

The paper introduces to **bioregion** concept and describes territorial metabolic flows tools usefull to identify and evaluate strategies and appropriate actions to increase the eco-efficiency of local productive systems. Bioregion concept involves better eco-efficiency conditions by directing production and consumption flows towards locally available resources use and therefore contributing to basic resources cycles closure. Tools presented support the application of the methodology **Elar (Ecodynamic Land Register)**. In accordance with the bioregional paradigm, this methodology is used to assess the self-sufficiency achievement of trans scalar territorial systems. This approach requires integrated measures effectiveness assessment, particularly with regard to energy use and food consumption categories. Therefore Elar can be considered one of the effective tools to support **Food and Energy Integrated Plans (FEIP)** development.

FEIP - Food and Energy Integrated Plans
FEIP is an experimental ("ad hoc" defined) planning tool. The aim of FEIP is to promote integrated local agro-food and energy systems able to give self sufficiency in food and a contribution to meet the energy demand for housing, transport and services, while providing anyway an adequate income from agriculture practices. The fact that the term Food precedes that of Energy, has a specific meaning. It means that in self-sufficiency scenarios, food sovereignty has to be guaranteed; namely strategies are oriented primarily to cover the local demand for food, the rest of the territory and wastes from agricultural production are used to cover the demand of the other categories, in particular housing and transport. FEIP is proposed as a tool which complements food planning in the energy oriented planning tools developed by Covenant of Mayors. In this experimental phase, which focuses on territory analysis and scenarios development tools implementation, a small territorial system has been chosen: the Albairate municipality in Milan County, within the South Milan Agricultural Park (PASM).

ELaR - Ecodynamic Land Register
In accordance with the bioregional paradigm, this methodology is used to assess the self-sufficiency achievement of trans scalar territorial systems - from the municipal to larger areas scales. Energy and material flows related to residential sector, food consumption, and private transport are considered. The method uses open-source Geographic Information Systems (GIS) and is articulated in the following processing phases:
1) Locally defined territorial boundaries identification.
2) Renewable Energy Technical Potential assessment - Analysis of contextual conditions and local renewable energy potential (RETP).
3) Local Demand of Energy and Matter (LDEM) for residential, food and private transport activities. Aggregated impacts evaluation with environmental impact indicators (NRE non-renewable primary energy, Local Productive Land).
4) Local self-sufficiency scenarios (LSS) assessment based on best practices transfer, filtered on the basis of local factors mapped on the GIS (climate, use, existing buildings shape and technology and local agriculture practices). Good practices effectiveness evaluation of is carried out through specific tools, (resources / impact geographies and "user histograms").

The Elar methodology is currently being applied on the case study, Albairate. The aim is to draw up an initial prototype of "Food and Energy Integrated plan" (FEIP) starting from the formulation of self-sufficiency scenarios. The data presented briefly in the text show a possible example of local food and energy supply self-sufficiency.

User histograms
They report in terms of per-capita flows local energy and matter demand and relate them with the extension of productive land per-capita. They are used to verify the proposed choices by calculating the local energy and materials demands through two specific indicators and related reference thresholds: Productive land demand compared with the locally available land. Primary renewable and non-renewable energy consumption, compared with threshold values, borrowed from the 2000Watt-Society program (1500W from renewable sources and 500W from not renewable ones)(www.2000watt.ch).

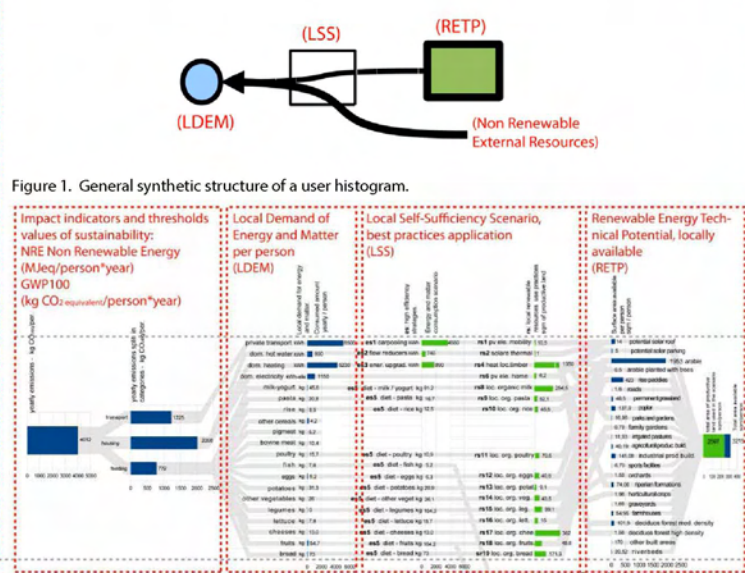


Figure 2. Example of user histogram describing the main components.

Impact geographies

They represent the supply chains of production and consumption through geo-referenced vectors which locate supply chain different nodes. Two different indicators quantify the environmental impacts associated to the different nodes of the supply chain, the use of primary non-renewable and renewable energy sources, expressed in MJ equivalent.

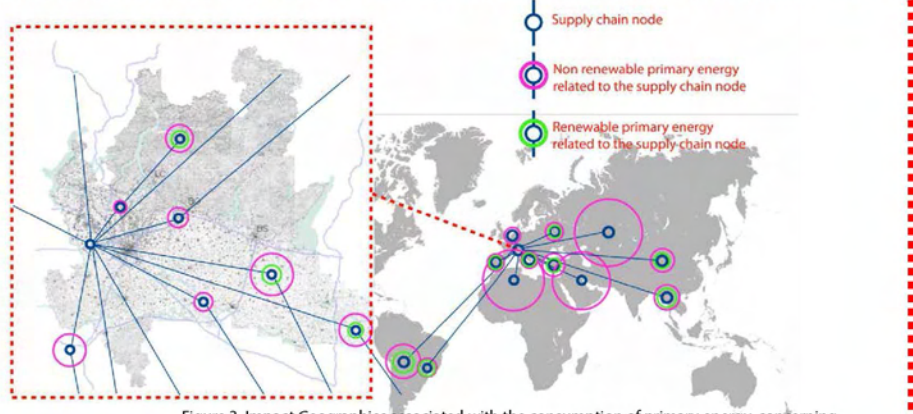


Figure 3. Impact Geographies associated with the consumption of primary energy, concerning the Local Demand of Energy and Matter (LDEM) in Albairate. Mapped supply chains are representative of the scenario 1 presented in the results of this paper.

Non-renewable primary energy used in the supply chain of bread

Chain: conventional bread
Indicator: MJeq / kg of final product
The diameter of the circle is proportional to the amount of primary energy used in the node, including transportation to the node itself.
The letters identify the main steps of the supply chain:
A: field production
B: transportation and milling
C: transport and production of bread
D: transport to the store

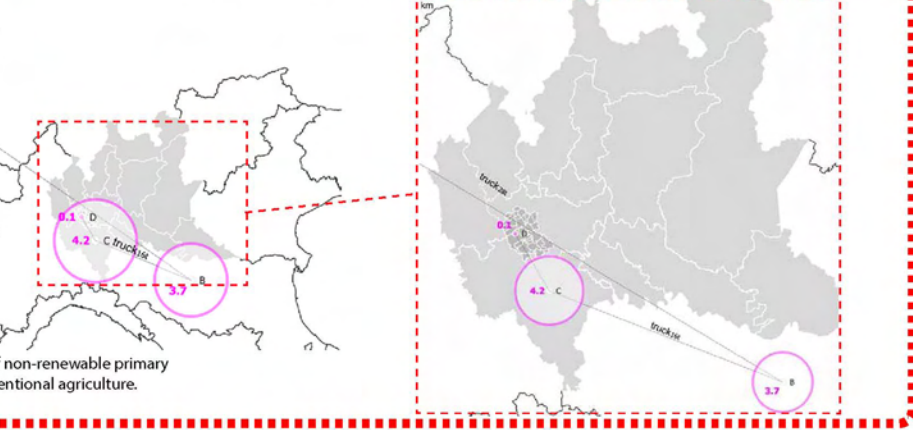


Figure 4. Impact Geography concerning the consumption of non-renewable primary energy for the production of 1 kg of bread from wheat conventional agriculture.

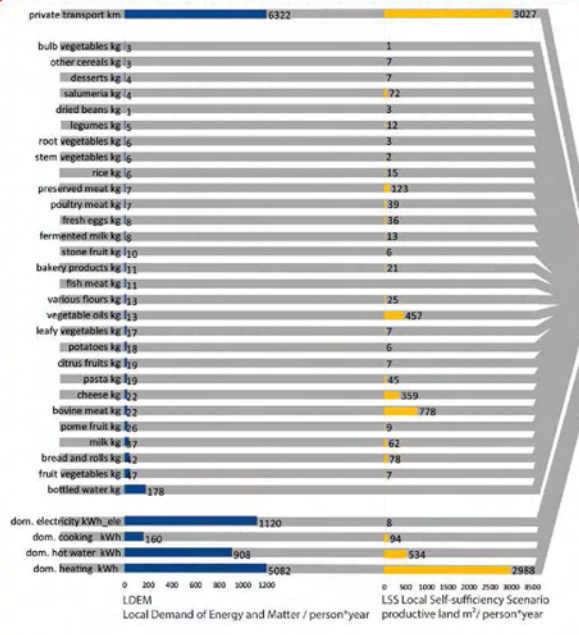
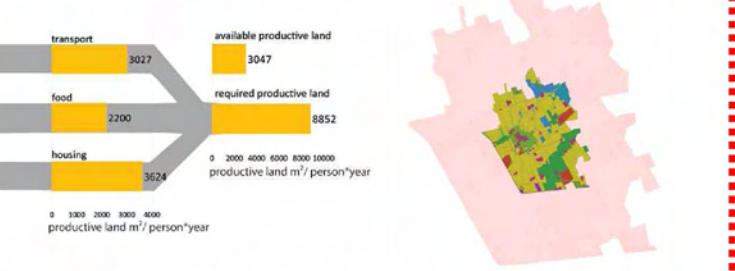


Figure 5. Extension of productive land per person (in orange) associated with the various items in the user histogram of Scenario2 (on the right values are aggregated by consumption category: transport, food and housing).

Scenarios

The results proposed in this text refer to the following scenarios:
1- Current status, no use of local renewable sources, full import of all resources.
2- Current demand of energy and materials, exclusive use of local resources.
3- Strategies to improve energy and material efficiency and exclusive use of locally available resources.



Scenario 2- Current demand of energy and materials, exclusive use of local resources. This scenario assumes that the energy and food resources currently consumed by the inhabitants of Albairate are sourced locally. Efficiency strategies in matter and energy use have not been adopted. From top to bottom, the principal items which characterize the categories of transport, food and housing are listed.

Scenarios 3 - Strategies for energy and material efficiency and exclusive use of locally available resources.

This paragraph on efficiency strategies lists strategies for each groups. It shows the impact on the extension of the productive land needed for each set of solutions (housing, feeding and transport).

Scenario 3 - Housing

Solutions concerning the heating item include strategies related to the energy upgrading of the existing buildings. The use of water flow reducers would lead to a reduction of 10% of the amount of energy for hot water. The amount of energy for cooking is left unchanged. Concerning electricity a consumption reduction by about 40% is assumed, due to the use of more efficient appliances and artificial LED lighting.



Scenario 3- Feeding 1 This strategy assumes a change in meat diet with exclusive use of poultry meat. Changing the amount of red meat (beef and pork) with a similar amount of legumes in terms of protein content. Halving protein intake by dairy products, and compensating with legumes.