCEL_CAM_ID:	2 781
CULTURE_99:	riz
CULTURE_98:	riz
CULTURE_97:	estim_riz
CULTURE_96:	riz
CULTURE_95:	riz
CULTURE_94:	riz
CULTURE_93:	riz
CULTURE_92:	
CULTURE_91:	riz
CULTURE_89:	riz
CULTURE_87:	riz
CULTURE_85:	riz
CULTURE_81:	0
CULTURE_75:	riz
CAMSAR:	0
DRAINAGE:	Fumemorte
IRRIG:	Toutoulen_Giraud
Zone:	parcellaire_ilec
AREA:	27 199,857
PERIMETER:	871,807
riz_9799:	3
X:	790 093,00
Y:	140 929,00

<< >> Liste

parcel_cam

Zoom : 13,55 km

Modifiable : Aucun

Sélection: Aucun

Use of artificial neural networks for predicting rice crop damage by greater flamingos in the Camargue, France

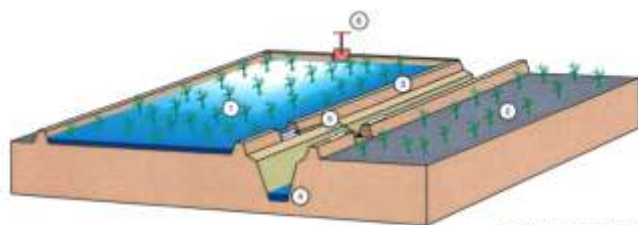
Christophe Tourenq ^{a,b,*}, Stéphane Aulagnier ^c, François Mesléard ^a,
Laurent Durieux ^a, Alan Johnson ^a, Georges Gonzalez ^c, Sovan Lek ^d

^a Station Biologique de la Tour du Valat, Le Sambuc, 13200 Arles, France

^b Centre d'Ecologie Fonctionnelle Evolutive, Université de Montpellier II, route de Mende, 34000 Montpellier, France

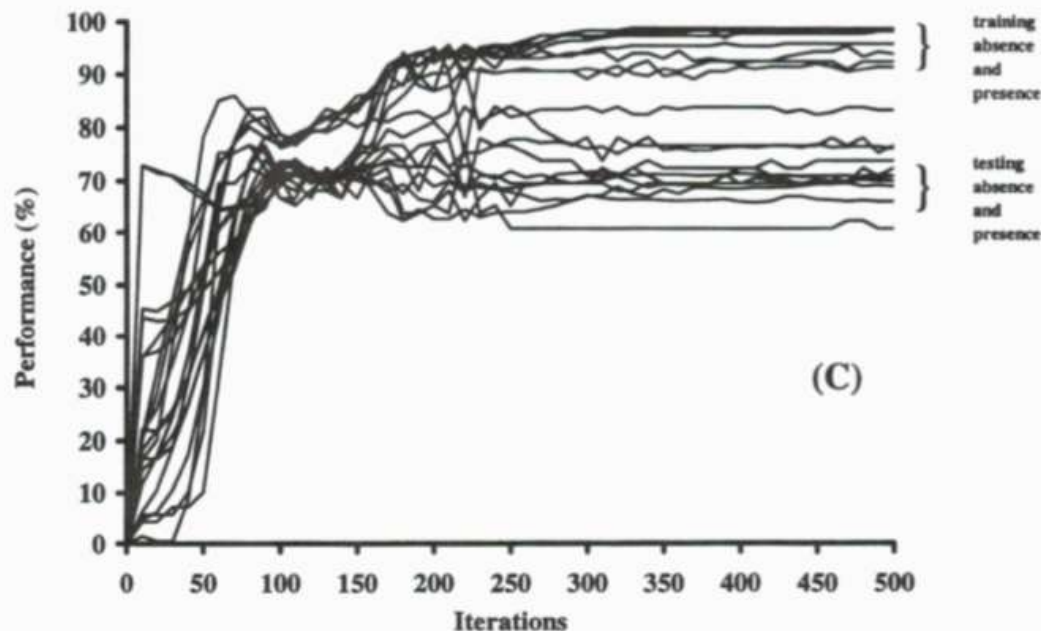
^c Institut de Recherche sur les Grands Mammifères, B.P. 27, 31326 Castanet-Tolosan Cedex, France

^d CESAC, UMR 5576, CNRS-Univ. Paul Sabatier, 118 route de Narbonne, 31062 Toulouse Cedex 4, France



P. Chauvelon, V. Heurteaux

- | | |
|--------------------|---|
| ① Rizière en eau | ⑤ Fossé de drainage |
| ② Rizière vidangée | ⑥ Seuil de vidange / surverse |
| ③ Lévadon | ⑦ Martelière d'alimentation en eau d'irrigation |



Variables	1996	1997
	p	p
Distance à la colonie	ns	ns
Distance route secondaire	ns	ns
Distance route principale	***	ns
Distance lignes électriques	***	ns
Superficie des parcelles	ns	*
Distance marais d'alimentation	***	ns
Distance aux habitations	***	**
Distance à la haie la plus proche	***	***
Nombre de haies par parcelles	***	***

Seuils de significativité:

ns: non significatif, * : $p < 0.05$, ** : $p < 0.01$, *** : $p < 0.001$

ANOVA (analyses de variance avec *un facteur*, et pour des échantillons inégaux).

Description du paysage d'une parcelle à risque

Les parcelles présentant le plus important risque de fréquentation par les flamants sont celles éloignées d'au moins 300 m des routes, et des constructions, dépourvues de haies d'arbres hauts de plus de 3 m, non survolées par une ligne électrique, d'une surface supérieure à 2.5 ha et proche des milieux naturels que les flamants fréquentent pendant la journée.

Fonctionnement du modèle prédictif

Fichier Edition Outils Objets Sélection Table Affichage Données Fenêtre Aide disp Distance											
PROPRIETE	SUPERFICIE	IRRIGATION	ZON	DIST_MH	DIST_HABITAT	DIST_RPRINCIP	DIST_RSECON	DistArcInfo	DistKorem	DistMapX	Risque
☐ Manusclat	3,11317	repomp_Fum	IDC	3 196,4	779,525	166,261	1 045,92	70,9291	68,1409	68,2831	1,29939e-242
☐ Manusclat	3,45421	repomp_Fum	IDC	2 931,9	914,923	455,968	1 119,49	172,62	172,466	172,466	0,952966
☐ Manusclat	1,09334	repomp_Fum	IDC	2 621,2	1 163,99	782,341	1 309,94	134,09	133,998	134,163	8,44399e-041
☐ Manusclat	1,81452	repomp_Fum	IDC	2 391,08	1 368,54	1 043,26	1 473,06	135,825	134,919	135,107	2,75684e-011
☐ Manusclat	1,63982	repomp_Fum	IDC	2 654,61	1 121,72	789,872	1 253,53	57,9013	54,2594	54,336	9,00963e-207
☐ Manusclat	1,65819	repomp_Fum	IDC	2 434,63	1 323,8	1 043,67	1 413,29	49,9763	47,9955	48,0404	2,39046e-193
☐ Manusclat	2,04989	Manusclat	IDC	2 934,24	69,6018	49,391	100,559	60,1632	93,9229	63,3944	1,4327e-159
☐ Manusclat	1,61775	Manusclat	IDC	3 602,99	395,214	818,583	80,6788	63,2614	62,8955	62,8956	2,27236e-302

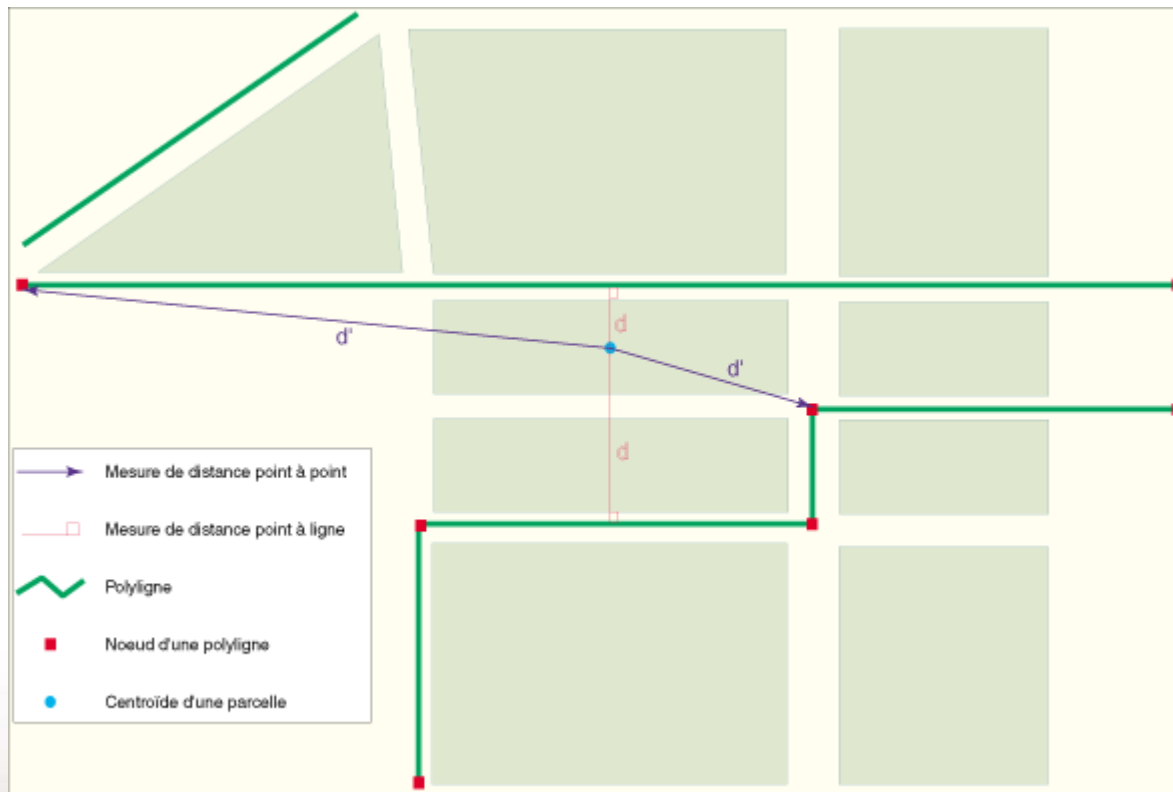
Association des variables à leur coefficient

$$Z = B_0 + B_1 X_1 + B_2 X_2 + \dots + B_n X_n$$

Intégration de la valeur retournée dans la fonction : $\frac{1}{(1 + e^{-Z})}$

Fonction d'analyse spatiale

*Mesure de la distance entre le centroïde de chaque parcelle
et la haie en étant le plus proche*



Résultat d'une simulation



The capacity to observe the Planet is radically evolving and this trend is accelerating

55 CEOS Agencies Operate 131 EO Satellites
300+ sensors and measurements



Unprecedented opportunities to access and integrate planetary data for solutions to fragility



1,738 Satellites in orbit in 2017
5,700 scenes per day
(open source)



15.4 billion sensors in 2015
75 billion by 2025



IoT creates 400 zettabytes of data
per year (400 billion terabytes)



5 billion unique mobile phones
Pull and push data



iNaturalist has 10m
unique records



Open source data and
software widely available

The Big Data Revolution



Copernicus is the largest producer of EO data in the world



European Space Agency

Big Earth Data, as a subset of big data,
provides a new methodology for Earth sciences,
and is becoming a new engine for conducting Earth and
environment science, informing decision making.



Cognition of the Earth system is transforming from collecting traditional empirical data, theoretical derivation, and simulating local physical processes to using and mining Big Earth Data for knowledge discovery. It follows that the development of Earth system science has been entering into the phase of data-intensive scientific discovery.

Zooming out to global level:

How to use big data and frontier technologies to:

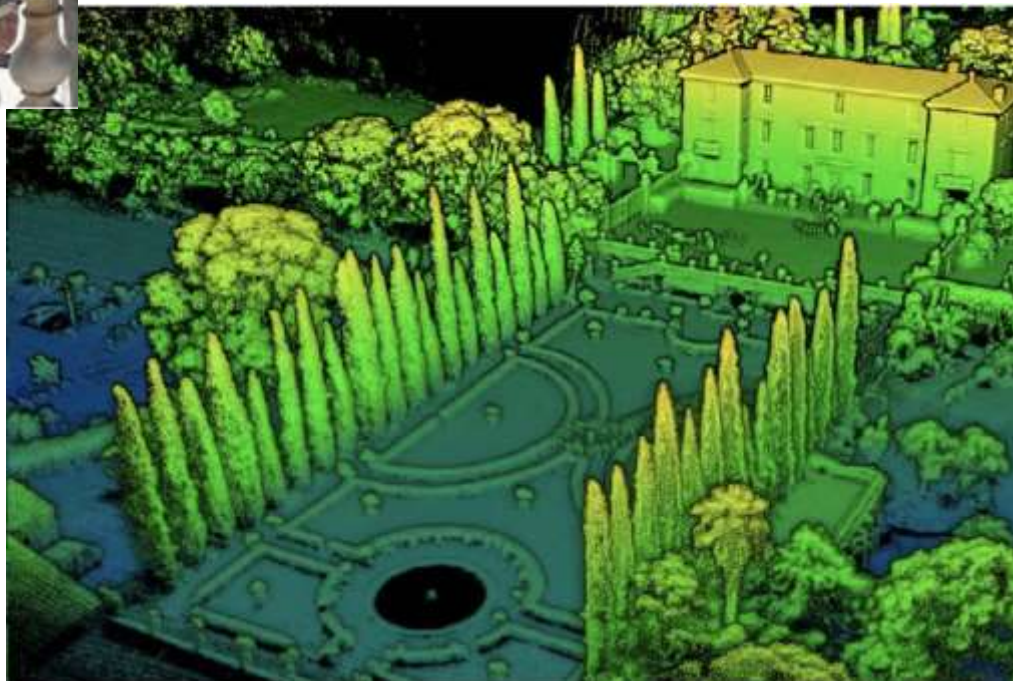
- Improve environmental transparency by all actors
- Support new markets and business models
- Inform citizen and consumer action
- Accelerate and scale solutions



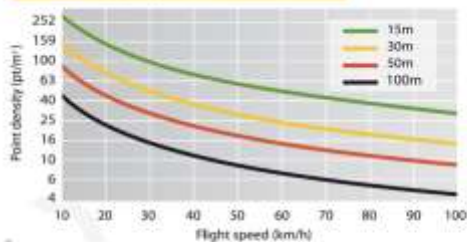


2018.01.23





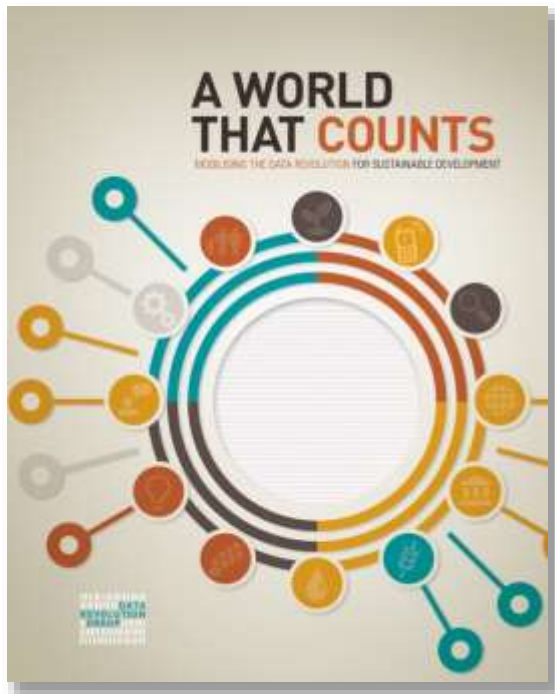
Point density by flight speed and altitude



YellowScan Vx.



Mobilizing the Data Revolution for Sustainable Development



“Data and evidence are the foundation of development policies and effective program implementation.”

Mahmoud Mohieldin, SVP, World Bank

UN SG Independent Expert Advisory Group, 11/2014

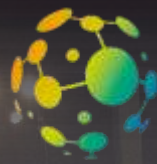




Figure 1: Areas in which Earth observation contributes to the SDGs (source: EO4SDG)



GEO "EO in Support of 2030 Agenda for Sustainable Development" (March, 2017)



SCIENCE
POLICY
BUSINESS
FORUM



UN SCIENCE-POLICY- BUSINESS FORUM ON THE ENVIRONMENT

United Nations Inter-Sectoral Platform for Green
Solutions



NAIROBI
Dec 2017

1st Forum Session

The Forum supported the launch of the world's first Alliance for Citizen Science.

Twelve months on, we are working with the Alliance to build the first global on-line platform for Citizen Science, hosted by Environment Live and the World Environment Situation Room



NEW YORK
May 2018

1st Steering Committee

The Forum's Governing Consortium identified work streams to support in 2018-2019, in consultation with relevant UN programmes and sister agencies



TALLIN
Sept 2018

Earth Innovation Summit

12 specialised sessions provided unique opportunities for dialogue, presentation of latest technologies, exchange of ideas and consultations that aimed to inform the UNEA bureau and key partners ahead of the Bureau meeting.

Speakers included :

Business sectors leaders, Startup innovators, Scientists and visionaries, Citizen science pioneers, Investors



PARIS
Oct 2018

Planetary Data Meeting

An Extraordinary Session was hosted by the Government of France.

Key tracks: Opportunities offered by Artificial Intelligence and Machine Learning; Big Data, Earth observations and remote sensing, Governance, Equity and Ethics; Financing and opportunities in PPP.

Next Steps: Launch a HL working group to strengthen and expedite delivery of the platform in coordination with Environment Live and the UN Environment Situation Room

Discussion paper:

The Case for a Digital Ecosystem for the Environment:

Bringing together data, algorithms and
insights for sustainable development



THINK
BEYOND

LIVE
WITHIN



SCIENCE
POLICY
BUSINESS
FORUM

Bandara 2018

AI4SDG – roadmap to a Global Data Commons to achieve the Sustainable Development Goals (1/2)



Strategic support by:

McKinsey & Company



We invited global technology leaders to submit their views on what it would take to make Global Data Commons a reality

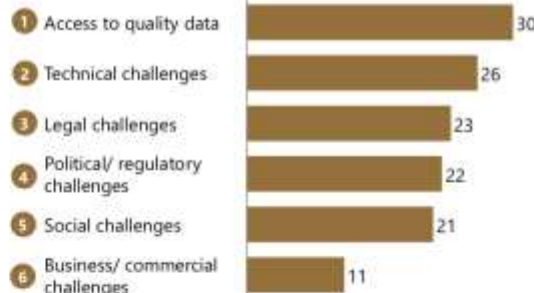


The Global Data Commons aims to deploy AI to help achieve the SDGs



- Capitalizing on the immense volume of data available and use AI to tackle the world's greatest challenges
- Detect, present and help scale-up use cases for AI enabling the 17 SDGs
- The use of AI for Sustainable Development Goals will allow us to:
 - Monitor progress towards the achievement of SDG
 - Simulate implications
 - Predict outcomes of measures taken
 - Provide recommendations for policy makers

The position papers discuss several challenges that prevent the implementation of a GDC



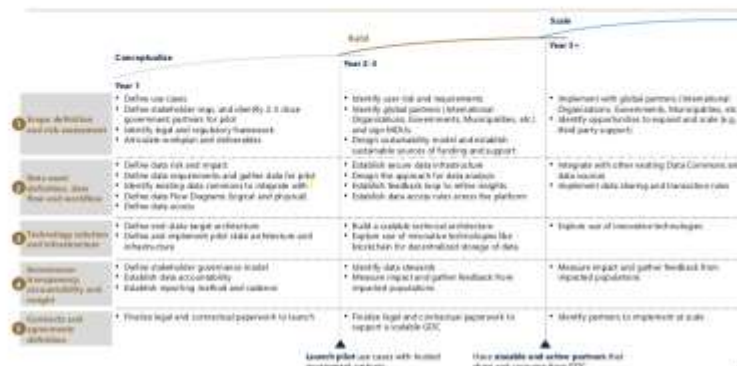
Example quotes from position papers

1	"We are looking at a growing list of challenges that this data and analytics ecosystem is going to face as it scales up to become a global commons."	"Data governance is a key challenge in the development of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."
2	"Governance and data ownership are key challenges that will be critical to the success of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."	"Data governance is a key challenge in the development of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."
3	"Data governance is a key challenge in the development of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."	"Data governance is a key challenge in the development of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."
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6	"Data governance is a key challenge in the development of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."	"Data governance is a key challenge in the development of a global commons. It is essential to have a clear governance framework that addresses the challenges of data ownership, data privacy, data security, and data quality."

Our review of the position papers indicates that we can follow an iterative and systematic approach to creating the Global Data Commons



- 1. Articulate use case context and scope
- 2. Identify stakeholders, associated risks and rewards
- 3. Identify legal and regulatory context
- 4. Identify rights and responsibilities for using data
- 5. Articulate collaborative workflow and deliverables
- 6. Identify relevant legal and standards and associated characteristics
- 7. Define data architecture and infrastructure
- 8. Define data security and privacy
- 9. Define data governance and policy
- 10. Define data impact and evaluation









"The fast-moving trends
get most of the attention.

The slow-moving trends
have most of the power."

- Stewart Brand

Welcome to the Anthropocene



Welcome to the Anthropocene

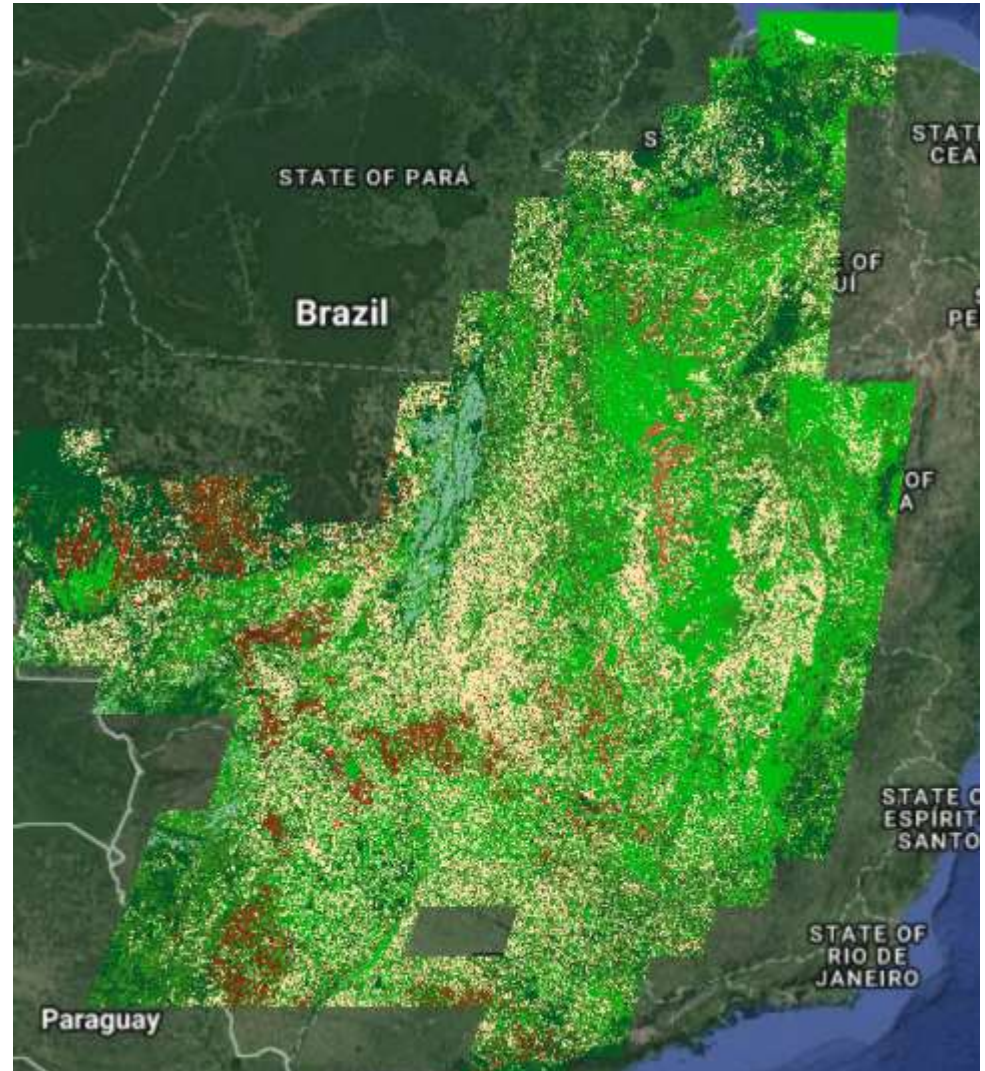


Ecology's revenge on machine learning!

Gilberto Camara, GE



“forest” ?



Brazilian Cerrado: 2.5 million km², 65.000 samples!