

Infrastructure écologique du Grand Genève

Préserveons la biodiversité et les services qu'elle rend à notre bien-être

Par Anthony Lehmann, Arthur Sanguet, Noé Waller et Benjamin Guineaudeau

CT SITG. Annemasse, 27 mars 2023

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Menaces qui planent sur la Biodiversité

FACTEURS

FACTEURS INDIRECTS

- Facteurs démographiques et socioculturels
- Facteurs économiques et technologiques
- Institutions et gouvernance
- Conflits et épidémies

FACTEURS DIRECTS

- Changeement d'utilisation des terres/mers
- Exploitation directe
- Changements climatiques
- Pollution
- Espèces exotiques envahissantes
- Autres

EXEMPLES DE DÉCLIN DE LA NATURE

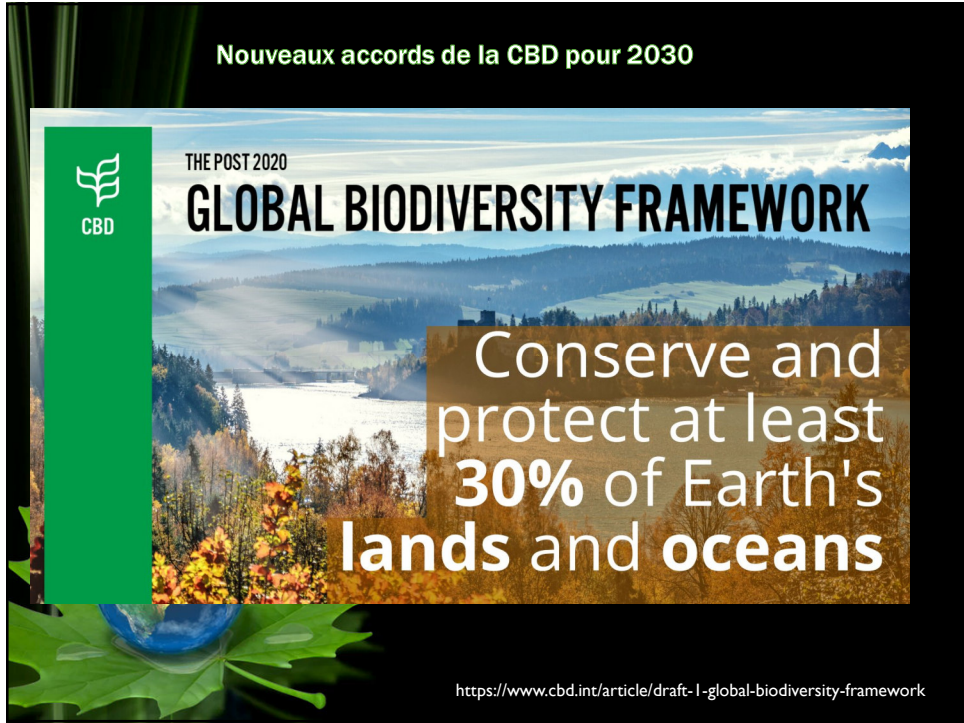
- ÉTENDUE ET ÉTAT DES ÉCOSYSTÈMES**
Les écosystèmes naturels ont **décliné de 47 %** en moyenne par rapport à leur état initial estimé.
- RISQUE D'EXTINCTION DES ESPÈCES**
Environ **25 %** des espèces de la plupart des groupes d'animaux et de végétaux étudiés sont déjà menacées d'extinction.
- COMMUNAUTÉS ÉCOLOGIQUES**
L'intégrité biotique—l'abondance des espèces naturellement présentes—**a baissé de 23 %** en moyenne dans les communautés terrestres.*
- BIOMASSE ET ABONDANCE DES ESPÈCES**
La biomasse mondiale de mammifères sauvages **a chuté de 82 %**.* Les indicateurs de l'abondance des vertébrés déclinent rapidement depuis 1970.
- LA NATURE ET LES PEUPLES AUTOCHTONES ET COMMUNAUTÉS LOCALES**
72 % des indicateurs élaborés par les peuples autochtones et les communautés locales montrent une **détérioration continue** des éléments de la nature qui leur sont importants.

* Depuis la préhistoire

Figure SPM 2 Exemples de déclin observés dans la nature au niveau mondial, soulignant le recul de la biodiversité provoqué par des facteurs de changement directs et indirects.

IPBES 2019

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Millenium Ecosystem Assemmment

ECOSYSTEM SERVICES

<p>Supporting</p> <ul style="list-style-type: none"> ■ NUTRIENT CYCLING ■ SOIL FORMATION ■ PRIMARY PRODUCTION ■ ... 	<p>Provisioning</p> <ul style="list-style-type: none"> ■ FOOD ■ FRESH WATER ■ WOOD AND FIBER ■ FUEL ■ ...
<p>Regulating</p> <ul style="list-style-type: none"> ■ CLIMATE REGULATION ■ FLOOD REGULATION ■ DISEASE REGULATION ■ WATER PURIFICATION ■ ... 	<p>Cultural</p> <ul style="list-style-type: none"> ■ AESTHETIC ■ SPIRITUAL ■ EDUCATIONAL ■ RECREATIONAL ■ ...

ECOSYSTEMS AND HUMAN WELL-BEING
OUR HUMAN PLANET
Summary for Decision Makers
MILLENNIUM ECOSYSTEM ASSESSMENT

Ce rapport a largement diffusé le concept des SE avec sa classification en services de:

- Soutien
- Approvisionnement
- Régulation
- Culturels

UN, MEA 2005

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Millenium Ecosystem Assessment

ECOSYSTEM SERVICES

Supporting ■ NUTRIENT CYCLING ■ SOIL FORMATION ■ PRIMARY PRODUCTION ■ ...	Provisioning ■ FOOD ■ FRESH WATER ■ WOOD AND FIBER ■ FUEL ■ ...	Regulating ■ CLIMATE REGULATION ■ FLOOD REGULATION ■ DISEASE REGULATION ■ WATER PURIFICATION ■ ...	Cultural ■ AESTHETIC ■ SPIRITUAL ■ EDUCATIONAL ■ RECREATIONAL ■ ...
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LIFE ON EARTH - BIODIVERSITY

CONSTITUENTS OF WELL-BEING

Security ■ PERSONAL SAFETY ■ SECURE RESOURCE ACCESS ■ SECURITY FROM DISASTERS	Freedom of choice and action OPPORTUNITY TO BE ABLE TO ACHIEVE WHAT AN INDIVIDUAL VALUES DOING AND BEING
Basic material for good life ■ ADEQUATE LIVELIHOODS ■ SUFFICIENT NUTRITIOUS FOOD ■ SHELTER ■ ACCESS TO GOODS	
Health ■ STRENGTH ■ FEELING WELL ■ ACCESS TO CLEAN AIR AND WATER	
Good social relations ■ SOCIAL COHESION ■ MUTUAL RESPECT ■ ABILITY TO HELP OTHERS	

ARROW'S COLOR
Potential for mediation by socioeconomic factors

ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being

	Low		Weak
	Medium		Medium
	High		Strong

Source: Millennium Ecosystem Assessment

Le rapport a aussi établi le lien entre les SE et le bien-être des personnes

UN, MEA 2005

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Des Services Ecosystémiques aux Capitaux Naturels

Natural capital

Ecosystem capital:		Abiotic assets:	Abiotic flows:
Ecosystems as asset: Extent, structure and condition of: Forests, woodlands, rivers, lakes, oceans, coasts, wetlands, grasslands, croplands, heathlands, urban parks, etc.	Ecosystem service flows: • Provisioning services (food, fibre, energy, etc.) • Regulation and maintenance (climate, river flow, pollination, etc.) • Cultural services (recreation in nature, spiritual use of nature, etc.)	Solar radiation Non-depletable Minerals, fossil fuels, gravel, ozone layer, etc. Depletable	Renewable energy (solar, wind, hydro, etc.) Non-depletable Phosphate fertiliser, radiation protection, etc. Depletable

On peut étendre le concept des SE aux Capitaux Naturels qui proviennent à la fois du vivant (SE) et du non vivant de manière renouvelable ou pas.

<http://biodiversity.europa.eu/maes>

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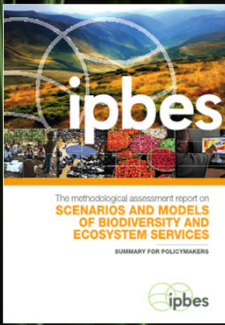
Cadre conceptuel de l'IPBES

- La "nature", les "contributions de la nature aux personnes" et la "bonne qualité de vie" sont des catégories inclusives qui ont été identifiées au cours d'un processus participatif.
- Cela inclut d'autres systèmes de connaissances, tels que ceux des peuples autochtones et des communautés locales.

<https://ipbes.net/global-assessment>

Concepts de la science
Autres systèmes de connaissance

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Scenarios and models

Policy and decision making

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Assessment and decision-support interface

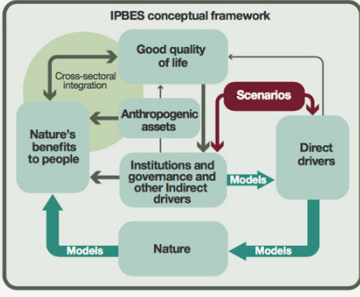
Models
translating scenarios into consequences for nature, nature's benefits and quality of life

Scenarios
describing plausible futures for indirect and direct drivers, and policy options

↕

Data and knowledge
(scientific, indigenous, local)

IPBES conceptual framework



Le panneau de gauche souligne que les scénarios et les modèles dépendent directement des données et des connaissances pour leur construction et leur test et apportent une valeur ajoutée en synthétisant et en organisant les connaissances.

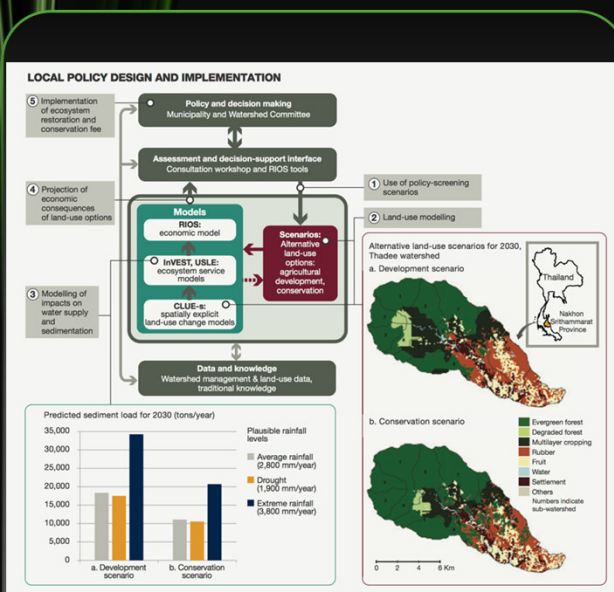
Le panneau de droite fournit une vue détaillée des relations entre les scénarios, les modèles et les éléments clés du cadre conceptuel de la plateforme

<https://www.ipbes.net/document-library-categories/assessment-reports-and-outputs>

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Scenarios and models

LOCAL POLICY DESIGN AND IMPLEMENTATION



Models: economic model, InVEST, USLE: ecosystem service models, CLUE-s: spatially explicit land-use change models

Scenarios: Alternative land-use options: agricultural development, conservation

Data and knowledge: Watershed management & land-use data, traditional knowledge

Policy and decision making: Municipality and Watershed Committee

Assessment and decision-support interface: Consultation workshop and RIOS tools

Implementation: Implementation of ecosystem restoration and conservation fee

Projection of economic consequences of land-use options

Modelling of impacts on water supply and sedimentation

Use of policy-screening scenarios

Land-use modelling

Alternative land-use scenarios for 2030, Thadee watershed

a. Development scenario

b. Conservation scenario

Legend: Evergreen forest, Degraded forest, Multi-layer cropping, Rubber, Fruit, Water, Settlement, Others. Numbers indicate sub-watershed.

Bar chart: Predicted sediment load for 2030 (tons/year)

Scenario	Plausible rainfall levels	Average rainfall (2,800 mm/year)	Drought (1,800 mm/year)	Extreme rainfall (3,800 mm/year)
a. Development scenario	~18,000	~15,000	~12,000	~20,000
b. Conservation scenario	~10,000	~8,000	~6,000	~12,000

Bassin versant de Thadee, Thaïlande, où l'approvisionnement en eau des agriculteurs et la consommation des ménages ont été dégradés par la conversion des forêts naturelles en plantations de caoutchouc.

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Données et outils

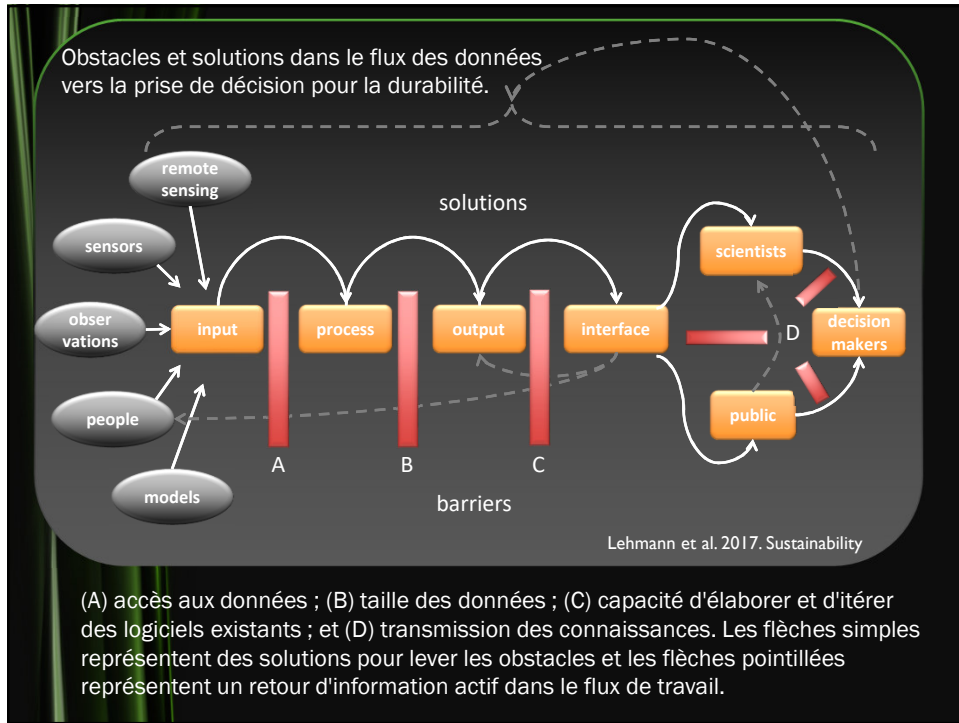
Les données et les modèles utilisés sont intimement liés au processus d'évaluation de la biodiversité et des services écosystémiques.

Des outils spécifiques ont été développés à différentes échelles avec des degrés e complexité variés.

TOOL	MODEL TYPE	SPATIAL AND TEMPORAL EXTENT	EASE OF USE	COMMUNITY OF PRACTICE	FLEXIBILITY	REFERENCE
IMAGE	Process	Global, dynamic	Difficult	Small	Low	StorWest et al., 2014
EcoPath with EcoSim	Process	Regional, dynamic	Medium	Large	High	Christensen et al., 2005
ARIES	Expert	Regional, dynamic	Difficult	Small	High	Vila et al., 2014
InVEST	Process and correlative	Regional, static	Medium	Large	Medium	Sharp et al., 2014
TESSA	Expert	Local, static	Easy	Small	Low	Peh et al., 2014

<https://www.ipbes.net/document-library-categories/assessment-reports-and-outputs>

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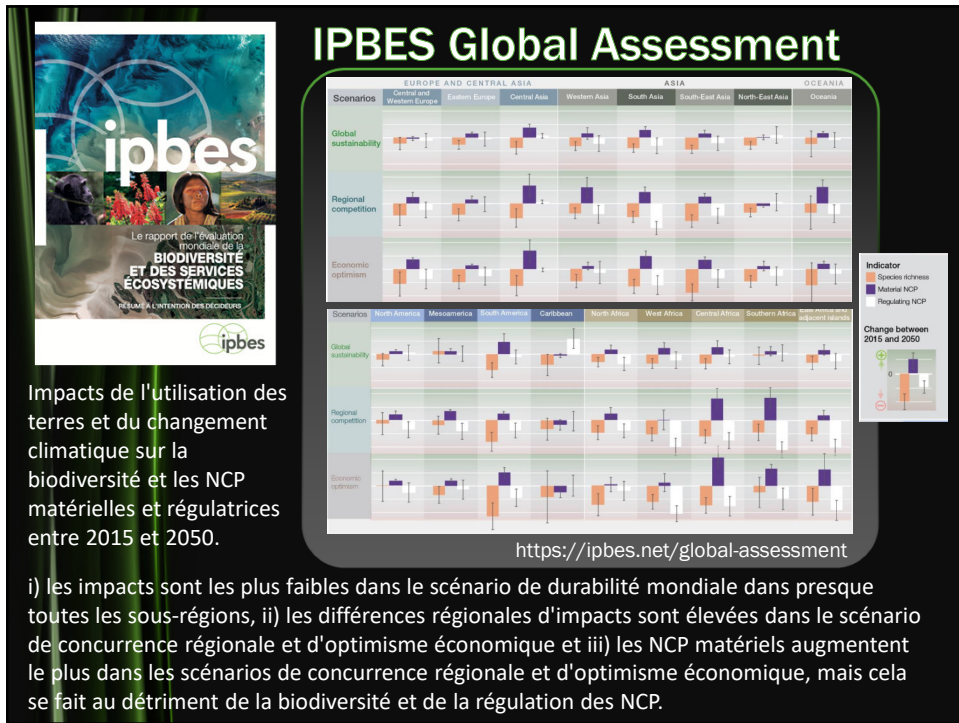
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Pour réconcilier les visions globales autour du concept, l'IPBES propose maintenant de parler des Contributions de la Nature aux Populations, et en a fait une première évaluation globale.

<https://ipbes.net/global-assessment>

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Cartographie des services écosystémiques

Mapping and Assessment of Ecosystems and their Services

An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020.

Discussion paper – Final, April 2013

http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

Mapping and Assessment of Ecosystems and their Services

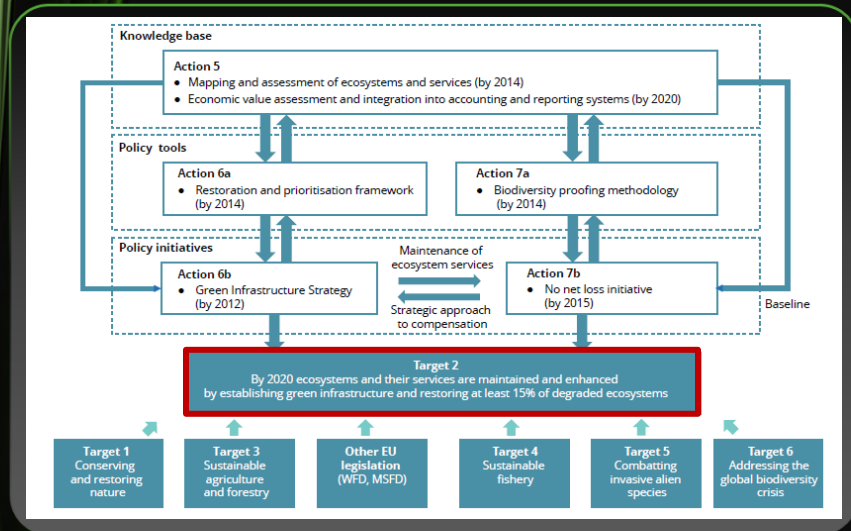
Mapping and assessing the condition of Europe's ecosystems: Progress and challenges

3rd Report – Final, March 2018

http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/3rdMAESReport_Condition.pdf

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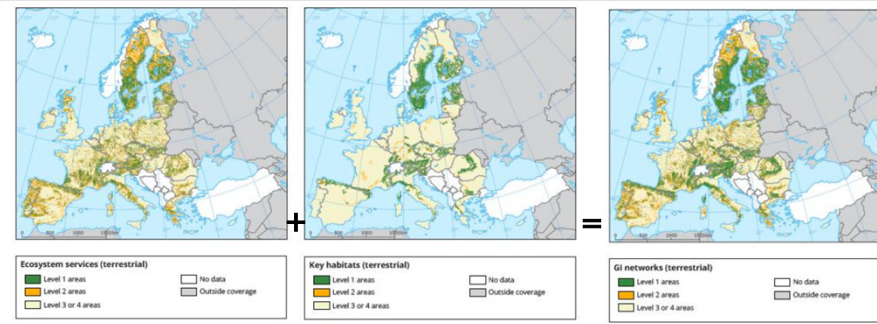
EU Stratégie Biodiversité



http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/3rdMAESReport_Condition.pdf

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Echelle européenne: Infrastructure écologique



27 % des EU-27 pourraient faire partie du réseau IE « C », la contribution la plus importante provenant des régions ayant la plus grande capacité de fournir des services écosystémiques.

17 % du territoire de l'UE pourrait correspondre au « R » de l'IE, principalement défini par des zones de service limitées.

EEA, 2014

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Stratégie Biodiversité Suisse

Swiss Biodiversity Strategy: 10 Strategic goals

10. Monitoring Biodiversity

1. Encourage Sustainable use



2. Develop Green infrastructure



3. Enhance survival of species



4. Preserve genetic diversity



5. Review Financial incentives



6. Assess and quantify ecosystem services



7. Strengthen Knowledge



8. Improve the quality in urban contexts




9. Strengthen International engagement



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ValPar.CH: Valeur ajoutée de l'IE



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Module A State and trend of nature's contributions to people

The objective of Module A is to assess the current state of biodiversity and nature's contributions to people (NCPs, ecosystem services) in Switzerland and in selected parks, in particular through mapping. The focus is on the quantitative, spatiotemporal analysis of the NCPs that are generated and ensured by the network of biotopes that form the ecological infrastructure (EI). At the national level, the analyses are based on a series of cover and land use maps with a resolution of 25 metres, maps created by modelling the soil cover and biodiversity as well as indices established based on satellite images stemming from the Swiss Data Cube. In selected parks, more precise analyses and models are implemented. Here, high-resolution data make it possible to take into account not only the landscape structures and spatial patterns with regard to land cover and land use, but also the relationship between the elements. The qualitative information on NCPs, assessed in Module B, is combined with these quantitative findings, and both are subsequently used to model and create maps of the EI at the national level, while also establishing a ranking of the areas to identify the regions which are best suited to establish a functioning EI. On a regional level, there will also be an assessment of the EI, however in a more detailed form. A generalisation based on a classification will lead to a number of EI archetypes allowing to transfer the results to other parks and landscapes in Switzerland.

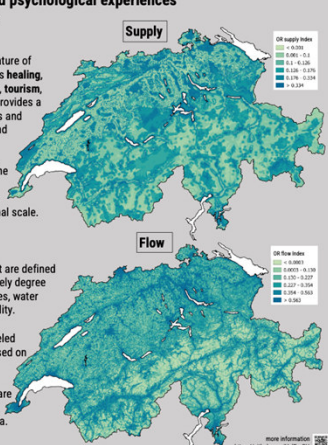
Insight Physical and psychological experiences – Outdoor Recreation

Defined as the provision by nature of beneficial experiences such as **healing, relaxation, recreation, leisure, tourism, etc.** This preliminary display provides a hint on possible discrepancies and similarities between supply and flow (use) of this NCP.

The patterns noticeable nation-wide also emphasize the importance of the scale of analysis, as different patterns are visible on a local or regional scale.


The supply of this NCP is generated by combining landscape characteristics that are defined as "recreation potential", namely degree of naturalness, natural reserves, water bodies, and general accessibility.

The flow of this NCP is modeled with a regression analysis based on geolocations from pictures retrieved in different photo sharing apps. The predictors are topological, demographical, and territory management data.



Methods

- Downscaling of the Swiss land cover maps
- Modelling the most important EI at the national level and in selected parks
- Modelling the potential land cover at the national level and in selected parks
- EI maps with prioritisation schemes for the entire territory of Switzerland and the selected parks
- Classification of the elements of the Swiss landscape based on their value in terms of biodiversity and NCP
- Provision of the guidelines and findings of the spatial analyses in a data infrastructure which is used to create dashboards and "story maps"


more information: 

<https://github.com/ValPar/CH>

Külling, in prep.


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Choix des indicateurs des SE base sur la liste des categories de l'IPBES



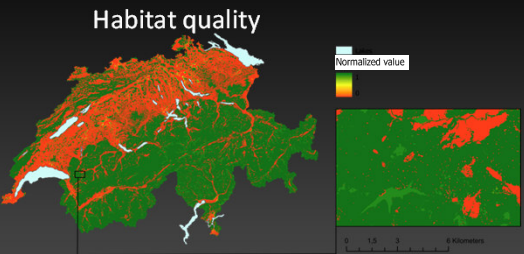
N°	Category	Name (IPBES)	IPBES reference	Indicator used
1	Nature/non anthropocentric	Individual organisms	N1	
2	Nature/non anthropocentric	Biophysical assemblages	N2	
3	Nature/non anthropocentric	Biophysical processes	N3	Landscape connectivity for target species
4	Nature/non anthropocentric	Biodiversity	N4	
5	Regulation	Habitat creation and maintenance	C2.1	Habitat quality index
6	Regulation	Pollination and dispersal of seeds	C2.2	Habitat abundance for pollinators
7	Regulation	Regulation of air quality	C2.3	Annual removal of PM10 by vegetation
8	Regulation	Regulation of climate	C2.4	Carbon stored in biomass and soil
9	Regulation	Regulation of freshwater quantity, location and timing	C2.6	Annual water yield
10	Regulation	Regulation of freshwater quality	C2.7	Annual nutrient retention by vegetation
11	Regulation	Formation, protection and decontamination of soils	C2.8	Erosion control by sediment retention
12	Regulation	Regulation of hazards and extreme events	C2.9	Landscape protection from natural hazards (forests + floodp)
13	Regulation	Regulation of organisms detrimental to humans	C2.10	Distribution of main predators to main pests
14	Material	Energy	C3.11	Wood-derived energy production
15	Material	Food and feed	C3.12	Crop production
16	Material	Materials and assistance	C3.13	Wood (timber) production
17	Material	Medicinal, biochemical and genetic resources	C3.14	Distribution of medicinal plant species
18	Non-Material	Learning and inspiration	C4.15	Picture-taking probability
19	Non-Material	Physical and psychological experiences	C4.16	Accessibility to recreation areas
20	Non-Material	Supporting Identities	C4.17	Index of species richness for "supporting identities" [1-0]
21	Options value for NCPs	Maintenance of options	C1.18	Genetic diversity distribution of selected species

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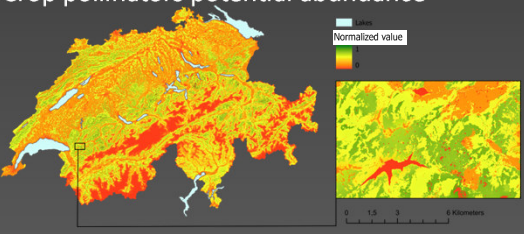
2 des 16 indicateurs cartographiés

Habitat quality



- InVEST model
- habitat quality and rarity
- estimating the extent of habitat and vegetation types across a landscape, and their state of degradation.
- function of four factors:
 - > threat's relative impact
 - > sensitivity of each habitat type to each threat
 - > distance between habitats and sources of threats
 - > degree to which the land is legally protected

Crop pollinators potential abundance




- InVEST model
- Wild pollinators
- Estimates nest sites availability and floral resources within flight ranges
- index of potential pollination supply based on:
 - > Potential abundance of pollinators nesting on each cell of the landscape
 - > floral resources
 - > foraging activity
 - > flight range information

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Nouvelles cartes de distribution des 10000 espèces pour la Suisse

- Using N-SDM, we produced maps for ~10,000 individual species (natives and invasives) and aggregated biodiversity indices
- These maps are covering all of Switzerland at a 25-meter spatial resolution
- They are made available for current and future (until 2100) time periods, under several climate change scenarios




	Predicted (1980–2021)	Projected (2070–2100)	
		RCP4.5	RCP8.5

Mapped current and future potential distributions for eight example species

Low █ █ High
Habitat suitability

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Infrastructure écologique nationale

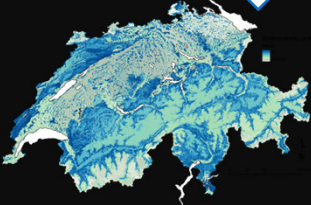


ValPar.CH

Ecosystem Services

SDMs

CONATION

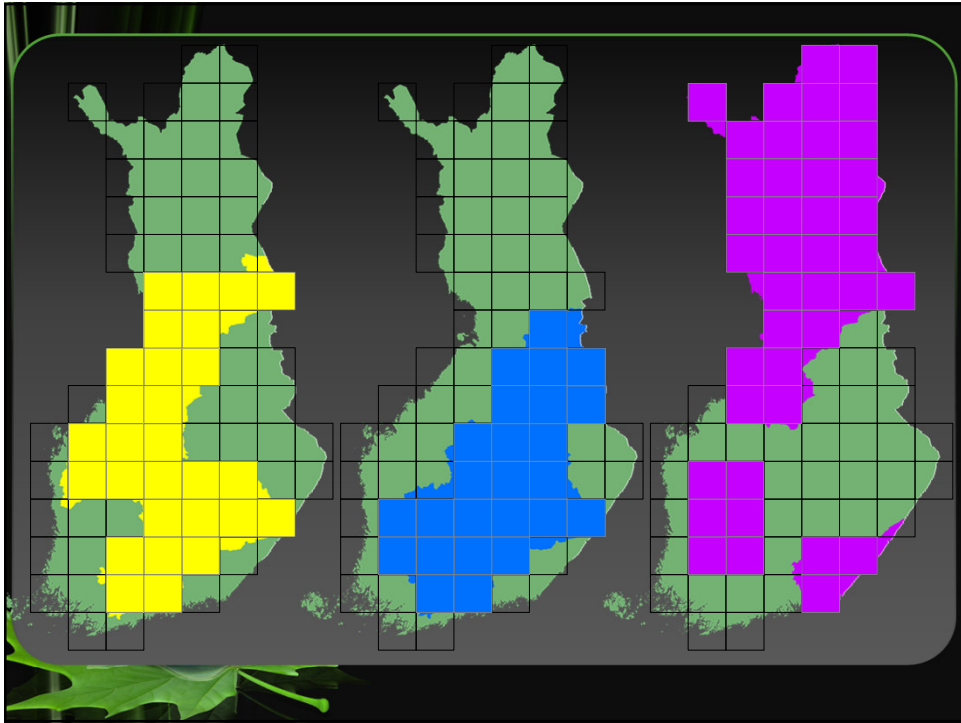


→ Parcs régionaux

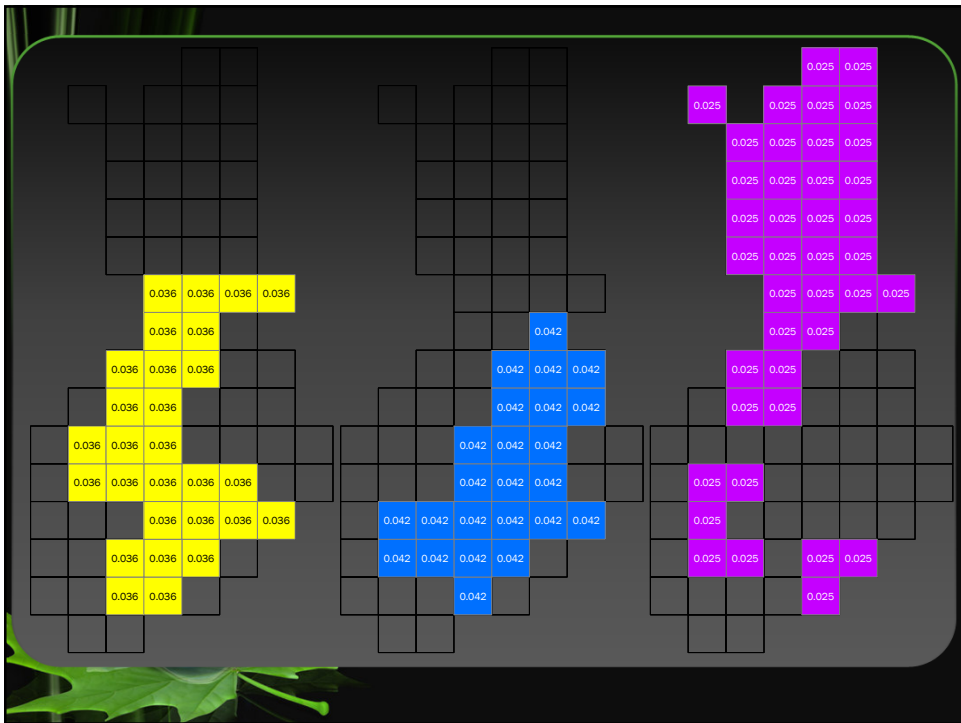
→ Cantons

→ Communes

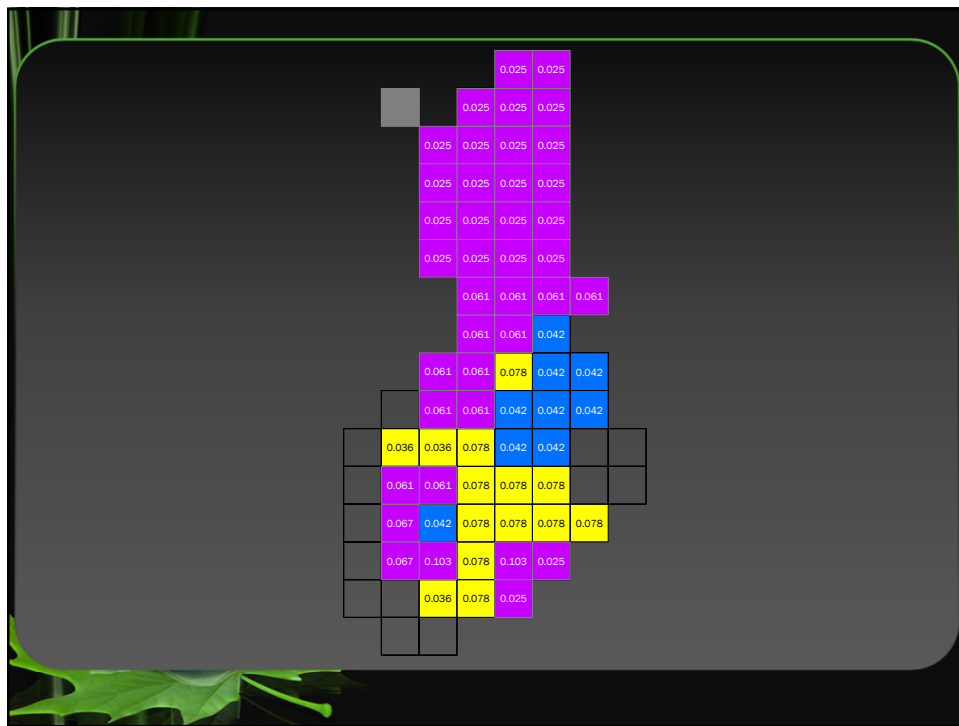
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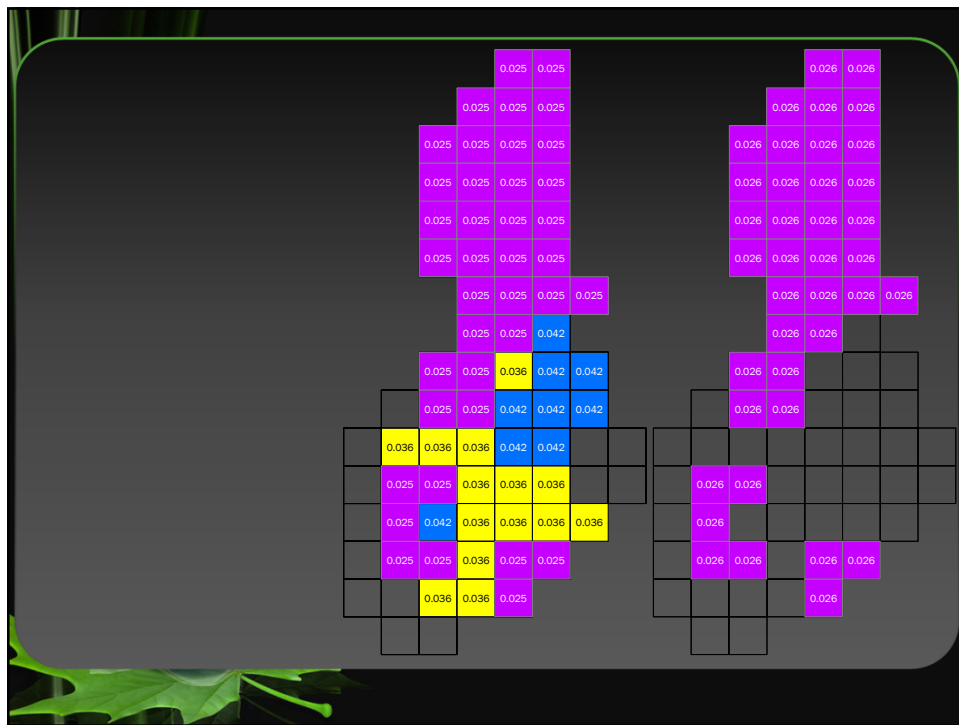
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Stratégie Biodiversité - Genève

REPUBLICAIN ET CANTON DE GENÈVE

1. Infrastructure Ecologique

2. Aires protégées

3. Forêt

4. Arbres

5. Rivières et lacs

6. Agriculture

7. Zones urbaines

8. Faune et Flore

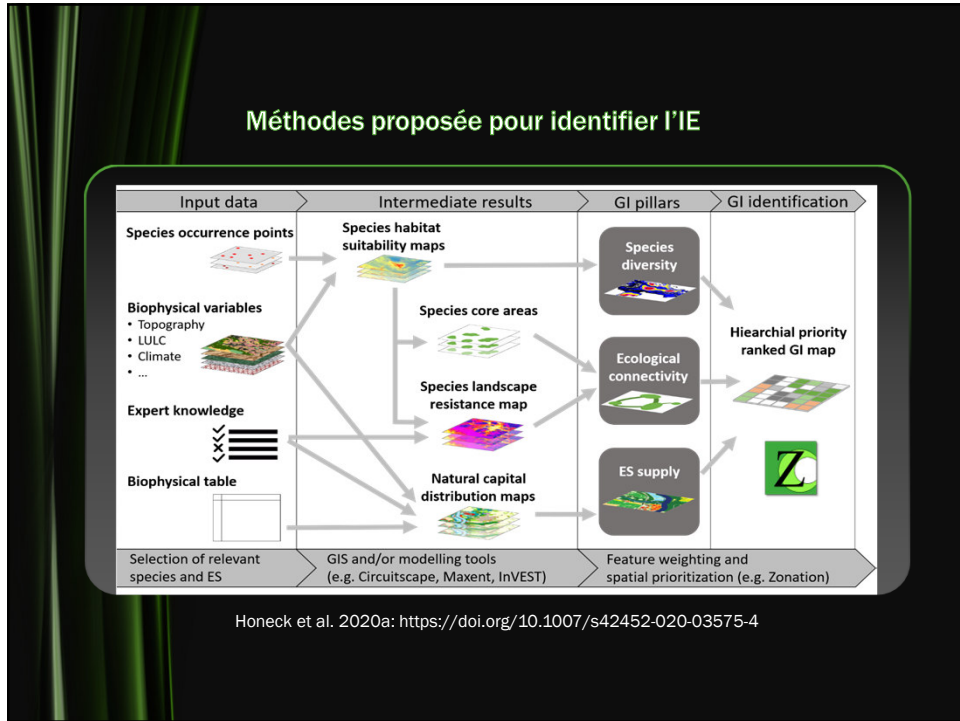
Stratégie Biodiversité Genève 2030 (SBG-2030)

Janvier 2018

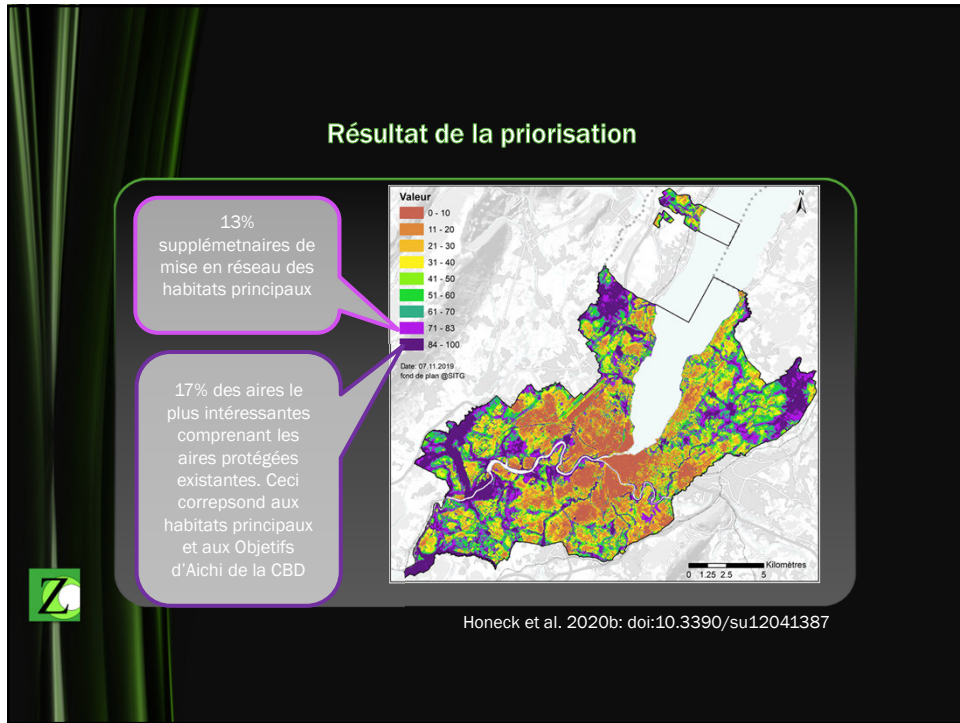
La biodiversité est constituée par la diversité des milieux naturels, la diversité des espèces, la diversité génétique ainsi que leurs interactions. Elle est la base de notre vie sur Terre.

Adoptée par le Conseil d'Etat le 21 février 2018

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Infrastructure Ecologique de Genève

L'infrastructure écologique

L'infrastructure écologique

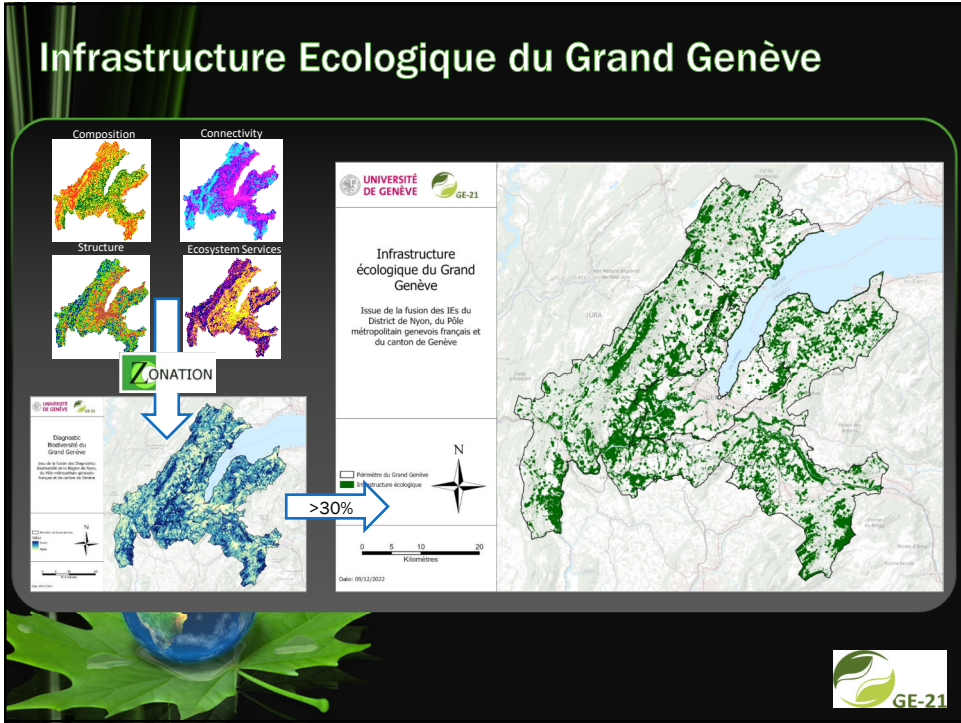
du Canton de Genève

November 5, 2020

OCAN, HEPIA: Alain Dubois et Nicolas Vallotton

<https://arcg.is/OzbCjq>

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Nombre et poids des couches

		Poids /couche	Nbre couche	Poids/ groupe	Poids/pilier
Pilier composition	Espèces flore	0.0116171	1480	25	100
	Espèces flore LR	0.0232342	336		
	Espèces faune	0.0347222	450	25	
	Espèces faune LR	0.0694444	135		
	Composition Habitats	2.5	20	50	
Pilier structure	Structure	8	5	40	40
Pilier services écosystémiques	Service écosystémique	4	5	20	20
Pilier connectivité	Connectivité	5 Trame Noire = 10	7	40	40
Total			2438	200	

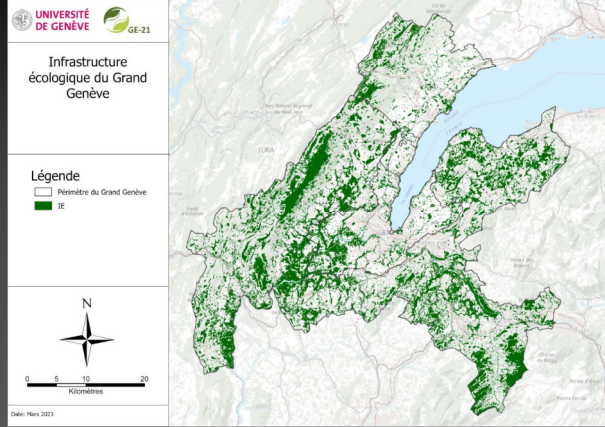
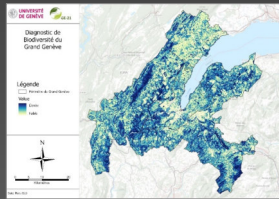
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Diagnostic Biodiversité du Grand Genève et Infrastructure Écologique

Lecture du tableau :

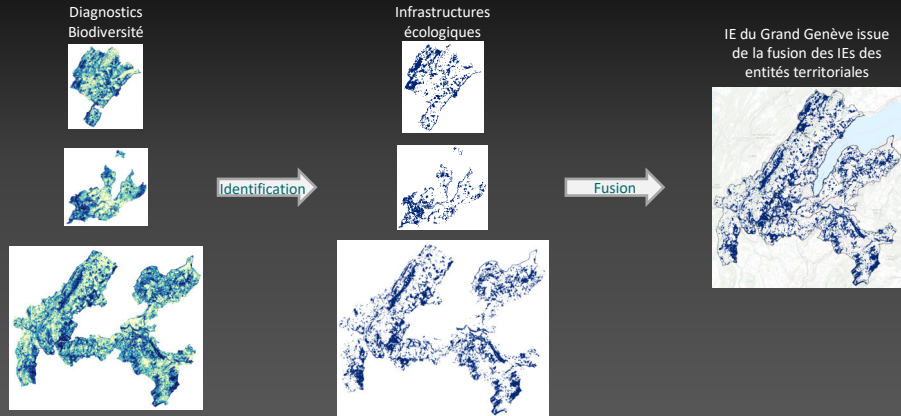
Le district de Nyon représente 15.4 % de la surface du GG, et contient en son sein 8.7 % de l'IE du GG, ce qui couvre 16.8 % de son territoire.

Entité territoriale	% Surface GG	% IE	Couverture IE
District de Nyon	15.4%	8.7%	16.8%
Pôle métropolitain	72.2%	81.5%	33.8%
Canton de Genève	12.4%	9.8%	24.0%

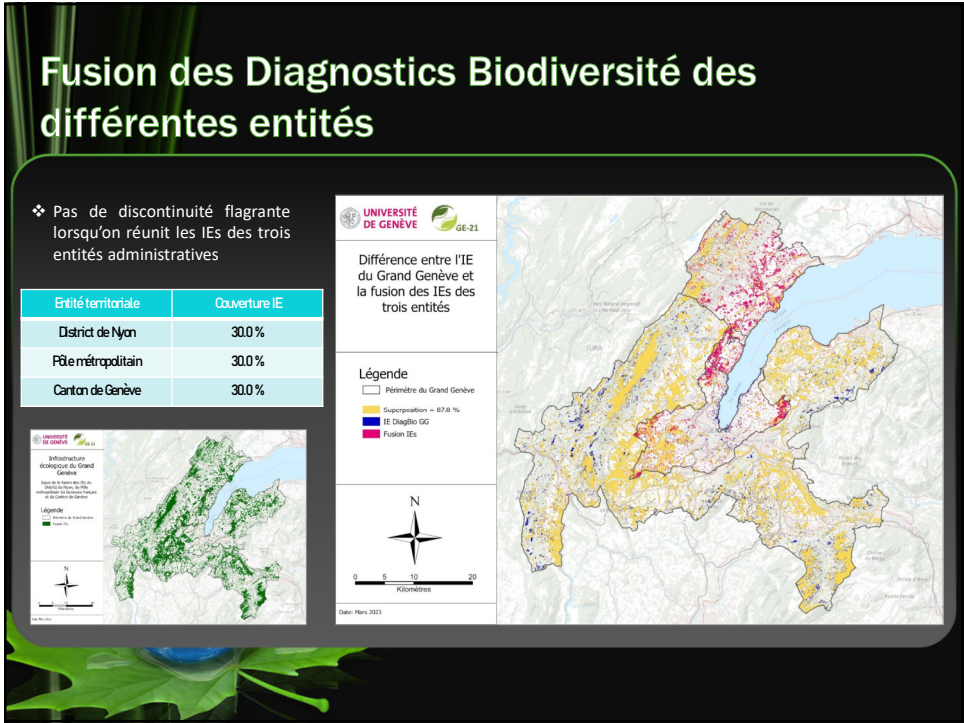


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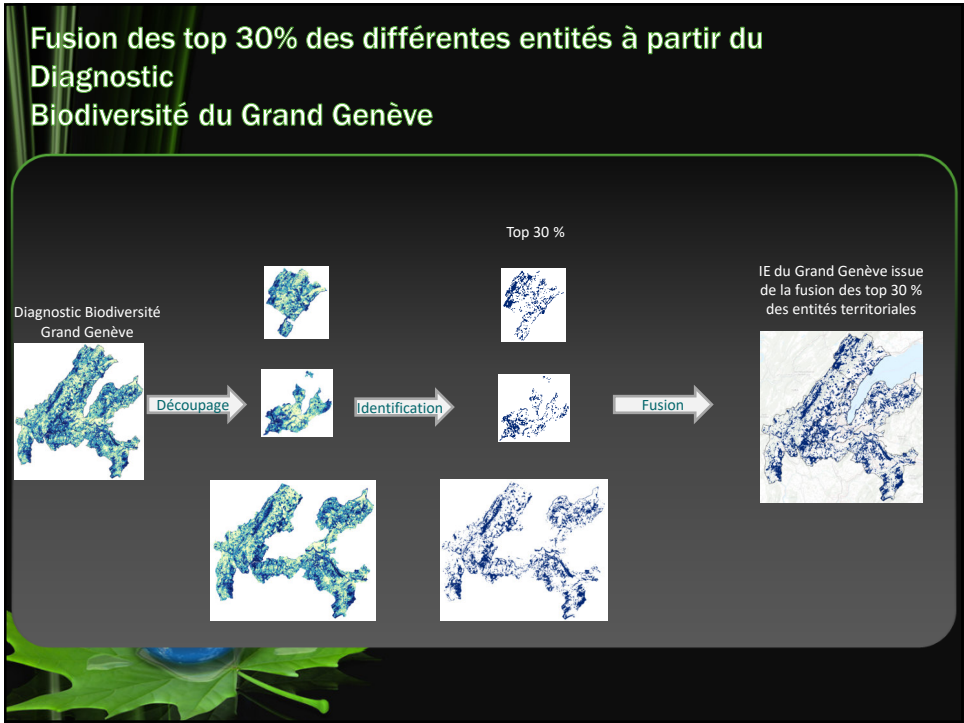
Fusion des Diagnostics Biodiversité des différentes entités



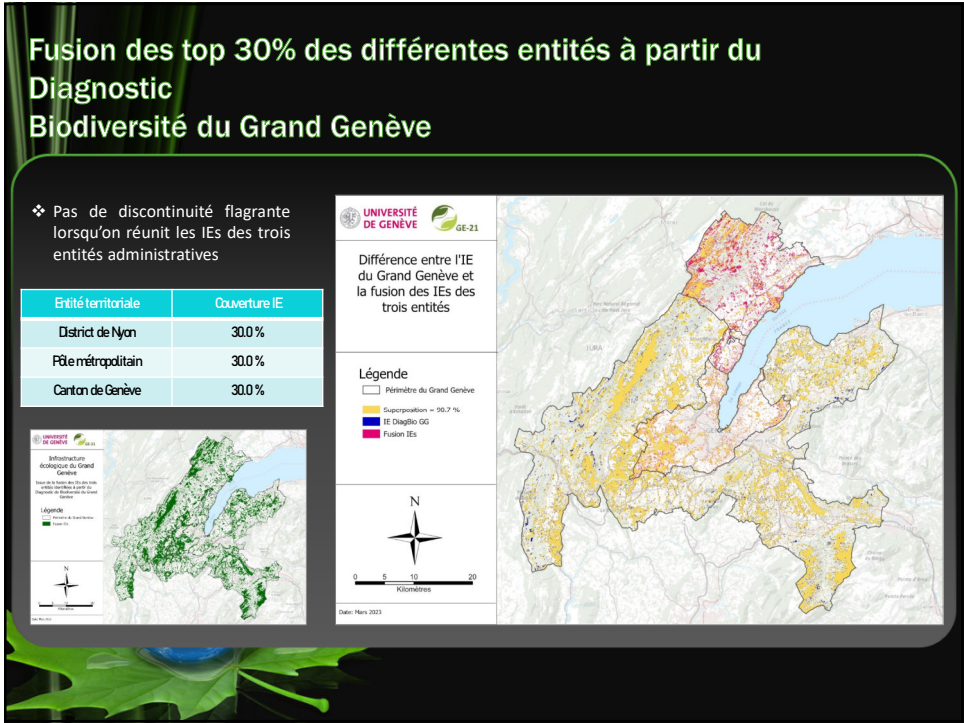
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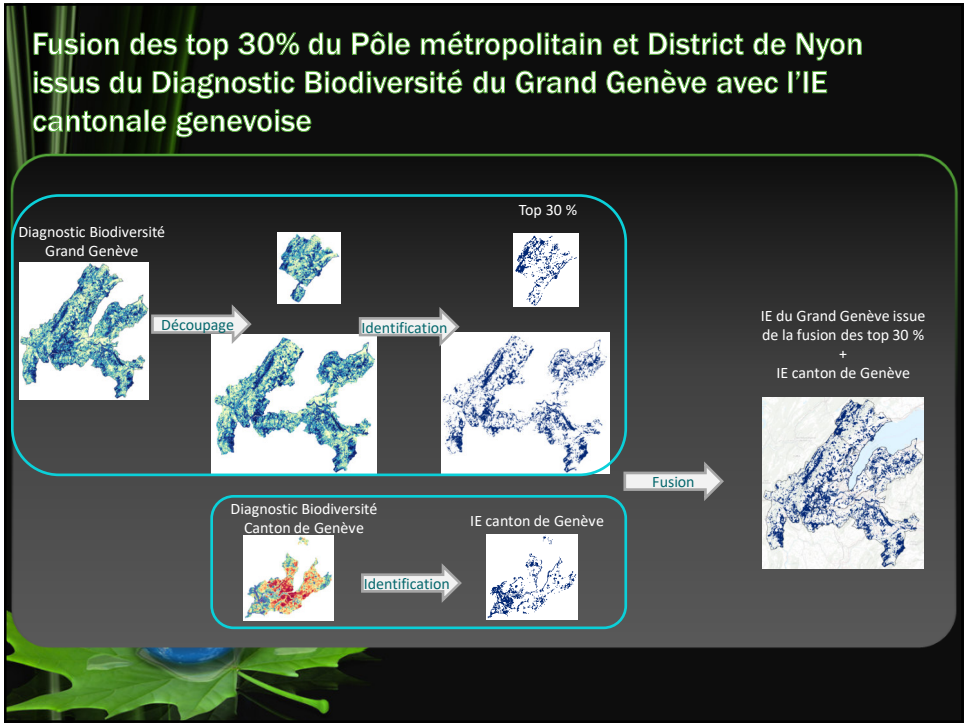
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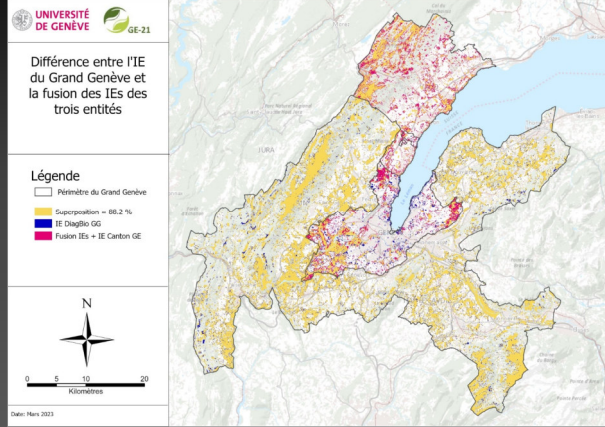
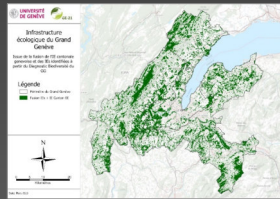


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Fusion des top 30% du Pôle métropolitain et District de Nyon issus du Diagnostic Biodiversité du Grand Genève avec l'IE cantonale genevoise

❖ Pas de discontinuité flagrante lorsqu'on réunit les IEs des trois entités administratives

Entité territoriale	Couverture IE
District de Nyon	30.0 %
Pôle métropolitain	30.0 %
Canton de Genève	30.0 %



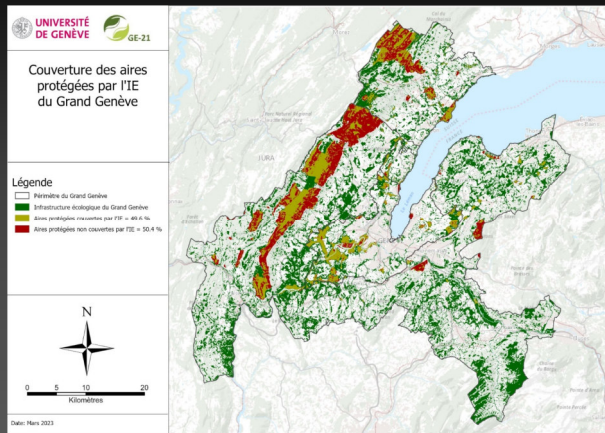
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Comparaison avec les aires protégées existantes

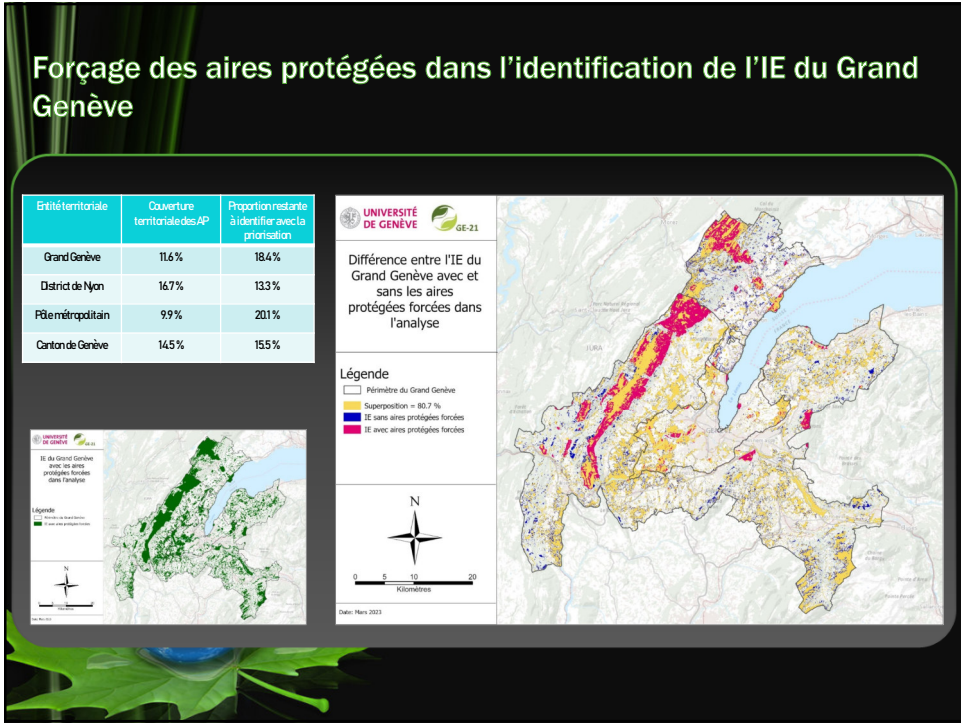
Lecture du tableau :

Les aires protégées sélectionnées couvrent 11.6 % du territoire du Grand Genève, et l'IE couvre 49.6 % de la surface des aires protégées.

Entité territoriale	Couverture territoriale des AP	Proportion d'AP couvertes par l'IE
Grand Genève	11.6 %	49.6 %
District de Nyon	16.7 %	51.6 %
Pôle métropolitain	9.9 %	40.7 %
Canton de Genève	14.5 %	82.4 %



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Quelques références

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