

Typology of sustainable development in Normandy

An appraisal at the intermunicipal level¹²

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Abstract:

The paper proposes an evaluation framework for comparing empirically the performance of Norman EPCIs in terms of sustainable development. The concept of sustainability is based on six dimensions: environment and natural resources, energy transition, sustainable mobility, economic dynamism, social cohesion and solidarity, and governance and citizenship. Considering a wide range of variables, we build aggregate composite indexes for each dimension of sustainable development. We use cartographical support to compare the performances of EPCIs in each of the six dimensions. Then a cluster analysis classifies Norman EPCIs and explores similarities and dissimilarities with respect to the six components of the sustainable development. The results highlight significant disparities between EPCIs regardless of the dimension considered. Six profiles of sustainable development are distinguished. Finally, the findings make it possible to identify the strengths and weaknesses of Norman EPCIs in implementation of sustainable development.

Keywords:

Sustainable development, French EPCIs, composite index, multidimensional data

¹ Etablissements Publics de Coopération Intercommunale (EPCIs): Public inter-municipal cooperation establishment.

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1. Introduction

Since the Brundtland report (1987) and the adoption of Agenda 21 at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, governments committed to developing strategies to achieve sustainable development. To address the challenges of the threat of ecosystems degradation and global warming, a radical technological transformation of the global energy system is required. Therefore, governments need to encourage concerted and coordinated efforts to integrate global ecological concerns into local and national policies (United Nations, 2008, UNEP, 2014). A whole set of initiatives are emerging locally to respond to these new challenges.

In France, the Grenelle Acts I and II have given local authorities a major role in setting up the energy transition by extending their field expertise in the field of energy policy, by enabling them to develop actions in favour of energy management and to intervene in the field of the production of renewable energy sources. To carry out its missions, the region has the Regional Plan of Climate, Air and Energy (SRCAE), created by the law 2010-788 of July 12, 2010, called "Grenelle Act II". The SRCAE must define, from an inventory, objectives and orientations for the horizons of 2020 and 2050 (DE CHARENTENAY et al., 2012). Regional strategies are defined and implemented at the local level by the local authorities which are strongly mobilized. In addition to the environmental issue, the creation of new sustainable and territorialized energy sectors is likely to generate local jobs that cannot be relocated.

According to THEYS (2018)³, France is now relatively well placed in terms of environmental performance; however, progress is very uneven from one territory to another and has not benefited everyone. In addition, results are not up to expectations in many areas: diesel, renewable energies, bike paths in cities, recycling, ecological food, safeguarding great natural continuity, health issues or environment. Areas in which we are in the middle of the ford while the ordinary biodiversity continues to decline and the advantage in terms of greenhouse gas is only because of the nuclear.⁴

The paper proposes an evaluation framework for comparing sustainable territorial development in France at the inter-municipal cooperation level, taking into account six dimensions: environment and natural resources, energy transition, sustainable mobility, economic dynamism, social cohesion and solidarity, and Governance and citizenship. Although the regional level is the most relevant for assessing and analyzing the effects of environmental policies in France - according to the law NOTRe⁵, the Regions have become the leader in the

³http://encyclopedie-dd.org/encyclopedie/neige-neige-economie-neige-neige/4-1-les-conditions-de-vie/cinquante-ans-de-politique.html#seconde_vague_pollution_industrielle_risques_et_conservation_de_la_nature_extraordinaire.

⁴ Corrected for climatic variations, the primary energy mix of the France is composed in 2017 of 40% of nuclear, 29% of oil, 16% gas, 4% coal and 11% renewable energy and waste (Ministère de la Transition Ecologique et Solidaire, 2018).

⁵ Nouvelle Organisation Territoriale de la République (New Territorial Organization of the Republic), 2015.

design and implementation of sustainable development actions, especially through the development of SRADDET⁶, which has become prescriptive - we chose to work at the inter-municipal cooperation. Two justifications can be advanced:

First, EPCIs⁷ are relatively new in the territorial landscape (at the end of the nineties). Yet, new impulse is given by the law NOtre strengthen EPCIs. Since 1 January 2017, 1600 EPCIs have been removed to constitute new EPCIs with a threshold of at least 15000 inhabitants. This policy enlarging and favouring gathering of existing communities gives them the ideal area to take into account local preoccupation about sustainable development especially sustainable mobility. Second, it allows for a more detailed analysis that promotes a better understanding of local characteristics and initiatives, such as local agendas 21.

Considering a wide range of variables, we build aggregate composite indexes for each dimension of sustainable development (OECD, 2008, O'CONNOR and SPANGENBERG, 2008, MAZZIOTTA and PARETO, 2013, 2017). The departments' performances in each of the six dimensions are compared by making use of cartographical support. Then a cluster analysis is used to classify French departments and to explore similarities and dissimilarities with respect to the six components of the sustainable development. The use of composite indexes allows us to easily summarise the performance of the departments in terms of sustainable as well as for an easy-interpretation of the results (MAZZIOTTA and PARETO, 2013). In this regard, the classification of French EPCIs makes it possible to identify the strengths and weaknesses of EPCIs as well as the levers and obstacles to sustainable development providing a useful tool for the application and coordination of sustainable development-based policies at the different administrative levels.

The results for each of the six dimensions of Sustainable Development are analysed by cartographical support in order to compare the performance of each EPCI in each of the Index dimensions. First, we use cartographical support to compare the performances of the EPCIs in each of the six dimensions. Then a cluster analysis is used to classify French EPCIs and to explore similarities and dissimilarities with respect to the six components of the sustainable development. Results make it possible to identify the strengths and weaknesses of the EPCIs as well as the the levers and obstacles to sustainable development. Spatial patterns may also eventually emerge. Finally, recommendations can be draw for public policies.

⁶ Schéma Régional d'Aménagement, de Développement Durable et d'Egalité des Territoires (*Regional Plan of Planning, Sustainable Development and Equality of the Territories*).

⁷ Établissements Publics de Coopération intercommunale (Public inter-municipal cooperation establishments).

2. Literature review

2.1 Definition of sustainable development

How can one define sustainable development? Sustainability refers to the capacity to maintain a certain activity or process indefinitely. Unsurprisingly, numerous definitions of sustainable development have been proposed by researchers and policy makers. The most commonly used is the one given by the BRUNDTLAND Report, which defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UNITED NATIONS GENERAL ASSEMBLY, 1987, p. 43). Conserving resources for future generations distinguishes sustainable development policy from traditional environmental policy which main goal is to internalize externalities of environmental degradation (EMAS, 2015). In a more global sense, sustainable development, is the answer to the question: How to preserve economic development while preserving environmental resources? The concept of sustainability is based on three interrelated pillars: environmental, social and economic, which are interconnected (PURVIS et al., 2019). This approach assumes that sustainable development can only be achieved if the three pillars are considered together and makes compatible economic development and protection of environment. Only then, sustainable development becomes the dominant paradigm for public policies. Any long-term public policies orientation towards growth must be environmentally beneficial, socially acceptable and economically feasible to be accepted by citizens. The interaction between the three pillars implies that achieving sustainability involves implementing measures must be put in place to balance the importance and impacts of these three pillars (JOVOVIC et al., 2017).

Environmental sustainability means that it is necessary to ensure both the availability and quality of natural resources and refers to the capacity of biological systems to maintain their functions and processes indefinitely. It focuses on natural capital and highlights the irreplaceability of some natural resources. The benefits for the environment concern the preservation of fossil resources and to the well-functioning of ecosystems⁸. At the condition of not exceeding its overexploitation thresholds, a natural ecosystem is part of the so-called *renewable resources* (DE PERTHUIS and SOLIER, 2018). The ecological footprint is a tool for measuring and monitoring environmental sustainability. WACKERNAGEL and REES (1996) defined the ecological footprint as the land area necessary to support the needs of a population and absorb all their wastes and proposed a method capable of determining the ecological limits by comparing the global human demand on the biosphere with its capacity for

⁸ An ecosystem is a "dynamic complex of plants, animals, micro-organisms and the surrounding still life acting as a functional unit" (DE PERTHUIS and JOUVET, 2013). We speak of natural ecosystem, naturally balanced, if at each level, the biomass is stabilized thanks to the interactions with the other levels. “Biomass is the living plant, animal, fungal, bacterial matter (as opposed to the necromass which is the dead matter). It is the product, almost all of the solar energy used by photosynthesis and secondarily organisms that feed on plants or live or dead animals”.

regeneration. According to the National Footprint Accounts (NFA), the world ecological footprint was 1.69 for the year 2014. It represents the Earth's biological incapacity to produce our resources and absorb our waste without questioning the future of the Earth, "one" is the reference that insures an environmentally sustainable development⁹. Note that two concepts of environmental sustainability coexist according to the works of SOLOW (1974, 1986, 1993) and HARTWICK (1977, 1978a, 1978b). The weak one considers that it exists a substitutability between Human (or produced) capital - in a wide sense that incorporates resources such as infrastructure, labour and knowledge - to Natural capital.¹⁰ Then the degradation of the ozone layer, tropical forests and coral reefs, if accompanied by benefits to Human capital, so that Total capital is left constant overtime, is accepted. In contrast, strong sustainability assumes that "Human capital" and "Natural capital" are complementary, but not interchangeable. Most of the ecologists are proponents of the latter definition (STODDART, 2011). Although the ecological footprint is widely used, it has received a lot of criticism. ZHANG et al. (2017) argue that ecological footprint is not a good indicator of the real ecosystem value and it not properly addresses water as a renewable source. BLOMQVIST et al. (2013) state that the estimation of the rate of carbon waste absorption is very uncertain. In addition, the meaning of the world ecological footprint differs from its meaning on sub-global scales. For example, at the country level, it is an indicator of self-sufficiency and patterns of trade.

Social sustainability must ensure a quality of life and services, as well as safety for all citizens. Socially acceptable refers to the idea that if huge efforts for urgent changes (i.e., climate change) are necessary, they need to be well distributed among the population to be accepted. STREN and POLESE (2000) define the social pillar as "development (and/or growth) that is compatible with the harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population". BRAMLEY and POWER (2009), who discuss social sustainability in respect to urban form and housing in the UK, consider that "social equity issues (access to services, facilities, and opportunities)" and "sustainability of community" entail concerns about social capital and cohesion. According to BAEHLER (2007), the social sustainability is concerned with the fundamental tensions of democracy as found in TOCQUEVILLE.¹¹ Then DAVIDSON (2010) notices that while incorporating "different

⁹ Of course, this average depends on living standards and demographic pressure. At the French scale, with the 2014 figures, it would take 2.9 Earth if all humanity lived like the French. As France is relatively sparse, compared to the bio capacity of France, it represents only 1.89 Earth that is still too much for sustainability. More than 55% of this ecological footprint is due to the carbon footprint. It should be noted that this ecological footprint does not take into account all the environmental damage, in particular it poorly integrates the degradation of water quality, does not take into account the reduction of surfaces due to rising water levels, the bio capacity necessary for other living species and nuclear energy.

¹⁰ Fossil resources, rare earths, forests, seas, lakes and a multiple of different ecosystems.

¹¹ "We might venture to define social and political (or "nationhood") sustainability as the ability of a society to resist internal forces of decay while also maintaining and reproducing the background social, cultural, and institutional conditions necessary for healthy democratic social relations to flourish", Alexis de Tocqueville (1956 [1835]). (Baehler, 2007, p. 27).

concerns, those such as equity, consensus and security [that] come to be recast as social sustainability”, the concept becomes more or less inconsistent. Social sustainability is then more a container than a content and is useful for political discourses in urban cities. The protestation movement of the “yellow vests”, initiated in France in November 2018, points the necessity to create the conditions for a fair acceptable ecological transition by ensuring that all sectors contribute, such as air, road transport and industry, and by preserving the budget of the most modest households.¹²

Economic sustainability expands development’s concern to include environmental and social issues. According to UN, it requires “societies to create the conditions that allow people to have quality jobs that stimulate the economy while not harming the environment. Job opportunities and decent working conditions are also required for the whole working age population”.¹³ From this perspective, the depletion of natural capital can be curbed by the implementation of policies and measures aimed both at saving non-renewable resources and at replacing them with renewable resources. To achieve these goals, a new business model needs to be implemented. Circular economy and innovation are the key drivers for this new model. The circular economy aims to change the paradigm with respect to the so-called linear economy, by limiting the waste of resources and the environmental impact (BRAUNGART and MC DONOUGH, 2002; ELLEN MAC ARTHUR FOUNDATION, 2013; BLOMSMA and BRENNAN, 2017). The circular economy targets sober and efficient management of resources. Undoubtedly, R&D, technology and eco-innovation play a key role in accelerating transition to a sustainable development. Fostering eco-innovation by environmental regulation is therefore essential. However, an important peculiarity of eco-innovations is the double externality problem that reduces the incentive for firms to innovate (RENNINGS, 2000). Indeed, in addition to generating knowledge spillovers, eco-innovation also generates environmental spillovers. Usual free riders of knowledge externalities add benefit of environmental externalities in the adoption and diffusion phases of eco-innovation that prevent them to invest in eco-innovations. Finally, double externality problem leads to a reduction of the incentive to invest in eco-innovation because the private return on R&D in environmental technology is less than its social return (GHISSETTI and RENNING, 2014; KRUSE, 2016). Many empirical studies have confirmed the key role of environmental regulation as a driver of eco-innovation (BRUNNERMEIER and COHEN 2003, HORBACH et al. 2012, KNELLER and MANDERSON 2012, HOJNIK and RUZZIER 2016, ANG et al. 2017). It is with this mind that, the European Commission set up the Eco-innovation Action Plan (2011) whose aim is to integrate eco-innovation in environmental and industrial policies by focussing on its contribution to economic growth, job creation and European Union industry competitiveness.

¹² Faced with the rising cost of fossil fuels - resulting from an increase in carbon taxes-, people should favour alternative modes of transport, softer, sober, and collective. Nevertheless, in reality a part of the French rural population, had no alternative of displacement –closure of railway lines- and no possibility to buy an electric car, for example, because it is too expensive. Finally, this pretty good reform in incentivizing terms had to be removed because it was not considered as a fair ecological reform.

¹³ More information available at the United Nations site: <https://www.un.org/sustainabledevelopment/economic-growth/>

The plan includes actions both on the demand and supply side, on research and industry and on policy and financial instruments.

Although these three pillars of sustainable development are commonly used, they are not universally recognized and some alternative approaches have been proposed. Additional pillars may be included, such as institutional, cultural, technical (PURVIS et al., 2019). In September 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals (SDG) and 169 specific targets. Even annual refinements of indicators are done, the actual total number of individual indicators in the list is 232.

In France, following a consultation conducted under the aegis of the National Council for Statistical Information (CNIS), a scoreboard of 98 indicators was proposed in mid-2018, which constitutes the national framework for monitoring progress of France in achieving the 17 SDGs.

2.2 A territorial perspective of sustainable development

2.2.1 Agenda 21

Because so many problems and solutions to sustainability lies at the local level, the Agenda 21 adopted by the United Nations in 1992 assigns an essential role of the territories in the implementation of sustainable development. Indeed, local and subnational governments exercise exclusive or shared competencies as regard to a wide range of areas such as mitigation and adaptation to climate change, energy, waste management, water and sanitation, biodiversity protection and conservation, agriculture, industry, education, transport, land use and planning, food production and security, transportation. Agenda 21 aims at stimulating citizens' actions at the local level and illustrates the need to “think globally and act locally”. It defines the sectors in which local and regional authorities must integrate the principles of sustainable development: Governance and citizenship, the fight against poverty, health, education, managing waste, resource and natural spaces, energy efficiency of buildings, the evolution of sustainable mobility... Territories have a decisive role to play in SDG achievements. OECD estimates “that 65% of the 169 targets underlying the 17 SDGs will not be reached without proper engagement of and coordination with local and regional governments”. The Green Paper on Territorial Cohesion (COMMISSION OF THE EUROPEAN COMMUNITIES, 2008) outlined the importance of territorial cohesion which “builds bridges between economic effectiveness, social cohesion and ecological balance, putting sustainable development at the heart of policy design”. Active participation of various actors is required. In France, Local Agenda 21 encompass territorial projects bringing together public institutions, associations, citizens and unions. It is built from a diagnosis, a dialogue between the different actors and the establishment of a plan of action subject to evaluation and indicators. It is implemented by a steering committee. A local Agenda 21 can be adopted by any community, regardless of its territorial scale (commune, community of communes, agglomeration, country, regional natural park,

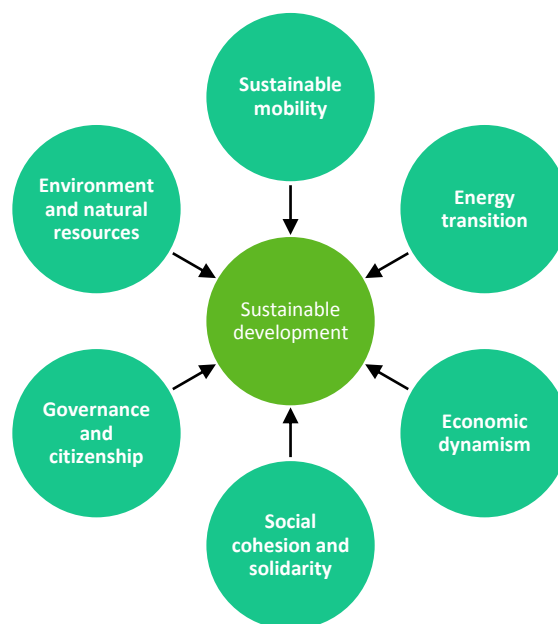
department, region). There is no single model, it is up to each territory, to take ownership and choose its path, based on its cultural, geographical, economic, social and societal specificities.

The Territorial Energy Climate Plan (PCET) constitutes the climate component of the territorial project for sustainable development whose primary purpose is the fight against climate change. It is obligatory for regions, departments, urban communities, agglomeration communities and municipalities and inter-municipalities of more than 50 000 inhabitants. Governed by the two laws “Grenelle” ((Law No. 2009-967 of August 3, 2009 and Law No. 2010-788 of July 12, 2010), it defines: i) The strategic and operational objectives to mitigate and effectively combat global warming and adapting to it; ii) the program of actions to be carried out, in particular to improve energy efficiency, increase the renewable energy production and reduce the impact of activities in terms of greenhouse gas emissions in line with the objectives of European energy and climate legislation and iii) a mechanism for monitoring and evaluating the results.

2.2.2 Building indices for sustainable development

In order to take account the special features of sustainable development at the inter-municipalities level, we decided to evaluate sustainable development in terms of six dimensions (MATSON et al., 2016). As shown in Figure 1, we consider: *Environment and Natural Resources*, *Sustainable Mobility*, *Energy Transition*, *Economic Dynamism*, *Social Cohesion and Solidarity* and *Governance and citizenship*.

Figure 1: The six dimensions of sustainable territorial development



The first one, *Environment and Natural Resources*, takes into account the Greenhouse Gaz Emission per capita and evaluates the capability of the territory to regenerate its resources

thanks to the share of non-artificialized surface area, aquatic surface area and shoreline length (BOYD, 2007).

The second one is *Sustainable Mobility*. Transportation is an important cause of pollution, more or less densified territories that conduct to more or less important commuting transportation for employs or education *plus* infrastructures and automotive equipment determine how important (in terms of average km traveled), clean and efficient is the way of displacement (MARSDEN, 2009; ARVIN et al., 2015). Sustainable mobility is one of the major challenges that territories must face and requires a radical change. Indeed, territorial policies must develop different mode of public transport, like bicycle and pedestrian lanes, electric vehicles, car sharing and rail freight and create new solutions that respect environment insuring the flow of people, goods and services.

The third one is *Energy Transition*, this dimension is at the heart of sustainable development, Goal 7 of the UN's SDG highlights the importance of affordable and clean energy. Therefore, a radical technological transformation of the global energy system is essential to reduce energy consumption, limit the use of fossil fuels, and promote the development of low-carbon energies. The European Union adopted the Climate Energy Package at the European Council of 12 December 2008 set out an action plan to enable the EU to achieve three objectives for the year 2020: (i) reduce greenhouse gas emissions (GHG) by 20% compared to 1990 levels; (ii) increase the share of renewable energy to 20%, and (iii) reduce energy consumption by 20% by 2020 compared to projections. This plan was reinforced in 2014 with the adoption of the EU 2030 Framework for Climate and Energy Policies, which sets even more ambitious targets¹⁴. In France, the two laws "Grenelle" gave local authorities play a major role in setting up the energy transition in extending their field of competence in the field of energy policy, to develop actions for the control of energy and to intervene in the field of production of renewable sources. To carry out its missions, the region has an Energy, Air and Climate Regional Scheme (SRCAE), created by law 2010-788 of 12 July 2010, known as the Grenelle II law. This scheme must define, from an inventory, objectives and orientations for 2020 and 2050 (DE CHARENTENAY et al., 2012). Regional Network Connection Plans for renewable energy (S3REnR) have been set up to promote the achievement of the objectives set by the SRCAE.

The fourth one, *Economic Dynamism* could have, a priori, two divergent influences, pollution and degradation of environment is often associated to growth, but in developed countries at a certain level, we observe a diminution of these drawbacks due to awareness, willingness and means to preserve natural capital (KUZNETS' curve, 1955). GROSSMAN and KRUEGER (1991) assumes that pollutant emissions increase with growth and then decrease, forming an inverted "U"-shaped relationship. According to ZUINDEAU (2005), access to a certain threshold of development makes "virtuous growth". Several arguments support this "optimistic" vision of growth: i) economic development and its corollary the tertiarisation of the economy reduce the environmental impact, (ii) increase the level of education and the level

¹⁴ i) a reduction in greenhouse gas emissions of 40%, (ii) an increase in EU energy from renewable sources to 27%, and (iii) an indicative target of 27% energy efficiency.

of life can induce a strong sensitivity to environmental concerns and change consumer behavior, finally iii) innovation and technical progress contribute actively to the development of depollution techniques and the establishment of clean technologies. We therefore assume that regional disparities in terms of economic performance and sectoral specialization (STERLACCHINI (2006), BEUGELSDIJK et al. (2018)) can induce contrasted environmental performances.

The fifth one, *Social Cohesion and Solidarity* is essential for succeeding in environmental regulation, as well as a certain equity (RENOU-MAISSANT et al., 2018). “Social cohesion involves building shared values and communities of interpretation, reducing disparities in wealth and income, and generally enabling people to have a sense that they are engaged in a common enterprise, facing shared challenges, and that they are members of the same community (MAXWELL, 1996). According to the Council of Europe, social cohesion is the capacity of a society to ensure the welfare of all its members, reducing disparities and avoiding exclusion. It must also create solidarity in society. All citizens must have access to housing, energy, water... Policy makers must be particularly vigilant that the financial burden of new environmental standards is equitably distributed and does not penalize the most vulnerable populations. Reducing energy insecurity is a major challenge for the acceptance and the success of the environmental policy. In France, two levers of actions are used to help households in precarious situations. They concern financial helps intended to improve the energy performance of housing as well as the payment of the energy bill (social tariffs and energy allowance since 2018).

The last one, *Governance and citizenship* is important because strong impulse of public policies that require cooperation, coordination and willingness to manage negative externalities is needed (ROSENOW et al; 2017). Many sociologists defend the position that a socio-environmental issue must be constructed, defined and negotiated according to the actors involved (HANNIGAN, 1995). Citizens are directly responsible at their height of the preservation of environment (AGGER, 2010). “Participatory civility” and “discursive democracy” are the cornerstones of building sustainable communities (POWELL, 2012). This is why the involvement of young citizens is crucial as they will be both the future leaders of society and the first victims of global warming (OJALA and LAKEW, 2017). The protest movement for climate change initiated by Greta Thunberg, a Swedish schoolgirl, in 2018 has gained momentum globally. More than one million students from a hundred countries followed her call to strike and demonstrated on March 15, and May 24, 2019. Only an environmental awareness and a strong civic engagement of young people are likely to promote a change in consumption patterns necessary for sustainable development.

In Annex 1, we present the six retained dimensions of sustainable development and their constitutive variables.

2.3 Measure(s) of sustainable territorial development

Having identified six dimensions for territorial sustainable development, we have to construct an indicator for each of these dimensions. Our goal is not to propose a global index - composite indicator- to establish a ranking of EPCIs; we propose to build an index for each of the dimensions of sustainable development to identify the strengths and weaknesses of the territories relative to these dimensions.

There has been increasing interest in the quantification of sustainable development using composite indicators and indexes (OECD, 2005). Composite indicators are popular tools usually used for assessing the performances of countries or territories. They provide a simple representation of complex and multidimensional phenomena. The use of composite indexes is threefold: policy monitoring, public communication and rank generation. They are a useful tool in policy analysis and public communication (OCDE, 2008). They can be used to evaluate the longer-term implications of current decisions and behaviours. They are increasingly used in benchmarking country performance (SALTELLI, 2007) because they provide simple comparisons between spatial units (e.g. countries, regions, departments...). Territorial benchmarking can help local actors in making strategic decisions taking into account the relative position of a territory relative toward others.

Yet if an index is simple to understand and analyse, it is difficult to formulate it in order to take into account the total complexity of sustainable development. "Making the concept of sustainable development operational for public policies raises important challenges in terms of measurement" (OECD, 2005). Complex synergies and trade-offs among the different dimensions of sustainable development are difficult to integrate. The usual way to build a composite index is to identify baskets of indicators thanks to some specific considerations or theoretical framework, to collect data, to normalise these data and to aggregate (ANG et al., 2015). Composite indicators may present in a clear manner the issues of sustainable development but at the cost of assumptions that are often subjective. Indeed, their construction requires several arbitrary choices, namely the selection of variables, the kind of weighted average to use, the values of the weights to apply (BOVAR et al., 2008; BECKER et al. 2017). Obviously, the relevance and quality of composite indicators depends widely on the options taken. If the indicators are poorly constructed or misunderstood, they may be difficult to interpret and send misleading information. Therefore, it is essential that the construction process is transparent. Let's note that these problems are all the more acute when aggregation is performed at an overall level and interrelationships between indicators are ignored (OECD, 2008).

The construction of the six specific indices of sustainable development is carried out in three steps. First, it requires the selection of variables representative of the six dimensions identified. This choice stems, on the one hand, from the relevance of the variables with regard to the dimension concerned and, on the other hand, from the availability of data at the level. Second, normalisation of data is necessary prior any aggregation of data because the different indicators usually have different units and are on different scales. Different methods of normalisation exist (OECD, 2008). According to ANG (2015), the Min-Max methods is the most popular. For this reason, we have chosen this methods, it consists of normalising indicators so that they have an identical range [0, 100] by subtracting from the value of the indicator its

minimum value and dividing by the range of indicator values. A figure of “100” is given for the highest desired figure and “0” for the lowest.

“An advantage of this method is its ability to gauge performance based on the best and worst performance, while a drawback is the need to recalibrate when additional data points are added” (ANG, 2015). The final step is the weighting and aggregation of normalised indicators. We have chosen to conform to common practice and we have proceeded to an additive aggregation (arithmetic average) by assigning equal weighting to all variables (OECD, 2008, ANG, 2015), with a few exceptions. The weighting used for the construction of the overall index is “one” for almost all standardized variables. In some cases, when several variables represent the same aspect of a characteristic, the weighting is smaller in order to avoid an overweighting of the characteristic. In this case, we construct a sub-index from the variables representative of the considered characteristic and we give it a weight of “one”. Tables A2 to A7 in Appendix provide detailed information on the variables selected and their weighting.

3. Empirical results

In this section, we first present in more detail the construction of the six composite indicators and their evaluations at the EPCIs level, then we use data analysis methods to account for the similarities and differences between territories in terms of these six indicators.

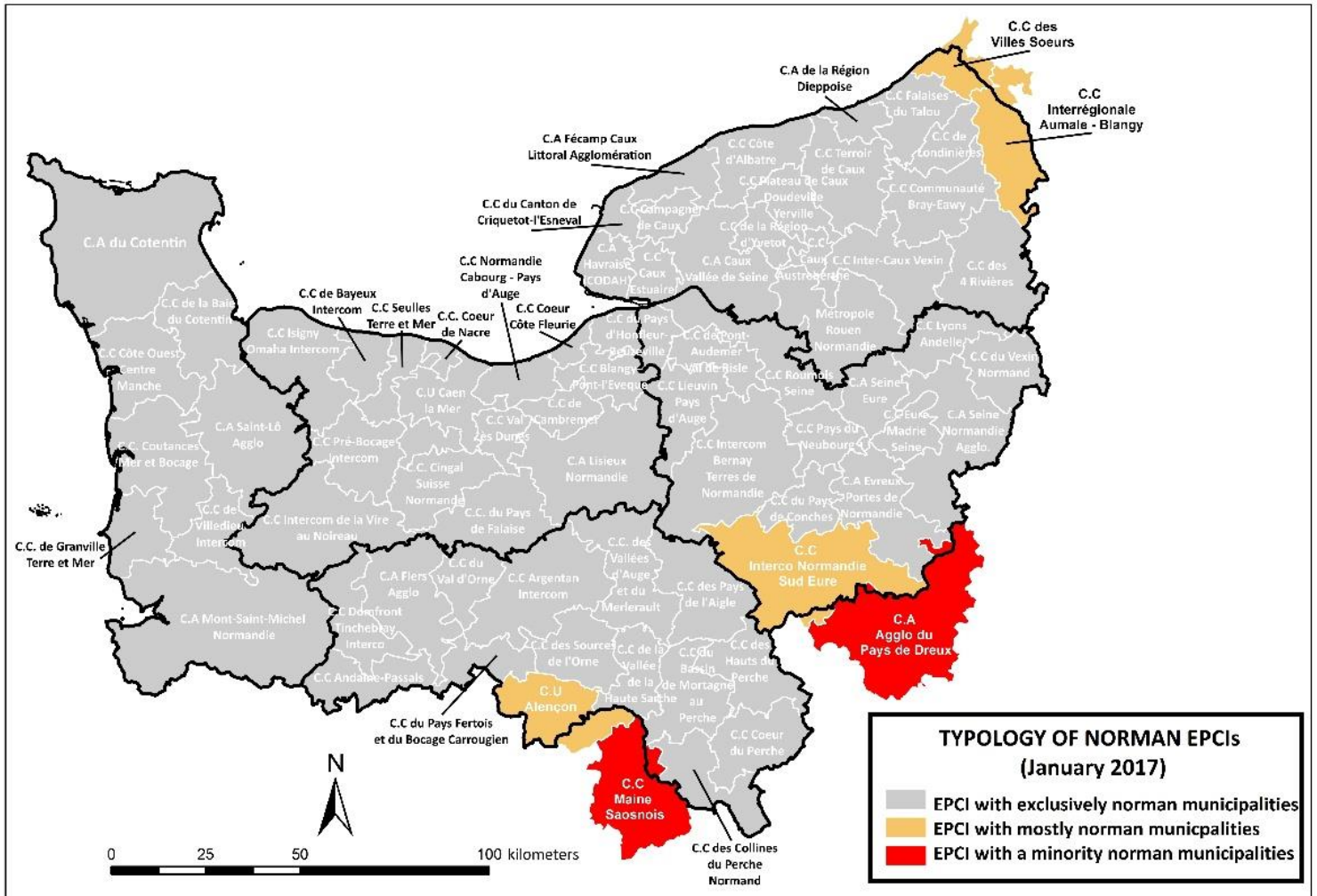
3.1 The construction of indices and the territory of application

The present study is based on the 75 Norman EPCIs (see below Map 1), six of them are located in two regions (inter-territorial EPCI) whose four of them with mostly Norman municipalities (Communauté de Communes des *Villes-Sœurs*, Communauté de Communes Interrégionale *Aumale-Blangy*, Communauté de Communes *Interco Normandie Sud Eure* and Communauté Urbaine *Alençon*) and two with a minority Norman municipalities (Communauté d’Agglomération *Agglo du Pays de Dreux* and Communauté de Communes *Maine Saosnois*).

Considering a wide range of variables, we built aggregate composite indices for each of the six dimension of sustainable development. All the indicators, definitions, sources and weights used for the creation of each of the six dimensions are summarized in Tables A2, A3, A4, A5, A6 and A7. In the weight column green colour means that the indicator is positively associated to the Index for dimensions Energy Transition and Sustainable Development, while red colour is used for those indicators that according to the literature are negatively associated to the Index.

The results for each of the six dimensions of Sustainable Development are analysed by cartographical support in order to compare the performance of each EPCI in each of the Index dimensions. The figure 2 below depicts index results in five quintiles, so that higher index performances are shown in dark green whereas lower index performances are shown in dark red.

Map 1. The study area: the 75 Norman EPCIs at 1 January 2017



We will exclude from the analysis the two EPCIs with a minority norman municipalities (*Communauté d'Agglomération Agglo du Pays de Dreux* et la *Communauté de Communes Maine Saosnois*). However, we will evaluate these two EPCIs in a territorial comparative objective.

3.1.1 Dimension « Environment and natural resources »

We aggregate a set of five variables (“Greenhouse gas emissions per capita”¹⁵, “Share of non-artificialized surface area”, “Share of farms engaged in organic farming”, “Shoreline length” and “Share of the aquatic surface”) to build the composite index. A weighting of 0.5 was assigned to the indicators "Shoreline length" and "Aquatic surface area" in the calculation

¹⁵ The variable takes into account the emissions caused by human or man-made activities by excluding maritime and aerial emissions –except for domestic transportation-. It does not take into account the carbon capture that mainly corresponds to the absorption of CO₂ for the growth of vegetation (photosynthesis) and methane (CH₄) by forest soils.

of the composite index. Map 2 depicts French Normand EPCIs performance on the «Environment and natural resources» dimension of the Index in Sustainable Development.

The mapping of the indices of this dimension of sustainable development at the scale of the Norman EPCI (Figure 2) shows two things:

-The lowest scores (less than 40) concern the Agglomeration Community of *Le Havre*, the Urban Community of *Caen la Mer*, the Urban Community of *Caux Vallée de la Seine*, the Inter-Regional Communes Community of *Aumale-Blangy* and the Communes Community of *Londinières*. The common denominator of these five EPCIs¹⁶ lies in their highly urbanized and / or highly industrialized profile. Theoretically, highly urbanized areas have fewer natural resources because of their large share of artificial soils and are therefore likely to have less favorable environmental indicators than more rural ones. However, if we look at the EPCIs with the best indices (more than 60), three of the five EPCIs are Agglomeration Communities (Agglomeration Community *du Cotentin*, Agglomeration Community of *Lisieux-Normandie* and Agglomeration Community of *Seine-Eure*), so territories with urban areas close to or greater than 50,000 inhabitants (*Cherbourg-en-Cotentin*¹⁷, *Lisieux*¹⁸ and *Louviers*¹⁹). In addition, other EPCIs with a urban and / or industrial marked profile, such as The Metropolis *Rouen Normandie* or the Agglomeration Community of *La région de Dieppe* also have rather good scores (respectively 53 and 51 for a regional average of 49).

As a result, these scores show that highly urbanized and / or industrialized territories are not necessarily at a disadvantage in obtaining a satisfactory index in a category relating to environmental performance and natural resources. Moreover, if we take for example the indicator “Greenhouse gas emissions per capita”, it is the territories with the highest urban densities that show the best results. This can be explained by the fact that urban residents emit on average half as much CO₂ as the rest of the population to go to their place of work or study (LEVY and LE JEANNIC, 2011). Only Community of Agglomeration of *Le Havre* is an exception with its high concentration of polluting industries in its territory (including the 16 industries SEVESO).

3.1.2 Dimension «Sustainable mobility»

For the “Territories and sustainable mobility” dimension, eight indicators were constructed and aggregated to produce a composite index for each EPCI (“Share of commuting to work by feet”, “Share of commuting to work by public transport”, “Share of commuting to work by car”, “Median commute distance”, “Median distance from home-study trips”, “NGV -Natural Gas Vehicle- station rate per 10,000 inhabitants”, “Carpool areas per 10,000 inhabitants” and “Rate of households with two or more cars”).

¹⁶ The other two EPCIs are the Community of Communes of Cambremer and the Community of Communes Coeur de Perche.

¹⁷ 116 517 inhabitants (2012).

¹⁸ 44 408 inhabitants (2012).

¹⁹ 48 347 inhabitants (2012).

The mapping of these indices (Figure 2) shows several things:

- A classic "center-periphery" opposition with more favorable scores in the EPCIs of the large and medium-sized cities of Normandy (Agglomeration Community of *Le Havre*, The Metropolis *Rouen Normandie*, Urban Community of *Caen la Mer*, Urban Community of *Cotentin*, etc.) and on the other hand, worse scores in peripheral EPCIs in these urban centers. In fact, peri-urban areas are generally less well served by public transport (bus, tramway) than urban areas, with between 16 and 33% of their inhabitants having a public transport line less than one kilometer away compared to 73% to 99% in urban areas (PAUL-DUBOIS-TAINE et al., 2012). The peri-urban are much more captive of the car with longer weekly trips than urban workers to workplaces or shopping centers (COUTARD et al., 2001; ROUGÉ, 2005).

- Good scores are also observed in the south-east of the Eure which concentrates several urban and economic secondary poles (Communes Community of *Eure-Madrie-Seine*, Agglomeration Community of *Seine Normandie Agglo*) as well as more surprisingly in the North-East of the Orne (Communes Community of *Le Pays de l'Aigle*, Communes Community of *Argentan intercom*, Communes Community of *La Vallée d'Auge et Le Merlerault*). If we analyze the scores by indicator, we can see that this area of the Orne department has good results in terms of possession of cars per household and median distance between home and work, probably reflecting more a strong socio-economic poverty²⁰ that would prevent the purchase of new motorized vehicles and / or long daily distances with his personal car.

- Indices between 35 and 45 are recorded in the rural EPCIs (*Manche* and *Orne departments* in particular) which are slightly above the regional average (35). It shows that these territories, although equally captive of the private car, use less frequently this type of transport. The average age of the population is older than elsewhere (26% of rural people are over 65 against 17.9% nationwide²¹) and by a predominance of jobs in agricultural branch of activity (16% of rural workers against 2.8% nationwide²²) which is characterized by short distances between home and work. However, political initiatives in favor of sustainable mobility are being introduced in several rural and peri-urban areas in order to reduce the captivity of their inhabitants vis-à-vis the polluting private car. For example, the purchase of about 60 electric bikes for long-term rentals for residents of the Communes Community Intercom *De La Vire au Noireau* or the wide development of electric charging stations in the *department of La Manche*.

3.1.3 Dimension «Energy transition»

Within the "Energy Transition" component, five indicators were constructed and then aggregated for the creation of a composite index ("Installed power per biomass per 1000 inhabitants", "Installed power per wind turbine per 1000 inhabitants", "Power installed by

²⁰ The indices of the components "economic dynamism" and "social cohesion and solidarity" for these three EPCIs are among the lowest in the region..

²¹ Source : INSEE, Recensement de la Population 2013.

²² Source : INSEE, Tableaux de l'économie française, 2016.

hydraulics per 1000 inhabitants”, “Installed power per solar unit per 1000 inhabitants” and “Length of heating networks per 1000 inhabitants”) -see annex for weights-. When reading map 4, two points can be identified:

- First, we can see that the mapping of these indices (Figure 2) does not really show any regional imbalance in the commitment to Energy Transition. However, sometimes large areas emerge in terms of poor results such as the west and north of *Calvados department*, the *Cotentin* and the *center-Manche*, the west of the *Eure department* and the west of *Le Pays de Caux*. On the other hand, the best results are concentrated in rural areas such as the north of the *Orne department* or *Le Pays de Bray*. There are no real territorial profiles more or less favored by the measurement of a composite index of the Energy Transition, be it an urban, peri-urban or rural space. In fact, even if rural areas will be better off in setting up wind turbines or anaerobic digestion plants, territories with a more urban profile will be better suited for the deployment of solar panels on rooftops of buildings or the development of heat networks in densely populated areas for example. Therefore, this index seems to be a real marker of a local desire to turn to the Energy Transition, especially in the context of the PCAET where EPCIs are invited to put a climate plan on their territory in order to fight against energy dependence or the increase in greenhouse gas emissions.

- Then, the results for all the Normand EPCIs are generally bad with a maximal index of only 52,33 (Community of Communes of Pays de Falaise) and several null indices (Community of Communes *Coeur Côte-Fleurie* and Community of Communes of *Le Pays de Honfleur- Beuzeville*). These low scores should be put into perspective since few *Community of Communes* are turned towards a multi-technological Energy Transition and thus it favors the composition of a low index by the presence of very unfavourable scores²³.

3.1.4 Dimension «Economic dynamism»

Within the “Economic Dynamism” dimension, we have a set of nine variables that have been aggregated to create a composite index (“*Economic Dependency Indicator*”, “*Business Start-up Rates*”, “*Jobs Concentration Index*”, “*Per capita fiscal potential*”, “*Unemployment rate of 15 years and over*”, “*Annual population change rate due to apparent net migration between 2010 and 2015*”, “*Median disposable income per unit of consumption*”, “*Tourism Accommodation Units per Square Kilometer*”, “*Number of Holidays homes / 1000 inhab*” and “*Share of Metropolitan Function Executives in Employment at the Workplace*”) -see annex for weights-.

Reading the mapping of these indices (Figure 2) tells us that territorial disparities are important:

- A classic “urban-rural” opposition with urban sectors that are much more economically dynamic (mainly regional metropolises and the Seine Valley) than rural areas. The effects of

²³ The "min-max" method is based on the value of the highest value (max) and the lowest value (min) to compose the index from 0 to 100.

polarization, the economy of agglomeration or accessibility are all factors that contribute to urban economic dynamism. If we analyze the results by indicator, it is mainly the variables of “*Economic dependence*”, “*Business start-ups rates*”, “*Per capita fiscal potential*” and “*Share of Metropolitan Function Executives in Employment at the Workplace*” that contribute to the good results of urban EPCIs. On the other hand, the best indices of the indicators “*Unemployment rate of 15 years and over*” and “*Median disposable income per unit of consumption*” are observed in peri-urban and even rural areas.

- The former *Haute-Normandie region* seems more economically dynamic than the former Lower Normandy. Indeed, the indices lower than 35 (regional average of 38), so unfavorable scores, are strongly represented in the *department* of Orne (only the Urban Community of Alençon has an index higher than 35), in the *department* of La Manche (5 EPCI out of 8 have a score lower than 35) and in the southern part of the *department* of Calvados. *Le Pays de Bray* in the *department* of *La Seine-Maritime* also has unfavorable indicators in the former *Haute-Normandie region*.

- The areas of the *Seine Valley* and the coastline of *Calvados* present the best indices of the region. These two geographical areas are located near urban developed areas (*Rouen* and *Le Havre* for the *Seine Valley*, *Caen* for the *Calvados* coastline) and therefore benefit from the concentric economic development of these three urban agglomerations (BISSON and BONNET, 2009). The *Seine Valley* is characterized by its industrial-harbour specialisation (Port 2000, Port-Jérôme, Renault-Sandouville and Renault-Cléon, etc.) and its high added value tertiary / scientific clusters (Pharma-Park of *Val de Reuil*, Technopole *Madrillet*, Universities of *Rouen* and *Le Havre*, etc ...). Regarding the north of *Calvados* (coastal fringe and *Caen* agglomeration), it is mainly the economic activities related to tourism (*Côte de Nacre*, landing beaches, etc ...) and research (University of Caen, North Caen *plateau*, etc ...) who participate in the good indicators of Economic Dynamism.

3.1.4 Dimension «*Social cohesion and solidarity*»

The “*Social Cohesion and Solidarity*” dimension groups together a set of ten variables that have been aggregated to create a composite index (“*Share of managers and higher intellectual professions among women in the population*”, “*Share of covered area in 4G by the best saying operator*”, “*Share of 15-64-year-olds in part-time employment*”, “*Share of bachelor's degree graduates among the over-15s out of school*”, “*Share of non-enrolled youth*”, “*Youth's index*”, “*Poverty rate*”, “*Cultural equipment rate per 1000 inhabitants*”, “*Sports equipment rate per 1000 inhabitants*” and “*Interdecile ratio of disposable income per unit of consumption*”).

According to the mapping of these indices (Figure 2), three points can be distinguished:

- Rural areas that are generally more suffering than urban or peri-urban areas. In fact, the indices below 40 (regional average of 50) mainly concern rural EPCIs (mainly northeastern *Orne* and *Pays de Bray*). However, other EPCIs with a rural profile have good indices such as the South of *Manche Department* (share of the territorial surface covered by 4G, rate of

equipment and health services, share of non-enrolled youth and the interdecile ratio of disposable income) and the *Pays de Caux* (share of the territorial surface covered by the 4G, youth index, poverty rate, sports equipment rate and interdecile ratio of disposable income per unit of consumption). This heterogeneity of the indices within the rural EPCIs shows contrasting social dynamics according to the territories.

- The peri-urban territories have rather good results. This is particularly the case of the periurban *Rouen* and *Caen* where EPCI concerned have for the vast majority of indices greater than 50 (up to 76 for the Community of Communes *Les vallées de l'Orne et de l'Odon*). These results are in line with the research of CHARMES (2011) which identifies several types of peri-urban areas with territories with low unemployment rates and where their residents have median incomes higher than the national average or even the city-center of the urban area. These results therefore run counter to the widely reported theses of a peri-urban area exclusively presented as being a place of social relegation.

- Only two urban EPCIs are concerned by poor social indicators, namely the Agglomeration Community of *Le Havre* and Agglomeration Community of *La région de Dieppe*. These two territories are particularly impacted by a high unemployment rate (with respectively 19.1% and 18.3% of the unemployment rate), partly explaining the very poor results for some of the social indicators such as the "Poverty Rate" or "Share of non-enrolled youth".

3.1.6 Dimension «Governance and citizenship»

For the "Governance and citizenship" dimension, five indicators were constructed and aggregated to produce a composite index for each EPCI ("Cit'Ergie Label", "Territory Zero Waste Winner", "Population rate covering a recognized Local Agenda 21", "Eva Joly Voting Rate at the 1st Presidential Round in 2012" and "Participation Rate at the 1st Presidential Round in 2017"). A weighting of 0.5 was assigned to the "Cit'Ergie" and "Zero Waste Territory Winner" indicators in the calculation of the composite index ".

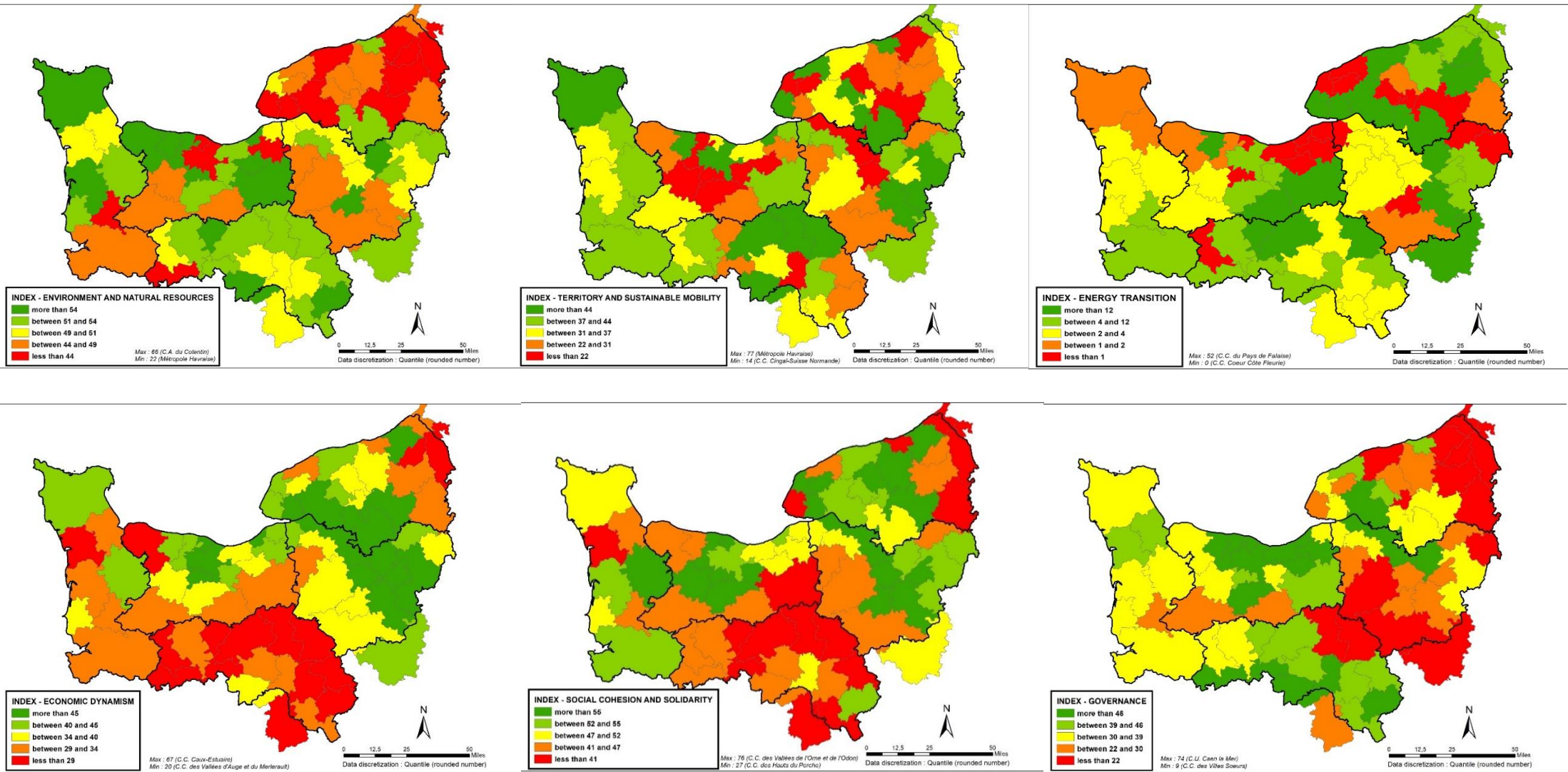
The mapping of the indices of this dimension of Governance and citizenship at the scale of the Normandy EPCIs (Figure 2) shows higher scores in the former Lower Normandy than in the former Upper Normandy:

- On the one hand, electoral geography is a heavy explanatory variable. Indeed, there is traditionally a stronger abstention at the east of Le Havre/Paris/Marseille line (COLANGE, BUSSI and GOSSET 2009). The territories to the east of this line (including the former Haute-Normandie) are notably characterized by less dynamism in terms of job creation (CHALARD and, 2011) and by an accumulation of unfavorable social indicators (LE BRAS and TODD, 2013), which partly explains these high rates of abstention, which tend to correlate geographically with extreme right-wing voting (*ibid*). Concerning the ecologist vote during the 2012 presidential elections (voting for Eva Joly), it is slightly more important in the former Lower Normandy (1.96%) than in the former Haute-Normandie (1.64%), even though there is

traditionally no a strong tendency for a greater ecologist vote in the west than in the east of Normandy.

- On the other hand, the local Agenda 21 initiatives recognized by the Ministry of the Environment are more numerous in the former *Basse-Normandie region* than in the former *Haute-Normandie region*.

Figure 2: Performances of French EPCIs in the six dimensions of sustainable development



3.2 Typology of sustainable development in the Normand EPCIs

Our proposal aims to establish a cluster analysis, more precisely, a hierarchical ascendant classification (HAC) of the Norman EPCIs according to the six dimensions of sustainable development. For that, we use the six indices built at the previous section, namely *ind_env* (environmental and natural resources), *ind_mob* (sustainable mobility), *ind_trans* (energy transition), *ind_eco* (economic dynamism), *ind_soc* (social cohesion and solidarity) and *ind_gov* (Governance and citizenship).

We have calculated indexes for each dimension. Table 1 presents summary statistics of indexes.

Table 1: Summary statistics of the six dimensions of sustainable development

Variables	Frequency	Mean	Min	Max	Standard deviation	Coefficient of variation (%)
<i>ind_env</i>	75,00	49,32	22,20	65,95	7,52	15,24
<i>ind_mob</i>	75,00	35,27	14,37	76,86	12,88	36,51
<i>ind_trans</i>	75,00	8,02	0,00	52,33	11,79	147,00
<i>ind_eco</i>	75,00	36,35	20,05	67,46	8,62	23,72
<i>ind_soc</i>	75,00	47,54	27,24	76,08	8,59	18,07
<i>ind_gov</i>	75,00	34,85	9,24	73,86	13,88	39,83

Indexes' Min is 0 for the energy transition index while Max of indexes is recorded by sustainable mobility index with a figure of 76,86. The coefficient of variation is an appropriate statistic to compare the dispersion level of several series; it ranges from 15.24% for environmental and natural resources index to 147 % for the energy transition index. For this latter index, with a Min level equal to zero (*Coeur Côte Fleurie EPCI*) the dispersion is important even if the Max is the lowest Max. It reveals a higher heterogeneity between the 75 EPCIs with regard to the development of renewable energies. The coefficient of variation is the more important for Energy Transition, then (but rather far) Governance and citizenship and Sustainable Mobility. At the end, Environment and Natural Resources presents the lowest coefficient of variation.

The approach adopted relies on a methodological sequence of two data analysis methods (LEBART et al. 2000, SAPORTA 2006, TUFFERY 2007). According to the similarity of the six variables representing the six dimensions of sustainable development, we can establish a typology of the 75 Normand EPCIs. An HAC, according to the Ward criterion²⁴, is applied to group the 75 EPCI into homogeneous classes on the significant factors of the principal component analysis (PCA) of the six sustainable development dimensions. This methodological

²⁴ Generalised Ward's Criteria, i.e., aggregation based on the criterion of the loss of minimal inertia.

linking of factorial analysis and clustering methods constitutes an instrument for statistical observation and the structural analysis of data.

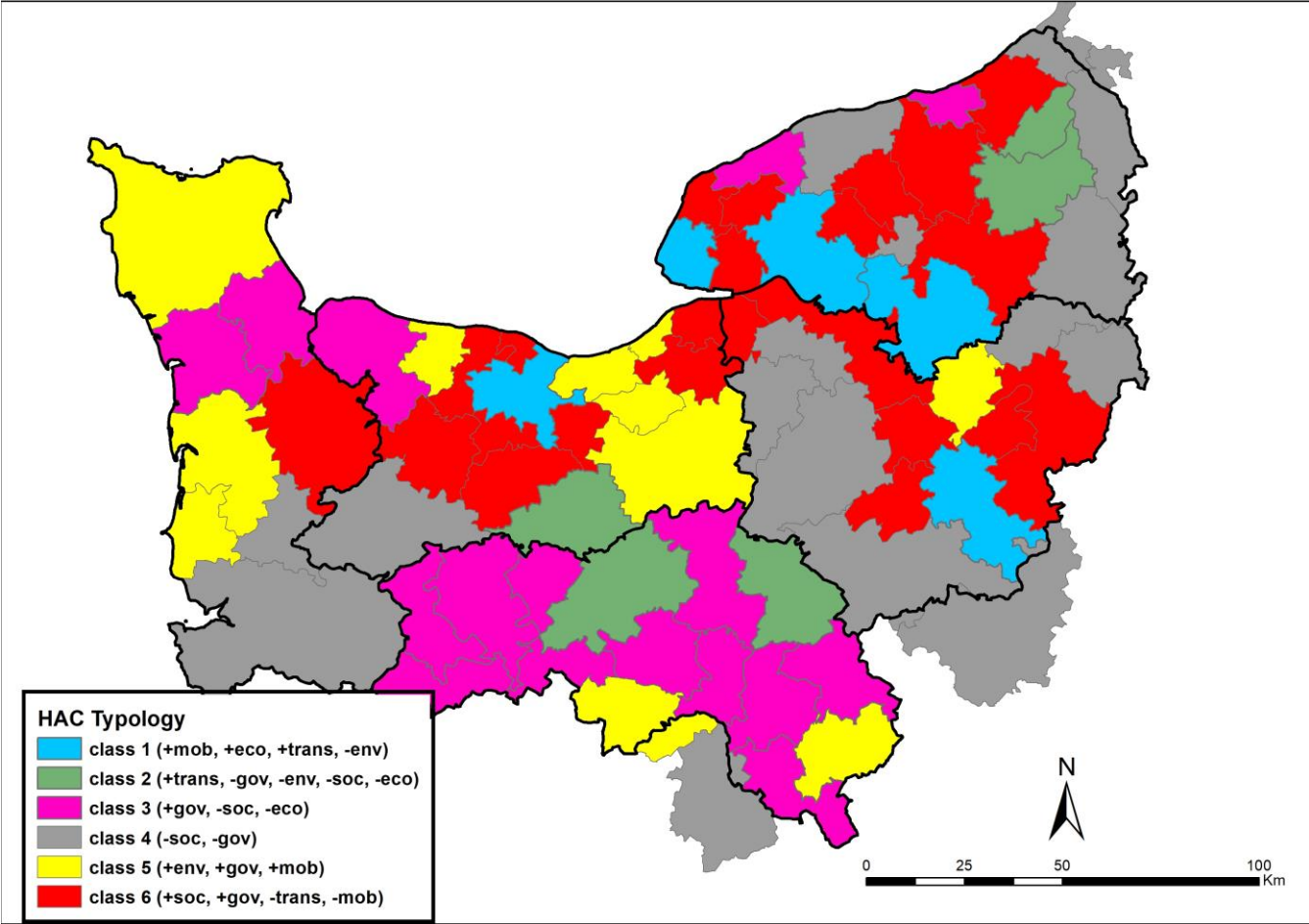
The HAC according to the six dimensions of sustainable development identifies six distinct sustainable development types in Normandy. Table 2 summarizes the main results and profiles of the five classes of the Normand EPCIs, obtained after cutting the hierarchical tree according to a judicious choice of the aggregation index. Figure 3 depicts Normand EPCIs performance in terms of sustainable development.

Table 2: Characteristics of the partition into six classes of the 75 Normand EPCIs²⁵

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Frequency (%)	5 (6.67%)	5 (6.67%)	16 (21.33%)	16 (21.33%)	11 (14.67%)	22 (29.33%)
Profile (+)	+ ind_mob + ind_eco + ind_trans	+ ind_trans	+ ind_gov		+ ind_env + ind_gov + ind_mob	+ ind_soc + ind_eco
Anti-Profile (-)	- ind_env	- ind_gov - ind_env - ind_soc - ind_eco	- ind_soc - ind_eco	- ind_soc - ind_gov		- ind_trans - ind_mob

²⁵ See annex for classes of EPCIs.

Figure 3: Norman ECPIs performance in terms of sustainable development



The first class presents high indexes in terms of *sustainable mobility*, *economic dynamism* and *energy transition* but *environment and natural resources* is lower. This class gathers the more urbanised and developed EPCIs (CA Caux Vallée de Seine, Métropole Rouen Normandie, CU Caen la Mer, CA Evreux Portes de Normandie, CA Havraise (Co.D.A.H.)). One explanation could be found in the mandatory domains of intervention of agglomeration communities which have in charge the spatial planning, economic development, social balance of housing and city policy²⁶.

The second class is compound of EPCIs that have made the choice of *energy transition* despite low indexes in the dimensions *governance and citizenship*, *environment and natural resources*, *social cohesion and solidarity* and *economic dynamism*. (CC Argentan Intercom, CC des Pays de l'Aigle, CC Communauté Bray-Eawy, CC du Pays de Falaise and CC de Londinières). This class gathers medium-sized towns that have lost their attractiveness (high rate of unemployment, deindustrialisation, downtown shops that close ...). More in-depth investigation is needed to see if measures in favor of energetic transition have been taken to restore the brand of the EPCI or if a political change could explain this orientation.

The third class gathers 16 EPCIs that present a good index in terms of *governance and citizenship* and two weak indexes (*social cohesion and solidarity*, and *economic dynamism*). These are mainly EPCI rural from ex-*Basse-Normandie* (citizens vote more than in ex-*Haute-Normandie*, for example, despite the fact that they do not have good scores in terms of socio-economic indicators). Only Fecamp and Dieppe are an exception with their less rural profile but also with unfavorable socio-economic indicators. These two EPCIs belong to ex-*Haute-Normandie*, they have also an important communism vote that could be a part of the explanation.

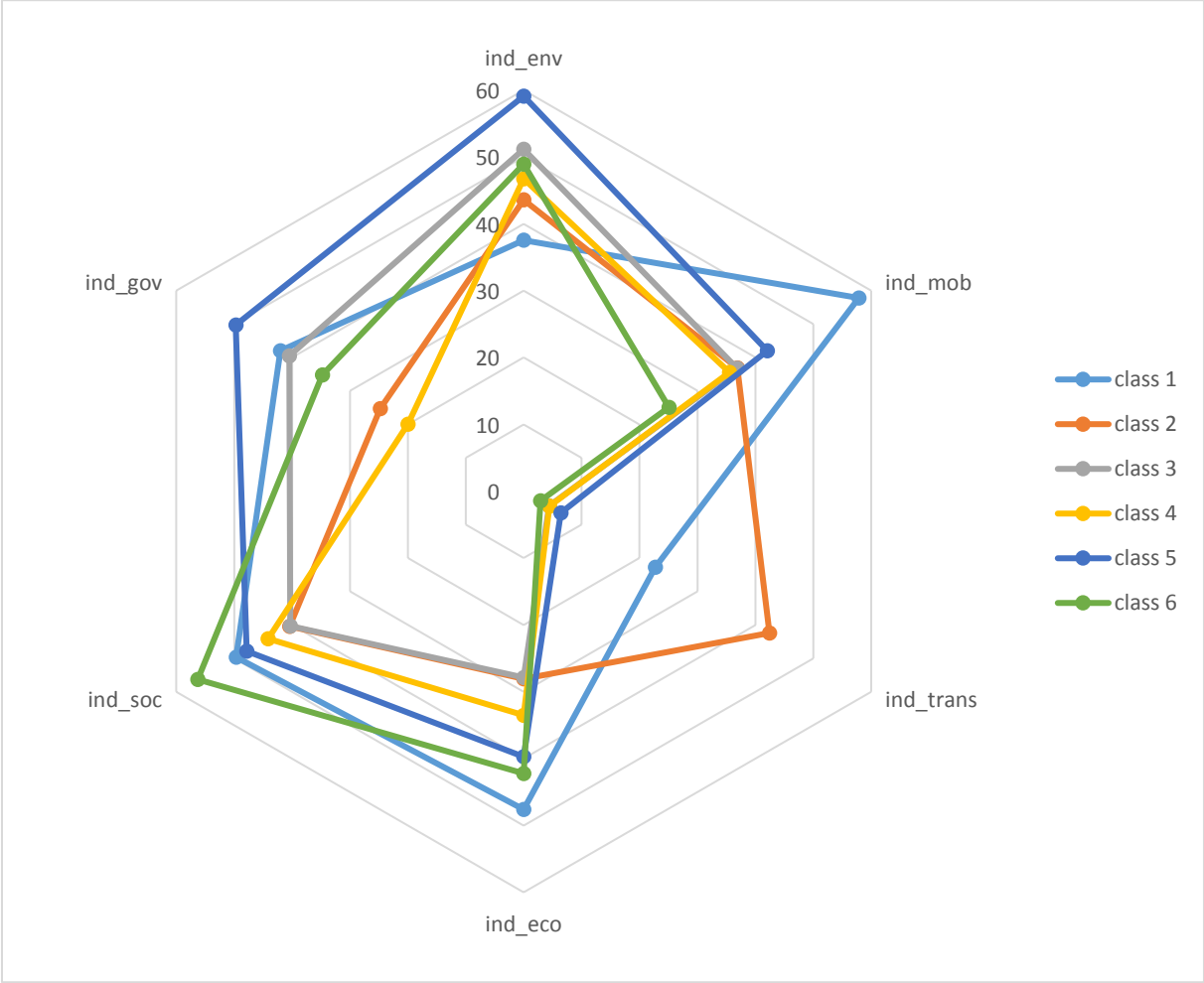
The fourth class presents two weaknesses ; in the social cohesion and solidarity dimension and in the governance and citizenship dimension. These are EPCIs that border the departments or the region as if the administrative boundaries could make performance in these two variables more difficult, the lack of social cohesion and solidarity being able to be translated into a weakness of the indicator of governance and citizenship

The fifth class is compound of EPCIs that present good performances in the *environmental and natural resources* dimension, in the *governance and citizenship* and in the *sustainable mobility* dimensions. There are a predominance of Touristic EPCIs (around 80%) where a higher sensitivity of these EPCIs with respect to the preservation of the environment can be measured. Some of them face erosion phenomena or incur water problem procurement during the summer period. Nevertheless the environment is important for them, so we can guess there are sensitive to this dimension.

²⁶ <https://www.vie-publique.fr/decouverte-institutions/institutions/collectivites-territoriales/intercommunalite-cooperation-locale/que-sont-communautes-communes-communautes-agglomeration.html>

The sixth class gathers EPCIs that present good performances in *social cohesion and solidarity*, *economic dynamism* and bad performances in *energy transition*, and *sustainable mobility*. They represent mainly EPCIs with a peri-urban profile (economically and socially favored because they are not too far from the center). The problem in these EPCIs is the lack of alternative solutions for people who mainly travels by car to go to work in the center . These EPCIs benefit from the redistributive effects of the growth of the agglomeration, they do not make so much for energy transition.

Figure 4: Strengths and weaknesses of the six sustainability profiles



4. Conclusion

This paper provides an evaluation framework for comparing sustainable territorial development in French EPCIs where performance in terms of sustainable development is analyzed through two main approaches. First, we propose a set of six indexes taking into account six dimensions associated to sustainable development (i.e., environment and natural resources, energy transition, sustainable mobility, economic dynamism, social cohesion and solidarity, and governance and citizenship). Second, by applying a hierarchical ascendant classification (HAC) we are able to classify French EPCIs into six classes. Then, by analysing and comparing them we are able to explore similarities and dissimilarities between EPCIs regards to the six components of the sustainable development. Thus, they allow for the diagnosis of strengths and weaknesses of the EPCIs on each of the considered dimensions by identifying of areas that would profit from being addressed by policy-makers.

Specifically, our results suggest that: i) better performances in the different indexes capturing regional sustainable development are generally associated to most densely populated EPCIs but for the environment and natural resources; ii) however, this last result does not hold for urban EPCIs that can also have a touristic dimensions like Community of *Lisieux-Normandie* Agglomeration Community *du Cotentin* or Agglomeration Community of *Seine-Eure* and show a good performance in environment and natural resources; and iii) from the HAC analysis we identified six types of sustainable development profiles: a first class could be labelled *Dynamic mainly Sustainable Urbanised EPCIs*, we identified a *Touristic* class with an environmental preoccupation and a *Peri-Urban* class where sustainable mobility and energy transition are a problem.

Still, these results have implications for policy. Firstly, as Norman development is spread around agglomerations (Bisson, Bonnet, 2009) and given that almost 30% out of the 75 Norman EPCIs (the Peri-Urban class) present a low performance, both in *sustainable mobility* and *energy transition*, policy makers should put all their efforts to gradually adopt a new productive system based on new modes of production and consumption. This should lead to the use of more renewable energy resources, to the adoption of new behaviours and new means of transportation to preserve fossil resources and limit green houses emissions, and it is, at the local level, that the mere efficiency is expected. Secondly, according to our results, agglomeration economies may explain in 5 populated EPCIs better performances in two of the dimensions of sustainable development; the lack of natural resources in urban areas is clearly cancelled out by a more efficient use of public infrastructures and systems, and by development of energy transition.

However, the present study has some limitations. The complexity behind the design and the implementation of composite indexes implies that our results should be carefully interpreted. Even our indexes satisfy the main requirements of a well defined composite index (MAZZIOTTA and PARETO 2013), the intrinsic arbitrary choices in terms of the selection of variables, methods of aggregation and normalisation of the same have a significant effect on

the results. In the same way, any future research should focus on the use of alternative indicators for capturing the energy transition dimension. Although the index on energy transition tries to capture the technological transformation of the global energy system, the set of selected indicators are capturing more the potential than the production or consumption of renewable energies. Unfortunately, detailed data on the production and consumption of renewable energies are not available at the EPCIs level. Finally, the empirical analysis could be extended by taking into account the temporal dimension in order to better understand EPCIs efforts in terms of promoting the sustainable transition of the economy. We propose in a future research to use methods allowing for a dynamic analysis as long as data for each of the suitable indicators are available.

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Annex:

Table A2. Indicators « Environment and natural resources» dimension

Indicators	Definition	Year	Units	Source	Weight
Off-site greenhouse gas emissions per capita ²⁷	Off-site greenhouse gas emissions per capita only taking into account emissions from human or man-made activities (international maritime and air emissions are not considered)	2012	Millions of tonnes of CO2 per inhabitant	INERIS	1
Share of non-artificialised area	Share of the non-artificialised area on the total surface. The non-artificialised area includes natural areas (forest, water, wetlands, etc.), agricultural areas and urban green spaces (Level 3).	2012	%	Corine Land Cover	1
Length of coastline	Length of coastline in Km.	2018	Km	Own elaboration	1/2
Share of the aquatic surface	The aquatic surface includes inland waters in nomenclature 2 (51). OC305111-Course Area and Waterways, OC305112-Course Area and Temporary Waterways, OC30512-Surface Waterbodies.	2012	%	Corine Land Cover	1/2
Share of agricultural areas engaged in organic farming	The indicator represents areas in organic farming (certified as organic and in conversion) relative to the agricultural area of interest.	2017	%	Agence Bio	1

²⁷ The variable takes into account the emissions caused by human or man-made activities by excluding maritime and aerial emissions –except for domestic transportation-. It does not take into account the carbon capture that mainly corresponds to the absorption of CO2 for the growth of vegetation (photosynthesis) and methane (CH4) by forest soils.

Table A3. Indicators « Sustainable mobility » dimension

Indicators	Definition	Year	Units	Source	Weight
Share of home-to-work commuting on foot	Share of active population moving mainly on foot to go to work, according to their place of residence.	2015	%	INSEE	1
Share of home-to-work commuting by car	Share of active population moving mainly by car to go to work, according to their place of residence.	2015	%	INSEE	1
Share of home-to-work commuting by Public transport	Share of active population moving mainly by Public transport to go to work, according to their place of residence.	2015	%	INSEE	1
Median home-to-work commuting distance	Median of kilometres between the municipality of residence for individuals to go to the municipality where they declare to be working.	2014	Km	INSEE	1
Share of households with two cars or more	Number of households with two cars or more relative to total household size.	2015	%	INSEE	1
Median home-to-study commuting distance	Median of kilometres between the municipality of residence from schooled individuals aged 2 and over to go to the municipality where they declare to be attending school.	2014	Km	INSEE	1
Ratio of NGV stations per 10,000 inhabitants	Natural Gas Vehicule (NGV) stations per 10,000 inhabitants.	2018	Indice	Association Française du Gaz Naturel pour Véhicules	1
Carpool areas per 10,000 inhabitants	Carpool areas per 10,000 inhabitants	2018	Indice	DREAL Normandie	1

Table A4. Indicators « Energy transition » dimension

Indicators	Definition	Year	Units	Source	Weight
Installed power per biomass per 1000 inhabitants	Installed Biomass for 1000 inhabitants (MW/1000 Inh)	2014	m/inhab	CEREMA	1/8
Installed power per wind turbine per 1000 inhabitants	Installed power per wind turbin for 1000 inhabitants (MW/1000 Inh)	2016	MW/inhab	Ministère de la transition écologique et solidaire	1/8
Power installed by hydraulics per 1000 inhabitants	Installed power by hydraulics for 1000 inhabitants (MW/1000 Inh)	2016	MW/inhab	Ministère de la transition écologique et solidaire	1/8
Installed power per solar unit per 1000 inhabitants	Installed power by solar for 1000 inhabitants (MW/1000 Inh)	2016	MW/inhab	Ministère de la transition écologique et solidaire	1/8
Length of heating networks per 1000 inhabitants	Length of heating networks per 1000 inhabitants (Meters/1000 Inh)	2016	MW/inhab	Ministère de la transition écologique et solidaire	1/2

Table A5. Indicators « Economic dynamism » dimension

Indicators	Definition	Year	Units	Source	Weight
Economic dependence	The economic dependence index is the ratio between the young population (under 20 years old) and the elderly (60 years-old and over). It is unfavourable when it is greater than 100 (or "strong"), that is to say when there are more young people and older people than people in working age.	2016	Indice	INSEE	1
New-firms startups ratio	The number of non-microenterprise start-ups in a year relative to the population in age of creation (15-64)	2015	%	INSEE (SIRENE)	1
Jobs Concentration Index	The employment concentration index measures the ratio between the total number of jobs offered in a territory and the number of employed persons (employed) who reside there. If this index is greater than 100 then the number of jobs offered locally is greater than the number of people who reside there and have a job. In this case, the territory in question occupies a function of employment pole.	2016	Indice	INSEE (SIRENE)	1
Per capita fiscal potential	Fiscal potential is calculated by the amount of taxes that each community would incur if it applied the average rates to its net tax bases and it is related to the number of inhabitants.	2017	Euros per inhabitant	DGCL	1
Unemployment rate	The unemployment rate is the ratio of the number of unemployed of 15 and more to the labor force.	2016	%	INSEE (RP)	1
Net migration	Annual migration rate of population due to net migration between 2010 and 2015	2010-2015	%	INSEE	1
Median of disposable income by consumption units	Household disposable income includes income from work (net of social contributions), wealth income, transfers from other households and social benefits (including pensions and unemployment benefits), net direct taxes.	2015	Euros	INSEE - FiLoSoFi	1
Tourism Accommodation Units	Tourist accommodation units include hotel rooms, campsites, Village Vacances rooms, Tourist Residences rooms and Youth Hostel rooms.	2018	Unit\km2	INSEE	1/2

Holiday homes	Number of Holidays homes / 1000 inhab	2014	Unit/1000 inhab	INSEE	1/2
Share of Metropolitan Function Executives in Employment at the Workplace	The indicator represents the share in the total employment in the workplace of the jobs of the managers of the metropolitan functions, defined from the nomenclature of occupations and socio-occupational category: design-research, intellectual services, inter-company trade, management and culture-hobbies. The jobs of the managers of the metropolitan functions are likely to favor the economic development and the creation of jobs well beyond their territory, because of their role of training on other productive functions, and thus to contribute to the productivity of the territory.	2014	%	INSEE	1

Table A6. Indicators «Social cohesion and solidarity» dimension

Indicators	Definition	Year	Units	Source	Weight
Share of women in executive and higher intellectual jobs	The indicator reports the number of women attached to "higher cadres and higher intellectual professions" to the population as a whole.	2015	%	INSEE	1
Health equipments and services per capita	Number of health facilities and services per thousand inhabitants	2017	Ratio per thousand inhabitants	INSEE	1
Poverty rate	The poverty rate is the proportion of individuals whose standard of living is lower for a given year than a threshold, called the poverty line. In the relative terms approach, the poverty line is determined in relation to the distribution of living standards of the entire population. In Europe, the threshold of 60% of the median standard of living is favoured.	2014	%	INSEE - FiLoSoFi	1
Inter-deciles ratio between the 9th and 1st deciles	Difference between decile 1 (the wage below which 10% of wages are situated) and decile 9 (the wage below which 90% of wages are situated) for a distribution of wages.	2014	Indice	INSEE - FiLoSoFi	1
Share of activity revenues among reported revenues	Share of the income received by an individual in exchange for his or her personal activity or the work that he provides to a private or public enterprise, or to one of the public administrations.	2014	%	INSEE - FiLoSoFi	1
Share of the area covered on 4G	This indicator represents the share of areas covered in 4G by the operator offering the best coverage rate in the municipality.	2016	%	ARCEP	1
Share of 15-64 year old population in part-time employment	Share of the employment rate of a class of individuals aged between 15 to 64 years old is calculated related to the total number of individuals in the class.	2013	%	INSEE	1

Share of tertiary graduates with 15 years old or over out of school	The indicator represents the share of 15 years or over population out of school with a university degree.	2015	%	INSEE	1
Share of young people neither in employment nor education	The ratio of the population of non-integrated youth related to the entire population. Unenrolled youth are defined as persons aged 15 to 24 who are not enrolled in a secondary or tertiary education and do not have a job, even if only occasionally.	2015	%	INSEE	1
Youth index	The youth indicator is the ratio of the population under 20 years old related to the population aged 60 and over.	2015	Index	INSEE	1
Cultural amenities per capita	Number of cultural equipments in the intermediate range including theatres, cinemas and museums per inhabitant	2015	Amenities per capita	INSEE	1
Intermediate range of sports equipments per capita	Number of sports equipments of the intermediate range including specialized gyms, swimming pools, athletic structures and skating, skate, biocross or freestyle biking trails per capita.	2015	Amenities per capita	INSEE	1

Table A7. Indicators «Governance and citizenship» dimension

Indicators	Definition	Year	Units	Source	Weight
EPCI awarded by the Cit'Ergie Award	<p>The Cit'ergie device is aimed at local public authorities (municipalities and inter-municipal authorities) wishing to have the quality of their air-energy climate policy recognized. Based on the principle of a label, it rewards for 4 years the process of quality management of the climate and energy policy of the community and its resulting actions. It is organized around three levels of labeling: Cit'ergie GOLD, Cit'ergie and CAP Cit'ergie. Each of these levels rewards the achievements and commitments made by the community and encourages it to move forward. Cit'ergie is the French name of the European Energy Award label.</p>	2018	binary	ADEME	1/2
EPCI awarded by the distinction «Territoires zéro déchet zéro gaspillage»	<p>The two editions of the call for projects "Zero debris, zero waste" territories have made it possible to distinguish winning territories, whose actions must contribute to the national objectives set in the energy transition law for green growth. The candidate territories are very diverse: Region, department, mixed unions with unique vocation, groupings of EPCIs, communities of communes, agglomeration, metropolises, communes even borough. 153 territories (58 in 2014 and 95 in 2015) are now engaged in programs to implement an integrated policy project on waste prevention and management in a circular economy.</p>	2015	binary	ADEME	1/2

Share of the population covered by a Local Agenda 21 at level	The indicator represents the share of the total population of each EPCI engaged in an Agenda 21 policy	2014	%	CGDD	1
Share of the ecologist vote in the results of the first round of presidential elections in 2012	Share of the ecologist vote in the results of the first round of presidential elections in 2012	2012	%	Ministère de l'intérieur	1
Participation rate in the first round of presidential 2017	The participation rate in an election is the ratio between the number of people who voted and the total number of voters.	2017	%	Ministère de l'intérieur	1

Annex

Hierarchical classification: classes

Class 1

CA Caux Vallée de Seine
Métropole Rouen Normandie
CU Caen la Mer
CA Evreux Portes de Normandie
CA Havraise (Co.D.A.H.)

Class 2

CC Argentan Intercom
CC des Pays de l'Aigle
CC Communauté Bray-Eawy
CC du Pays de Falaise
CC de Londinières

Class 3

CC de la Vallée de la Haute Sarthe
CC des Sources de l'Orne
CA Flers Agglo
CC du Bassin de Mortagne Au Perche
CC de la Baie du Cotentin
CC Isigny-Omaha Intercom
CC Côte Ouest Centre Manche
CC Andaine - Passais
CC des Hauts du Perche
CC des Vallées d'Auge et du Merlerault
CA Fécamp Caux Littoral Agglomération
CC des Collines du Perche Normand
CC Domfront Tinchebray Interco
CC du Pays Fertois et du Bocage Carrougien
CC du Val d'Orne
CA de la Région Dieppoise

Class 4

CA Agglo du Pays de Dreux
CC de Villedieu Intercom
CC de Pont-Audemer / Val de Risle
CC Lieuvin Pays d'Auge
CC Intercom Bernay Terres de Normandie
CC Interco Normandie Sud Eure
CC Intercom de la Vire Au Noireau
CA Mont-Saint-Michel-Normandie
CC Interrégionale Aumale - Blangy-Sur-Bresle
CC des 4 Rivières
CC Côte d'Albâtre
CC Lyons Andelle
CC du Vexin Normand
CC Maine Saosnois
CC des Villes Soeurs
CC Caux - Austreberthe

Class 5

CA Seine Eure
CC de Granville, Terre et Mer
CC Normandie-Cabourg-Pays d'Auge
CC Coutances Mer et Bocage
CA du Cotentin
CC Coeur du Perche
CA Lisieux Normandie
CC Coeur Côte Fleurie
CC de Bayeux Intercom
CC de Cambremer
CU d'Alençon

Class 6

CC Val Ès Dunes
CA Saint-Lô Agglo
CC Roumois Seine
CC Cingal-Suisse Normande
CC Vallées de l'Orne et de l'Odon
CC du Pays de Honfleur-Beuzeville
CC Terroir de Caux
CC Seules Terre et Mer
CC Pré-Bocage Intercom
CC Plateau de Caux-Doudeville-Yerville
CC Inter-Caux-Vexin
CA Seine Normandie Agglomération
CC Coeur de Nacre
CC Blangy-Pont l'Evêque Intercom
CC du Pays de Conches
CC du Pays du Neubourg
CC Eure-Madrie-Seine
CC du Canton de Criquetot-l'esneval
CC Campagne-De-Caux
CC Caux Estuaire
CC de la Région d'Yvetot
CC Falaises du Talou