CSTB
le futur en construction

Urban area impacts on the biodiversity: how to take into account the local/ *in-situ* and the *ex-situ* impacts ?

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ecoSummit
29 August - 1 September, 2016
Montpellier, France

5TH INTERNATIONAL ECOSUMMIT
ECOLOGICAL SUSTAINABILITY
ENGINEERING CHANGE

This work was supported by the :

CSTB
le futur en construction

Scientific and Technical Centre for Building

ADEME
French Environment & Energy Management Agency

French Environment and Energy Management Agency under the TAMMIS project grant
digital Tool for multidisciplinary Assessment based on Thematic software Interoperability

eedems

Scientific Interest Group (7 institutes) on environmental assessment of waste effluents, materials, sediments and soil

Urbain area : in-situ and *ex-situ* impacts on the environnement

IN-SITU

Impacts (positive or negative) on the construction project site

EX-SITU OR EMBODIED

Impacts (positive or negative) due to the extraction of raw materials, the transformation, the manufacturing, the transport, the recycling /end-of-life of all materials needed for the construction project

How to asses the environnemental performance of the construction projets in urbain area ?

By using the Life Cycle Assessment method

LCA is defined as the "*compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle*" (ISO 14040)

European standard for Buildings LCA : EN 15978

- contain 7 life cycle environmental impact categories
- work in progress to include a broader set of environmental impacts categories, such as the impacts on the Biodiversity (CEN/TC 350, 2016)

	Indicator	Unit
Impact Assessment	Global warming potential, GWP	kg CO_2 equiv
	Depletion potential of the stratospheric ozone layer, ODP;	kg CFC 11 equiv
	Acidification potential of land and water; AP;	kg SO_2 equiv
	Eutrophication potential, EP;	kg $(PO_4)^{3-}$ equiv
	Formation potential of tropospheric ozone photochemical oxidants, POCP;	kg Ethene equiv
	Abiotic Resource Depletion Potential for elements; ADP_elements	kg Sb equiv
	Abiotic Resource Depletion Potential of fossil fuels ADP_fossil fuels	MJ, net calorific value
Resource use	Use of renewable primary energy excluding energy resources used as raw material	MJ, net calorific value
	Use of renewable primary energy resources used as raw material	MJ, net calorific value
	Use of non-renewable primary energy excluding primary energy resources used as raw material	MJ, net calorific value
	Use of non-renewable primary energy resources used as raw material	MJ, net calorific value
	Use of secondary material	kg
	Use of renewable secondary fuels	MJ
	Use of non-renewable secondary fuels	MJ
	Net use of fresh water	m^3
Waste	Hazardous waste disposed	kg
	Non-hazardous waste disposed	kg
	Radioactive waste disposed	kg
Output Flows	Components for re-use	kg
	Materials for recycling	kg
	Materials for energy recovery (not being waste incineration)	kg
	Exported energy	MJ for each energy carrier

How to asses the environnemental performance of the construction projets in urbain area ?

By using the Life Cycle Assessment method

Cause-effect chain

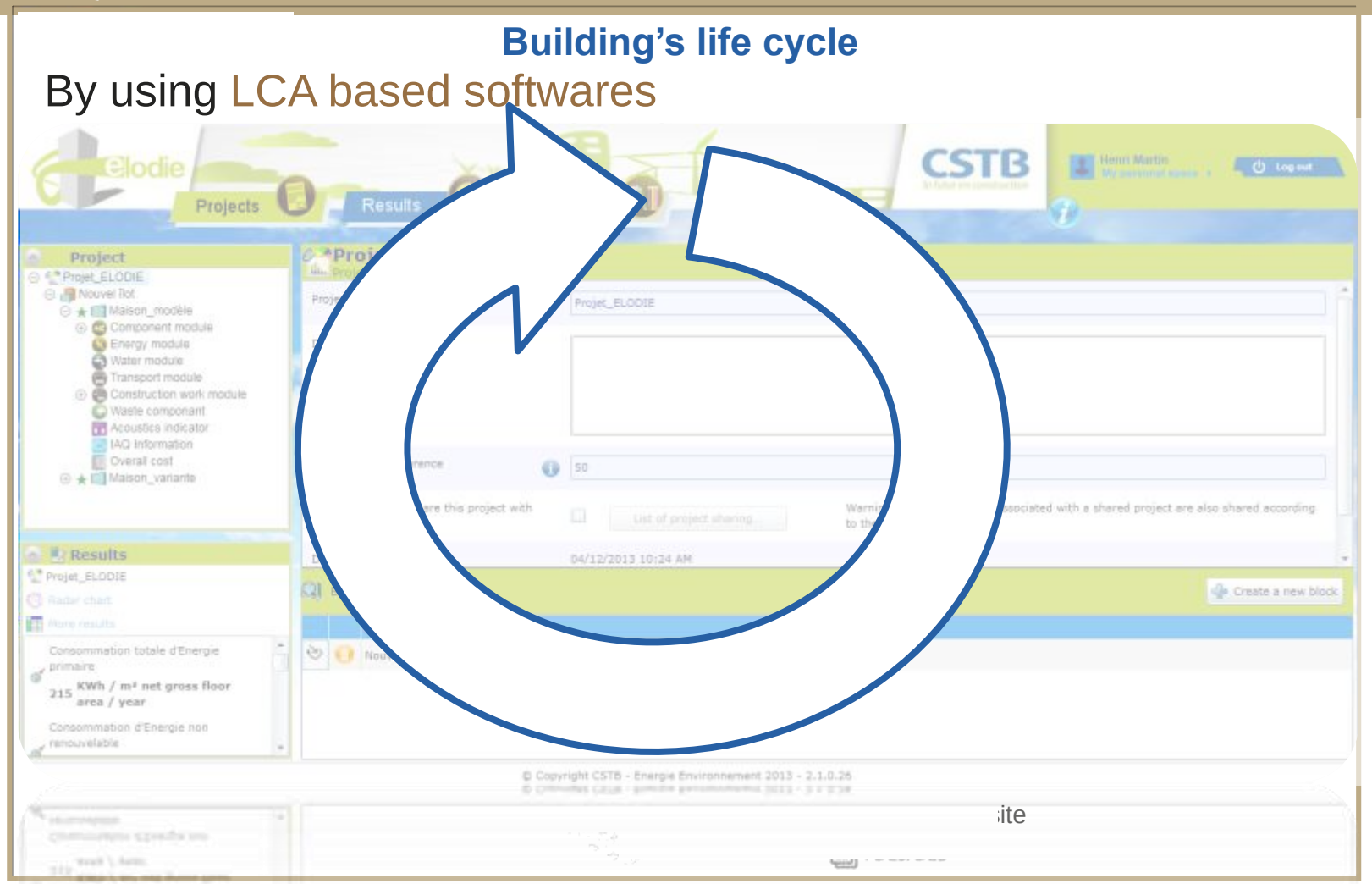
LIFE CYCLE INVENTORY	MID-POINT INDICATORS	END-POINT INDICATORS
> Emissions of CO2, CH4, etc. > Resources consumptions	> Climate change > Pollutions (air/soil) > Acidification / Eutrophication > Ecotoxicity > Etc.	Biodiversity damage Unit recommended by the ILCD - *The International Reference Life Cycle Data System* http://eplca.jrc.ec.europa.eu/?page_id=86 **PDF = Potentially Disappeared Fraction of species**

More “user friendly” indicators but higher incertitude

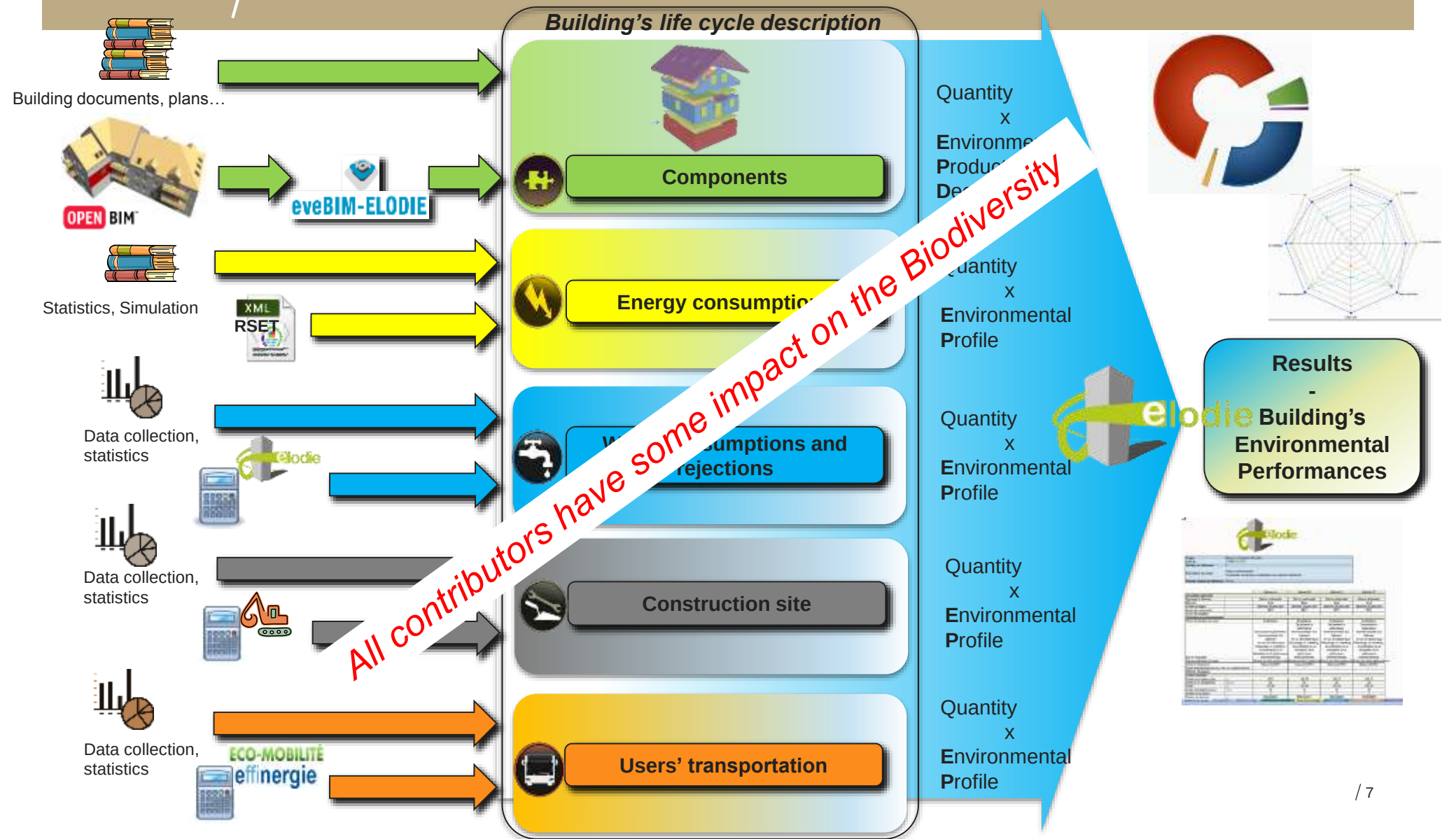
How to asses the environnemental performance of the construction projets in urbain area ?

Building's life cycle

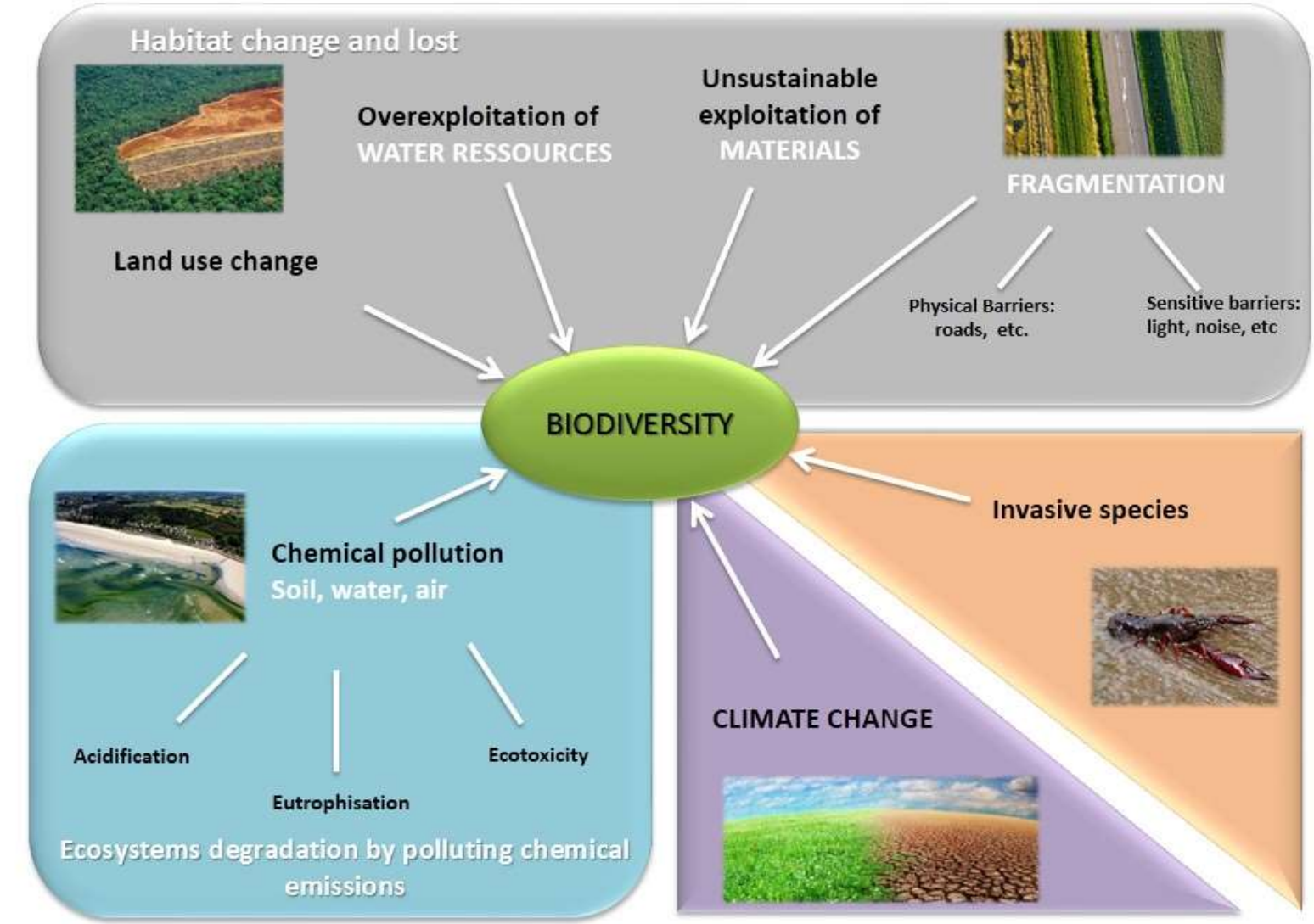
By using LCA based softwares



Building's contributors to the environmental impacts

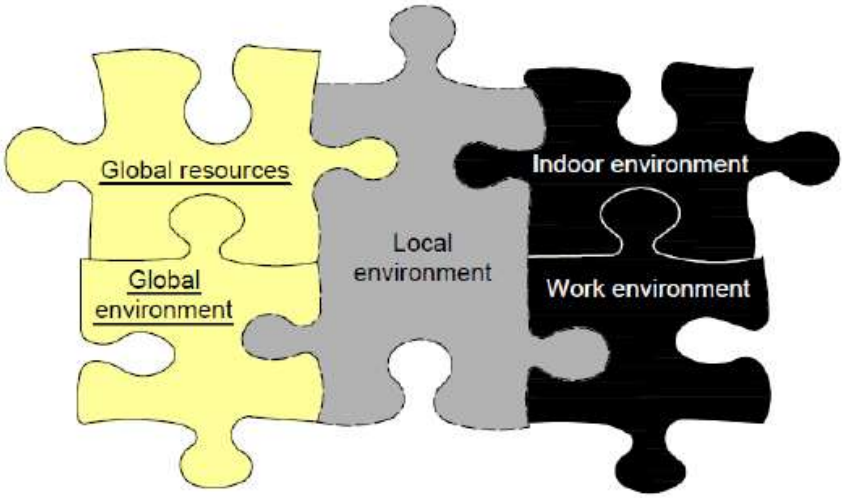


Biodiversity erosion causes



How to asses the environnemental performance of the construction projets in urbain area ?

By using the Life Cycle Assessment method …but not only !



Domain of LCA

(CEN/TC 350, 2016; Oberg, M., 2005)

Local impacts need to be better taken into account by using :

Ecological expertise
Geographical Information Systems (GIS), etc.

⇒ this means **hybridation of different methods**

How to asses the environnemental performance of the construction projets in urbain area ?

By using a hybrid method !

The innovative character of the approach lies in the:

- **spatially-differentiated** life cycle approach

  based on the **LCA – GIS** and by using the **URBAN DIGITAL MOCK-UP**
- integration of the **ecological / field expertise** into the overall approach, for the *in –situ* impacts assessment
- **models harmonization**, through CityGML international standard,
- **capitalization** and **enrichment** of input and output data
- **support decision** processes through integrated and informative **visualization**

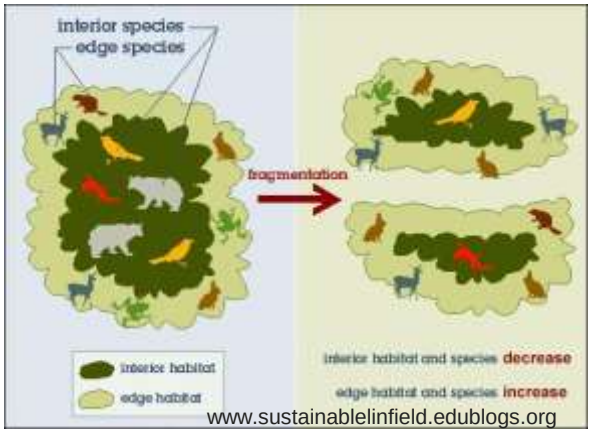
The beauty & challenge of the work :

- **multidisciplinary skills needed** (buildings, energy, water, ecology, GIS, sociology, etc.)
- **reaching the equilibrium** between the technical, environmental, socio – economical aspects of a construction project

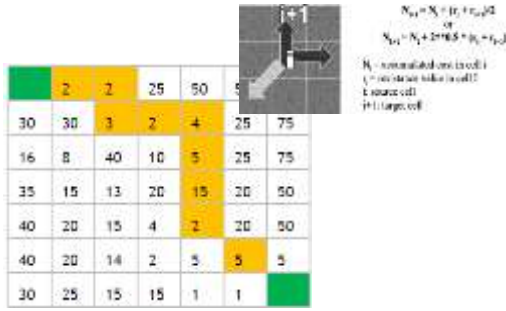
Firsts developments and results

Ex situ / embodied impacts

In situ impacts – e.g. habitat fragmentation



Graph theory
Least cost path algorithm



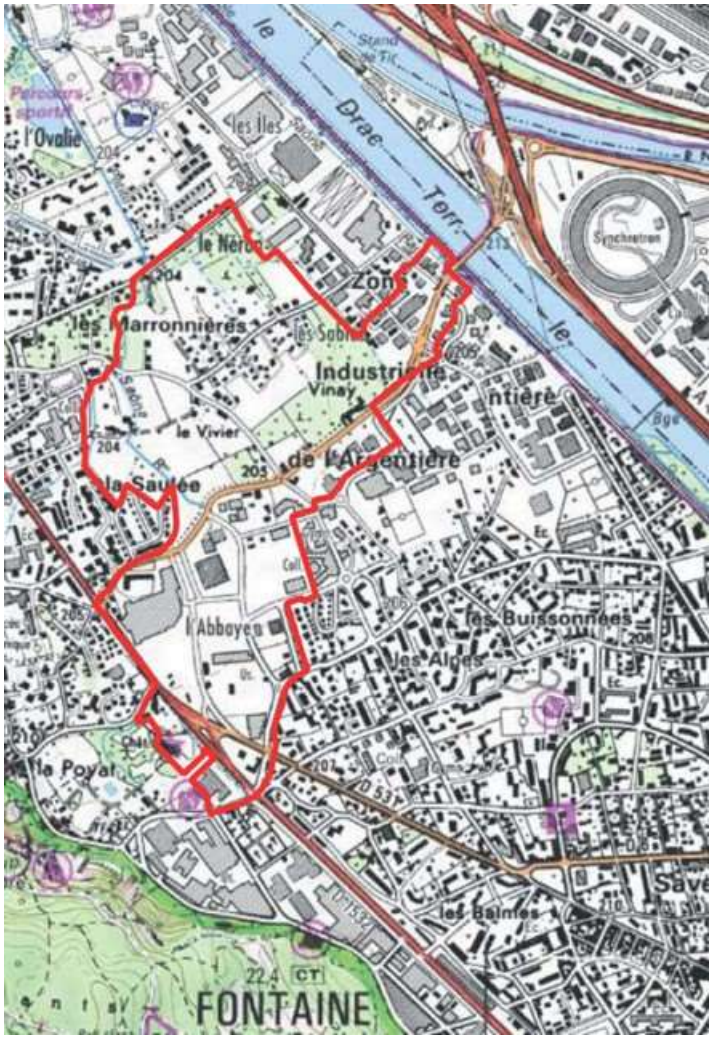
Adriaensen et al, 2003, CETE, 2014, QGIS

Index of Permeabilty Faune = $\frac{\text{Euclidean distance}}{\text{Least cost path x pixel size}}$

EVE City Digital Urban Mock-Up

Firsts developments and results

Portes de Vercors project



Firsts developments and results

In situ impacts -> habitat fragmentation -> Index of Permeabilty Faune (IPF)

IPF

1 0

Initial site

- Small mammals : 298,59/ 1092,38 = **0.27**
- Larges mammals : 298,59/1731,6 = **0.17**
- Birds and chiroptera : 298,59/980,07= **0.30**
- Amphibians and reptiles : 298,59/547,77= **0.54**
- Lepidoptera : 298,59/522,36= **0.57**





Project

- Small mammals : 298,59/ 644,04 = **0.46**
- Large mammals : 298,59/1290= **0.23**
- Birds and chiroptera : 298,59/983,55= **0.30**
- Amphibians and reptiles : 298,59/322,01= **0.92**
- Lepidoptera : 298,59/327,61= **0.91**

Firsts developments and results

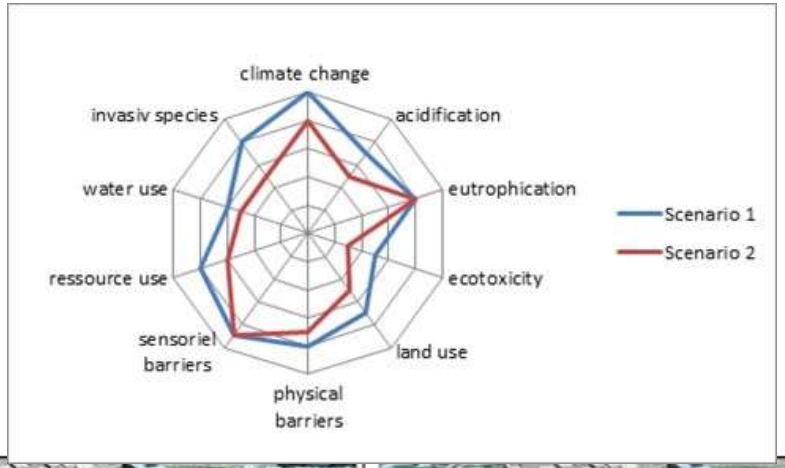
Overall results presentation

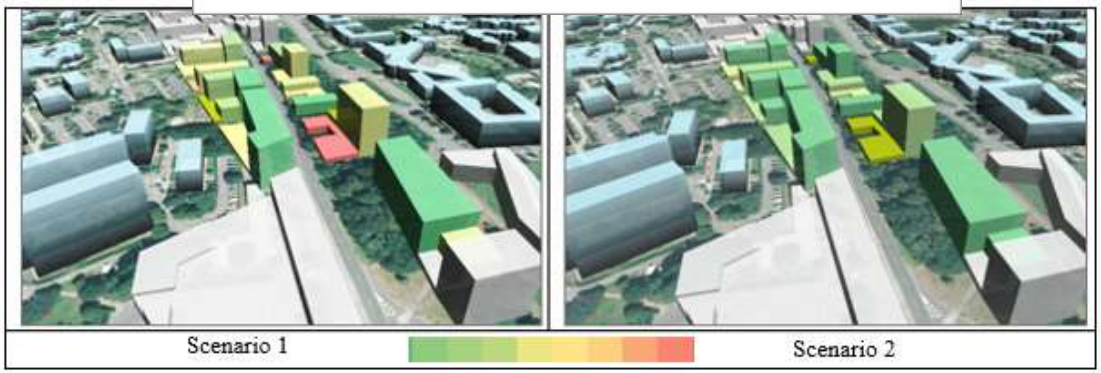
The results could be presented as :

- multicriteria graph (one indicator for each pressure/impact, assuring transparency) or as
- a global note after a weighting step (less transparent but considered as easier to use for decision process)

- At building or at overall project scale

- Numerical or visual presentation by using the urban digital mock-up





To be continued…

A lot of work still to be carried out :

⇒ Models improvements and hypothesis validation

⇒ Integration of the opportunities and challenges of the local context,

⇒ Integration of the ecosystem services issues,

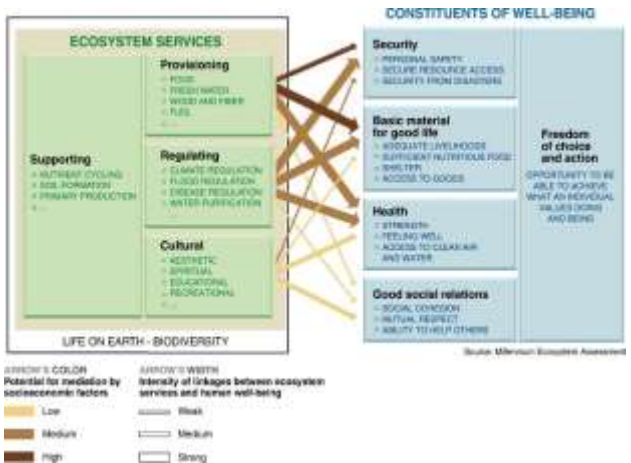
⇒ Taking into account social and economic aspects

⇒ Integration of other aspects of the urban life (e.g. food flow -> Wolff *et al*, *Integrated assessment of the pressures associated with raw food production on biodiversity in view of an absolute ecological sustainability assessment,* SETAC, Montpellier, 2016)

⇒ Handle poor data availability and the operational aspects

Collaborations needed

A PhD work planned



Thank you !

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Paris Smart City 2050, Vincent Callebaut