UNISECO

UNDERSTANDING & IMPROVING THE SUSTAINABILITY OF AGRO-ECOLOGICAL FARMING SYSTEMS IN THE EU

Deliverable Report D2.1
Adapted SES Framework for AEFS and Guidelines for Assessing Sustainability of Agricultural Systems in Europe

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DATE OF APPROVAL:	07.11.2018
APPROVED BY PROJECT COORDINATOR:	Gerald Schwarz (Thünen Institute)
DATE OF APPROVAL:	07.11.2018
CALL H2020-SFS-2017-2	Sustainable Food Security-Resilient and Resource-Efficient Value Chains
WORK PROGRAMME Topic SFS-29-2017	Socio-eco-economics - socio-economics in ecological approaches
PROJECT WEB SITE:	www.uniseco-project.eu

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ACRONYMS

A	Actors
AEFS	Agro-ecological farming system
CPR	Common Pool Resources
CS	Case study
EC	European Commission
ECO	Related ecosystems
ES	Ecosystem Services
FADN	Farm Accountancy Data Network
GS	Governance system
I	Interactions
IAD	Institutional Analysis and Development
NRP	Natural Regional Park
O	Outcomes
P	Products
PDO	Protected designation of origin
RS	Resource system
RU	Resource Units
S	Social, economic and political settings
SES	Social-Ecological System
SLA	Sustainable Livelihoods Approach
TS	Transformation system
UNISECO	Understanding and Improving the Sustainability of Agro-ecological Farming Systems in the EU
WP	Work Package

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SUMMARY

Deliverable D2.1 explains the adapted SES framework for the sustainability assessment of agro-ecological farming systems and operationalises the framework by providing guidance for the analytical WPs (WP3, WP4, WP5, and WP6) and their collection of information and assessment of SES variables. This summary synthesises answers to key questions on the application and operationalisation of the SES framework in UNISECO.

1. What is the main objective of UNISECO and WP2?

UNISECO aims at enhancing the understanding of socio-economic and policy drivers and barriers for further development and implementation of agro-ecological approaches in EU farming systems. In order to achieve this, the main objective of WP2 is to develop a conceptual framework suitable for:

- the sustainability assessment of farming systems in Europe;
- the identification and the analysis of barriers and drivers towards agro-ecological transition
- establishing linkages between WPs as an umbrella framework.

In order to achieve this, the Ostrom's framework (2007) of social-ecological systems (SES), revised by Marshall (2015), was chosen (Figure 1).

Indeed, SES is a relevant theoretical framework to understand drivers and barriers towards agro-ecological transition both at individual and collective scales. SES framework allows to link technical, environmental, social and economic and political dimensions of AE transition within a complex set of interactions. Moreover, SES framework includes the identification of drivers and barriers that may not directly concern agricultural practices and farming system but can influence them (i.e. market, local dynamics, interactions between farmers and environmental NGO's).

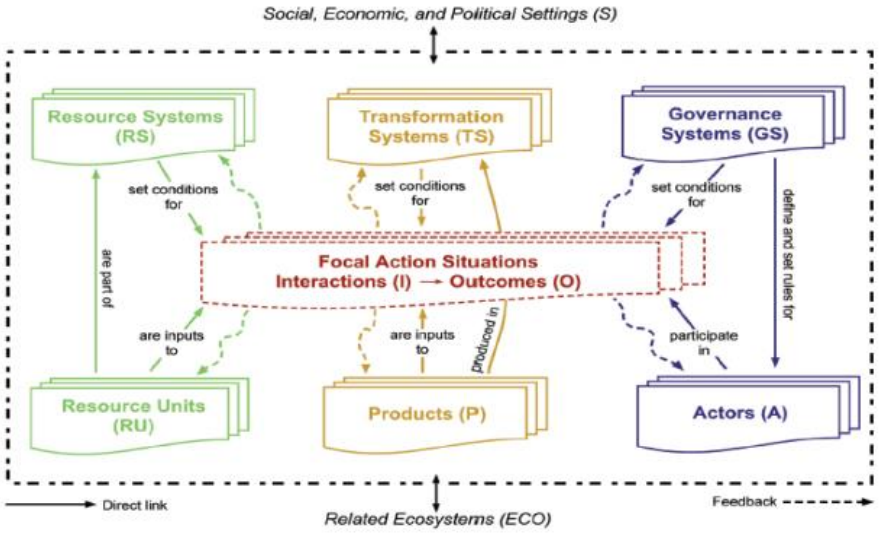

***Figure 1**. Social-ecological system (SES) framework (Source: McGinnis Ostrom, 2010, revised by Marshall, 2015)*

2. How does UNISECO define agro-ecological farming systems (AEFS)?

Agro-ecological farming systems AEFS) are "*based on sustainable use of local renewable resources, local farmers' knowledge and priorities, wise use of biodiversity to provide ecosystem services and resilience, and solutions that provide multiple benefits (environmental, economic, social) from local*

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to global. (Wezel *et al.*, 2018)*".* This refers to different interacting scales, not only the level of agricultural practices but also the farming system, the local level and the food system level.

With reference to transition pathways (question 4) we distinguish two forms of agro-ecological farming systems (Duru *et al*., 2015; adapted from Horlings and Marsden, 2011):

- "weak" agroecology or ("efficiency/substitution-based agro-ecology") based on increasing resource use efficiency (fertilizer, pesticides, water) and substitution of inputs (replacing chemical inputs with organic inputs);
- "strong" agroecology (or "biodiversity based agro-ecology") aiming to enhance ecosystem services and generally requiring a redesign of the farming system.

Examples of agro-ecological practices include split fertilization, organic fertilization, drip irrigation, natural pesticides and biological pest control, integration of semi-natural landscape elements in the field, extensive use of permanent meadows, farm and landscape levels.

3. Which farming systems will be considered in the scope of UNISECO?

Various farming systems will be considered. In UNISECO, particular attention will be given to the transition of agriculture towards agro-ecological farming systems and practices. Therefore, the whole continuum from conventional to agro-ecological farming systems (including weak and strong agro-ecology) will be analysed and compared to "conventional" farming systems.

4. How to characterize agro-ecological farming systems and transition to AEFS in UNISECO?

According to Foran *et al.* (2014), AEFS studies need to be extended to the complexities of the food system. Social-ecological system framework is a relevant scope to take into account this dimension. Even more, SES is composed by interacting sub-systems that include the different influencing factors in AEFS transition: social and political settings, agricultural practices and farming systems, local governance of agriculture, food system and market (Figure 2).

To analyse the transition pathways from conventional to agro-ecological agriculture the Efficiency, Substitution, Redesign (ESR) approach (Hill et Mac Rae, 1995) is a relevant framework. It assesses the strategies to support the transition from conventional to sustainable agriculture. This framework has been widely used to analyse the transitions towards different types of sustainable agriculture, for example for the transition pathways from conventional to organic agriculture (Lamine and Bellon, 2009). In our case, we will mobilise it to transition towards AEFS. ESR framework identifies three types of strategies to move towards sustainable agriculture: **increase of efficiency**, (e.g. reduced input of fertilizers), **substitution (**e.g. substitution of chemical inputs by organic inputs) and **redesign of the farming system** (complete transformation of the farming system to use renewable resources and ecosystem services). This framework is closely linked to weak and strong agro-ecology.

5. What is the SES concept and what are its objectives?

A SES can be defined as "*an integrated complex system that includes social (human) and ecological (biophysical) sub-systems in a two-way feedback relationsh*ip" (Ostrom, 2009; Berkes *et al.,* 2011). SES is a holistic transdisciplinary approach proposed to analyse how interacting sub-systems[1] influence a given situation ("Focal Action Situation"). The SES framework aims at analysing:

- why some exploitations of nature are sustainable whereas others collapse; and

[1] A subsystem is a secondary system defined as a set of processes, organized practices, intended to ensure a defined function.

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- in a practical way it aims to solve wicked problems (for which there is no optimal solution, Duckett *et al.,* 2016).

Analysing a SES aims at understanding how outcomes are explained by interacting sub-systems.

Properties of SES:

- A coherent system of biophysical and social factors that regularly interact;
- A system defined at several spatial, temporal, and organizational scales;
- A set of critical resources (natural, socioeconomic, and cultural) which uses are regulated by a combination of ecological and social systems;
- A dynamic, complex system with continuous adaptations.

A SES is composed by interacting sub-systems:

- Sub-systems are top or first tier attributes of SES;
- Each sub-system is described by a set of second-tier variables which in turn can be described in more detail by third-tier variables or indicators (quantitative or qualitative) (Del Mar Delgado, 2015).

6. What purpose do the different sub-systems have?

The operationalization of SES for UNISECO is designed around this core question: What are the most influential variables in each sub-system and how do these variables influence agro-ecological transition in focal action situations? Thus, the operationalization concerns the different sub-systems of the framework. Sub-systems are first tier attributes of SES; the understanding of their interactions aims at analysing what's happening in the focal action situation and have for UNISECO specific objectives as presented in table 1.

Table 1. *Main questions and objectives of each sub-system*

Approach of SES Sub-system	Objective/core questions for UNISECO
Focal Action situation = *Interactions* (I) + Outcomes (0) (environmental, social et economic performances and impacts)	What are the agro-ecological performances of concerned farming systems? What are their transition « pattern » and their drivers and barriers?
Resource systems (RS) = farming systems (from conventional to agro-ecological ones)	How are farming systems organized and managed? (RS can concern all types of agriculture : in AEFS or not)
Resource units (RU) = agricultural productions of the resource systems (RS);	What are the different factors of production and agricultural productions (at farm gate)
Actors (A): e.g. farmers or environmental NGOs, state representatives, …	Who are the actors involved in agriculture governance? Who are the major actors able to influence?
Governance (GS): strategic decision-making bodies	What are the main governance systems (from state regulations to collective rules)? What are the main decision-making processes?
Transformation system (TS) = secondary and tertiary transformation processes	How do the food systems work? Are the farmers the main beneficiaries of the added value?
Products (P): (generated by processes in TS)	What are the final marketed products?
Social, economic, and political settings (S)	Refers to the general context: Economic development; demographic, social and cultural settings; Political context and stability; markets, media, environment….

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7. *What are the strengths and weaknesses of the SES framework to analyse AEFS transition?*

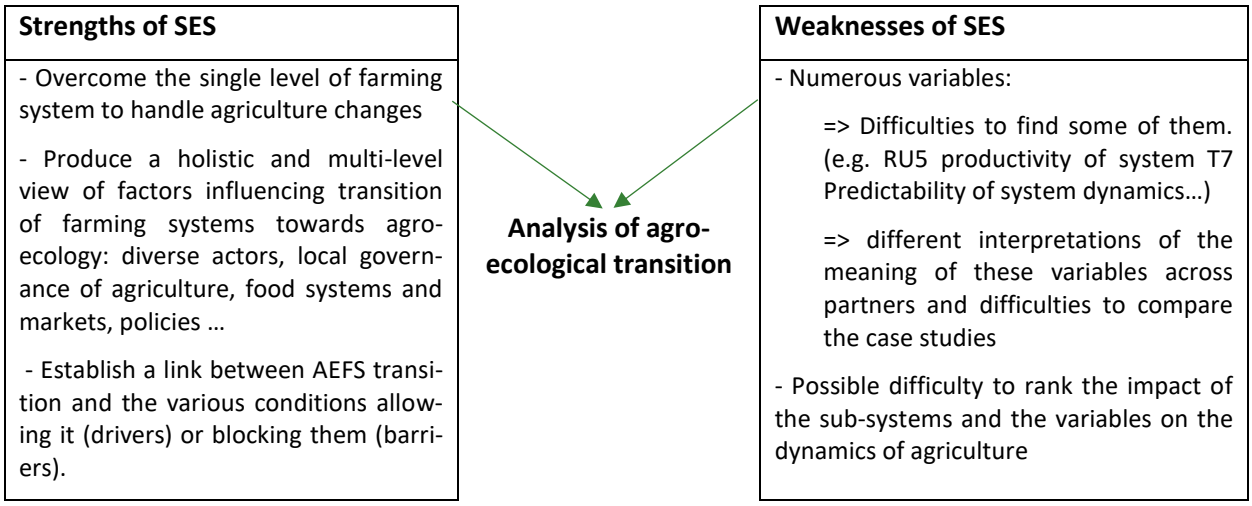

Figure 2. Strengths and weaknesses of SES framework for the study of agro-ecological transition.

8. *How the SES framework has been adapted to be used in UNISECO?*

To adapt and use SES relevantly in UNISECO we have:

- Integrated Marshall's proposal to consider the transformation and products sub-systems (rather than only considering the agricultural production part).
- Adapted the approach of SES sub-systems to the specificities of agriculture (Table 1) (e. g. resource systems correspond to farming system in UNISECO, and biodiversity is not considered as a resource unit but as an outcome);
- Modified some variables in each sub-system and simplified as far as possible the variables;
- Specified the purpose of each variable and the detailed way to fill it (to avoid different interpretations across partners) see Table 2 and Section 3 (operationalization of an adapted SES framework) including the example of the case study (cheese Bleu du Vercors-Sassenage).

9. *How shall the case study teams identify and analyze a SES?*

There must be in the selected case studies, farms and farmers engaged in a process of transition towards agro-ecological farming. Two main types of case studies are possible: 1) network-based case 2) place-based case. In both cases, SES will be used in the same way.

Network case studies don't have geographical boundaries (or refer to large area at regional or national levels). It could be a network of farmers to share experiences on conservation agriculture and no tillage practices. Internet exchanges, regular meetings and visits are the main frequent media used in such networks.

Place based case studies are local case studies with specific geographical boundaries such as a biodistrict, a national or regional park, a PDO (product of designated origin) area, a valley, a local community.

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10. How will teams analyse a case study using the SES framework?

The analysis of the SES of each case study refers to WP 3.1 (description and assessment of the SES in the case studies), which informs subsequent tasks in WP3, WP4 and WP5 and the synthesis of an integrated sustainability assessment of AEFS in WP6 (Task 6.2) as well as WP2.4 (practical validation of the conceptual framework and recommendations for future applications).

Concretely, for each selected case study, each team will have to:

- Collect different kinds of data (quantitative or qualitative) from official data bases and interviews. A lot of these data will be collected for WP3 (assessment at farm level) and for WP5 (governance and policy assessment). Some complementary data are also requested. Finally, the debate in the multi-actors platform will provide useful information
- The WP2 group will provide a detailed template to collect, organize these variables in the different sub-systems of SES framework.
- An analysis will be done by each team to produce the story map describing each SES (Task 3.1 Description and assessment of the SES in the case studies) (D3.3, month 17) and Update Story Maps on lessons learnt from each case study (Task 3.5, D3.6, month 28)

At UNISECO project level the SES framework will be used as an umbrella framework to progress in a consistent way between WP to an improved sustainability assessment of farming systems from farm level (WP3) to territorail level (WP4) including governance and policy settings (WP5) :

- Report on key barriers of AEFS in Europe and co-constructed strategies to overcome them (D3.4, month 23)
- Report on participatory scenario development of AEFS (Task 4.3, D4.2, month 26)
- Report on sustainability trade-offs of innovative management strategies, market incentives and policy instruments at farm level (Task 3.4, D3.5, month 27)
- Report on territorial impacts and lessons learnt of the diffusion of AEFS under scenarios (Task 4.4, D4.3, month 30)
- Synthesis report of the integrated sustainability assessment (Task 6.2, D6.2, month 33);
- Report on practice-validated SES framework for sustainability assessment of farming systems and recommendations for future applications (Task 2.4, D2.3, month 36).

In parallel with the start of the case studies, the next step is to finalise a relevant set of sustainability indicators suitable at farm, territorial and governance levels. A mapping exercise between SES variables and the sustainability indicators planned to be used in the assessments in WP3, WP4 and WP5 will be done to avoid major overlapping between the different WPs and to ensure a consistent basis for the integrated sustainability assessment in WP6.

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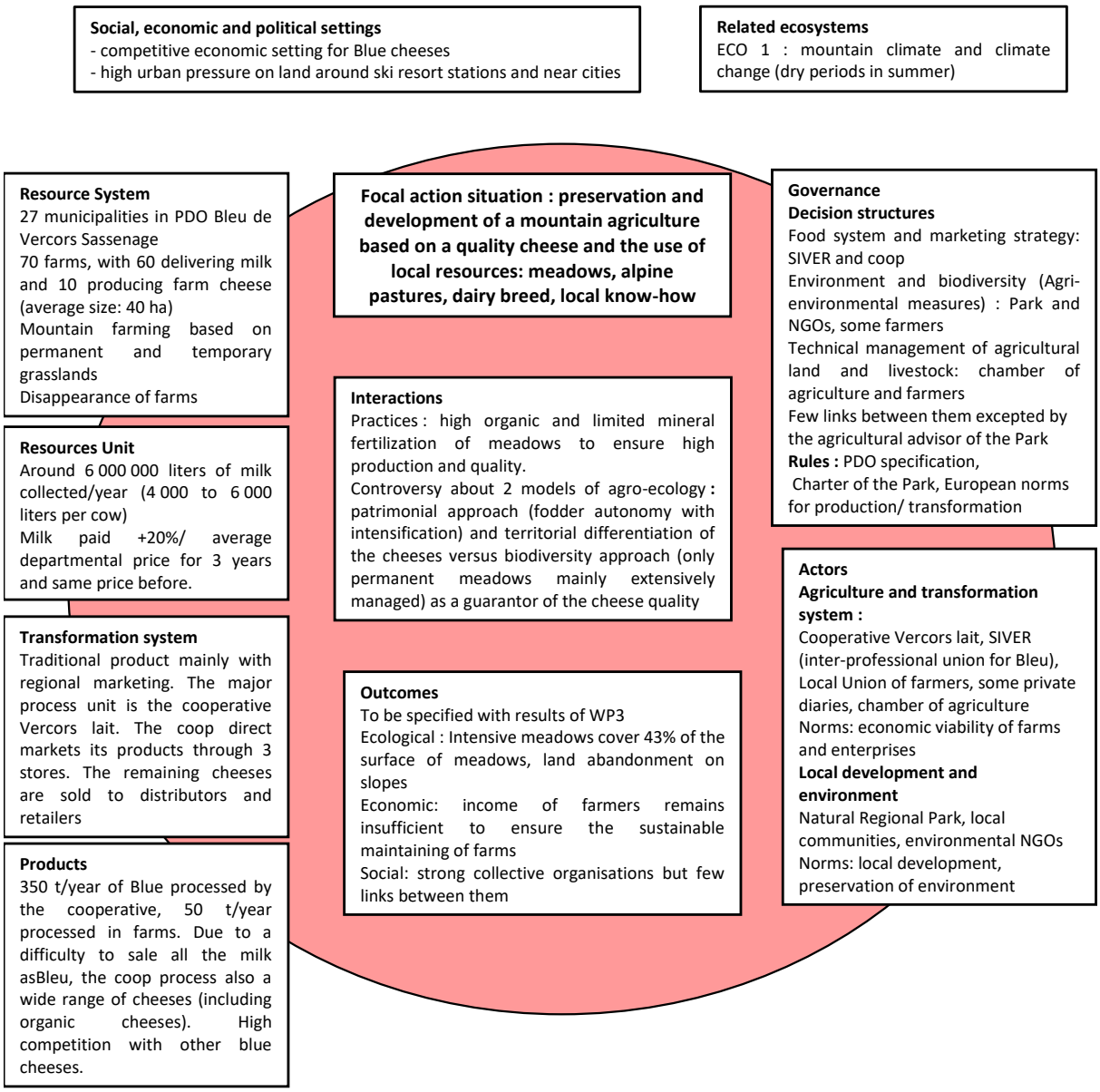

***Figure 3**. An example of SES case study: The cheese PDO Bleu du Vercors-Sassenage and its agriculture (France).*

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11. What are the adaptations of the SES framework for UNISECO?

Table 2. *List of the variables of the different sub-systems for SES framework in UNISECO*

Social, economic, and political settings (S) S1- Economic development. S2 - Demographic, social and cultural settings. S3 – political stability S4 - Other governance systems. S5 - Other markets. S6 - Media organisations. S7 - Other technology and infrastructure. S8 – History		
Resource systems (RS)	**Transformation system (TS)**	**Governance system (GS)**
R1 Sector	T1 Sector	GS1 Policy area
R2 Perimeter and clarity of system boundaries	T2 Clarifications about T1 sector	GS2 Policy area: Non-Governmental organisations
R3 : Number and size of farming systems	T3 Size of transformation system	GS3 Decision making structures
R4 Human-constructed facilities	T4 Human-constructed facilities	GS4 Rules-in-use- property rights
R5 Productivity of system	T5 Business relationships along the transformation system	GS5 Monitoring and sanctions
R6 Equilibrium properties of farming systems	T6 Equilibrium properties	
R7 Predictability of system dynamics	T7 Predictability of system dynamics	
R8 Storage characteristics	T8 Storage characteristics	
R9 Location	T9 Location/Geographical distribution	
R10 Input	T10 Inputs	
Resource units (RU)	**Products system (P)**	**Actors (A)**
RU 0: types of products	P0: Diversity of Products	A0 Description and role of the actors in the system
RU1 Resource unit mobility	P1 Product mobility	A1 Number of actors/purposes/actions
RU2 Growth or replacement rate	P2 Substitutability of the product	A2 Socio-economic attributes
RU3 Interaction among resource units	P3 Interaction among products	A3 History or past experiences
RU4 Economic value	P4 Economic value	A4 Leadership / entrepreneurship
RU5 Distinctive characteristics	P5 Number of units	A5 Knowledge of SES / mental models Norms
RU6 Spatial and temporal distribution	P6 Distinctive characteristics	A6 Vision of agro-ecology
RU7 Marketing characteristics	P7 Temporal distribution	
	P8 Marketing characteristics	
Action Situations: Interactions (I) ➔ Outcomes (O)		
Interaction/Activities and Processes		**Outcome criteria**
I1 Harvesting I2 Information sharing and self-organising activities I3 Deliberative processes I4 Conflicts I5 Investment activities I6 Networking and Lobbying I7 Evaluative activities and monitoring and sanction activities I8 Exchange activities		O1 Social performance O2 Ecological performance measures O3 Economic performance O4 Externalities to other SESs
Related Ecosystems (ECO) ECO1- Climate patterns; ECO2 - Pollution patterns; ECO3 - Flows into and out of focal SES		

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1. DEVELOPMENT OF AN ADAPTED SOCIAL-ECOLOGICAL SYSTEM (SES) FRAMEWORK FOR ASSESSING THE SUSTAINABILITY OF FARMING SYSTEMS

1.1 About this report in UNISECO project

This report is an official deliverable of UNISECO: "D2.1: Adapted SES framework for AEFS and guidelines for assessing sustainability of agricultural systems in Europe". It includes the 2 sub-tasks of task 2.1 (WP2[2]):

- Sub-task 2.1.1 Review and development of a conceptual framework for assessing sustainability of farming systems: this task includes a review of relevant theories to facilitate a better understanding of SES concept for the whole UNISECO and an adaptation of the SES framework to the issue of AEFS;
- Sub-task 2.1.2 Operationalization of an adapted SES framework: in this task the adapted conceptual framework of SES has been operationalized by providing guidance for the collection of information and assessment of the different sub-systems of each case studies: definition of variables, establishment of interrelationships between variables and sub-systems, consistency and complementarities with analytical WPs of UNISECO: WP3, WP4, WP5, WP6 and WP7).

1.2 Objectives of the report

The objective of this deliverable is to develop a conceptual framework suitable for the sustainability assessment and improvement of agro-ecological farming systems (AEFS). This conceptual framework is based on the concept of SES proposed by Ostrom (2007, 2009).

The challenge is to develop modifications of the SES framework able to:

- improve the sustainability assessment of farming systems and the understanding of the factors affecting their sustainability;
- identify the main drivers and barriers in a transition towards AEFS and how these barriers can be addressed;
- guide the different WP of UNISECO to contribute in a consistent way to an improved sustainability assessment of farming systems from farm level (WP3) to territorial level (WP4) including governance and policy settings (WP5). Figure 4 presents the different guidance levels that the SES framework will provide to WPs. More linkages will emerge during the project and will be specified as UNISECO is progressing.

[2] WP2 is organized into 4 tasks: Task 2.1 Development and operationalization of an overall conceptual framework; Task 2.2 Inventory and typology of AEFS; Task 2.3 Case study design and selection; Task 2.4 Practical validation of the conceptual framework and recommendations for future applications.

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The final challenge at the end of UNISECO is to explain why some SES develop sustainable AEFS and why others not. This will refer to a comparative analysis of SES case studies conducted by each project partner (in WP2 from an academic standpoint and in WP6 from a practical and policy recommendations perspective).

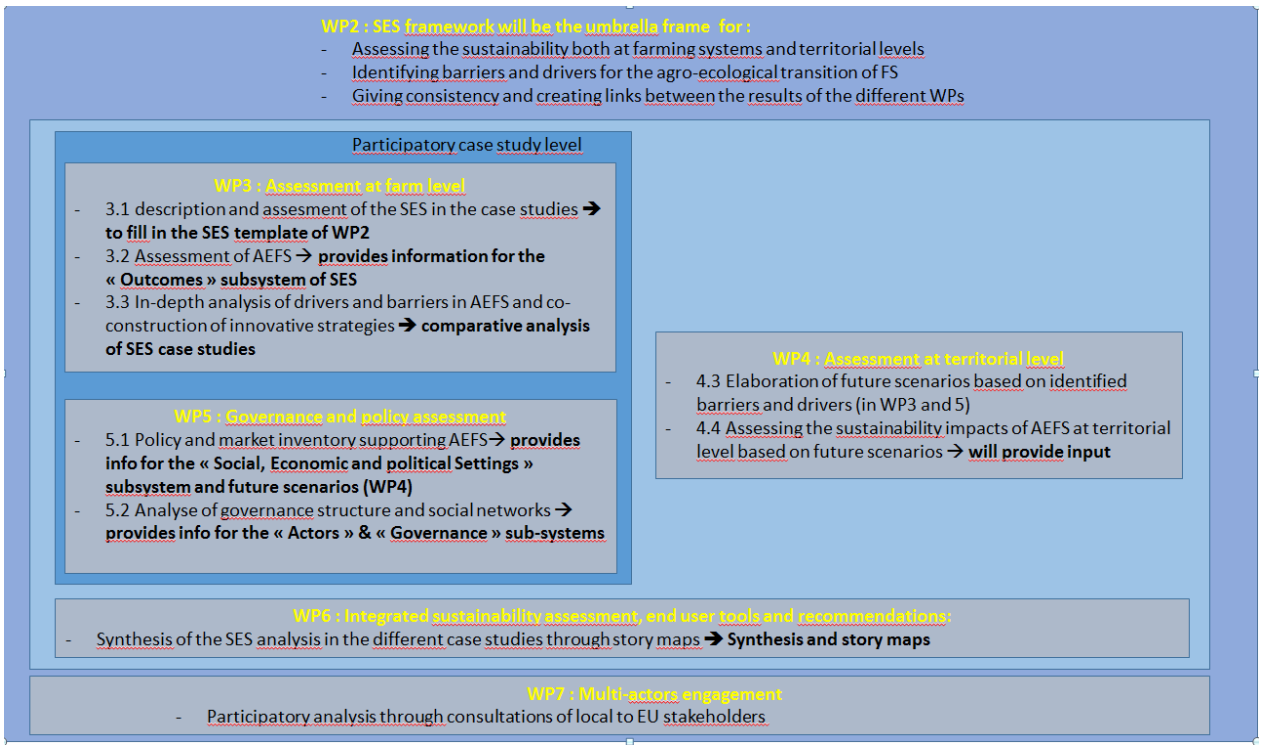

Figure 4. *Links between the SES framework and the different WPs of UNISECO.*

This report provides an operationalized conceptual framework for the assessment of the sustainability, and the barriers and the drivers to an agro-ecological transition of farming systems. It is organized in two main parts:

- Review and development of a conceptual framework for assessing the sustainability of farming systems;
- Operationalization of an adapted SES framework including an example of the use of the adapted SES framework on a case study and a detailed list of variables.

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2. Review and Development of a Conceptual Framework for Assessing the Sustainability of Farming Systems

This conceptual framework based on an adaptation of the SES framework is conceived to be used as:

- A unifying approach between the partners of UNISECO to guide in-depth analysis of action situations in case studies to overcome weaknesses of AEFS (WP3 and WP5);

A consistent framework to guide the indicator-based assessments of changes in the economic, social and environmental performance and trade-offs assessment at farm and territorial levels (WP3 and WP4) (sustainability assessment) and the design of end-user tools and recommendations (WP6).

2.1. Assessing sustainability of AEFS with SES: conceptual challenge and methodological difficulties

The main challenge of WP 2.1 is to adapt the SES framework for the sustainability assessment and improvement of AEFS. It is related to the following methodological difficulties:

- The design of a SES framework able: 1) to consider the diversity of drivers and barriers for agro-ecological transition of farming systems; 2) to assess the diversity of performances (outcomes) related to this transition, from an ecological, economic and social perspective;
- The definition of what agroecology is and the specification of how to identify and describe agro-ecological practices and agro-ecological farming systems in the context of European diversity of agriculture and policies objectives related to transformation of agriculture.

The crucial issue is to link an adapted SES framework consistently to the transition of farming systems towards agroecology and an assessment of their sustainability. The inventory and typology of AEFS will be detailed in Deliverable 2.2 (report on typology of AEFS and practices in the EU and the selection of case studies (Month 9). This chapter will begin with a broad definition of agroecology and AEFS followed by a presentation of the SES concept.

2.2. Agroecology, AEFS and agro-ecological practices

It remains a challenge to define agroecology. There are no official standards as for organic farming. There is not yet a generally agreed definition for agroecology, consequently there are many different interpretations of the concept (FAO, 2017).

According to the Association of Agroecology Europe (www.agroecology-europe.org): *"Agroecology is considered jointly as a science, a practice and a social movement. It encompasses the whole food system from the soil to the organization of human societies. It is value-laden and based on core principles. As a science, it gives priority to action research, holistic and participatory approaches, and transdisciplinarity including different knowledge systems. As a practice, it is based on sustainable use of local renewable resources, local farmers' knowledge and priorities, wise use of biodiversity to provide ecosystem services and resilience, and solutions that provide multiple benefits (environmental, economic, social) from local to global. As a movement, it defends smallholders and family farming, farmers and rural communities, food sovereignty, local and short marketing chains, diversity of indigenous seeds and breeds, healthy and quality food."* (Wezel *et al*., 2018)

A recent review of the concept of agroecology in Europe illustrates that across Europe the concept is used in different ways with some applying it more as a science than a practice, while agroecology as a social movement is rather limited (Gallardo-López, Hernández-Chontal, Cisneros-Saguilán, &

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Linares-Gabriel, 2018). The review identifies four different scales for analysis of agroecology:

1) The farming system scale, which relates to the physical and biological factors and form a first level of analysis.
2) Agroecosystem scale is used for a systems approach, which includes ecological, social and political aspects.
3) Regional scale is the intermediate scale between agroecosystem and the food system, using a landscape and interdisciplinary approach to integrate agricultural and non-agricultural activities. The review identified different aspects at this scale (Natural resources; Socio-economic impacts; Sovereignty; and Human activities) which are forces in the process of achieving sustainable agriculture.
4) Agri-food scale system focuses on food security and sovereignty more broadly.

Wezel *et al*. (2018) argue that agroecology is a transdisciplinary, participatory and action-oriented approach, which as a movement has the potential to transform food systems, but there is a range of actions required including: developing a common understanding of agroecology; enhancing the education and knowledge exchange; investing in research; developing policies to enhance agroecology; supporting agro-ecological practices and farms; transforming the food system; and reinforcing communication and alliances.

Another important issue refers to the transition pathways towards agroecology. The Efficiency, Substitution, Redesign (ESR) framework (Hill and MacRae, 1995) is an interesting and often used approach. The ESR framework assesses the strategies to support the transition from conventional to sustainable agriculture. It identifies three types of activities to move towards sustainable agriculture and could be also an efficient framework for agro-ecological transition: **increase of efficiency**, (e.g. reduced input and improved crop productivity), **substitution** of chemical for natural inputs **or redesign of the farming system** (Hill and MacRae, 1995). Agro-ecological transitions, especially in case of redesign of the farming systems, are not just related to changes of practices at fam level but they can include the development of collective actions (between farmers or with multi-actor's involvement) or new markets strategies (i.e. product differentiation with quality labels or local marketing) (Therond *et al*., 2017).

To recap: a working definition of agroecology for UNISECO

To design an adapted SES framework, we retain that agroecology is defined as a practice, a social movement as well as an action science based on holistic and transdisciplinary research approach. In the assessment of farming systems in UNISECO, we refer to agroecology ***as a set of agricultural practices*** more or less strongly based on ecological inputs and processes organized in a holistic way. In such farming systems farmers use their knowledge and decision priorities for sustainable use of local renewable resources and biodiversity to provide multiple benefits (environmental, economic, social) from local to global. This refers to different interacting scales, not only the level of agricultural practices but also farming system, local community and food system levels.

With reference to transition pathway we distinguish two forms of agro-ecological farming systems (Duru, 2015 adapted from Horlings and Marsden, 2011):

- "weak" agroecology ("efficiency/substitution-based agroecology") based on increasing resource use efficiency (e.g. fertilizer, water) and substitution of inputs (chemical with organic inputs);
- "strong" agroecology (or "biodiversity based agroecology") aiming to enhance ecosystem services and generally requiring a redesign of the farming system.

Examples of agro-ecological practices: split fertilization, organic fertilization, drip irrigation, natural pesticides and biological pest control, integration of semi-natural landscape elements in the field, extensive use of permanent meadows, farm and landscape levels.

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2.3. Bibliographic Review: The Social-ecological System, Concept and Principles

The general concept of UNISECO is built around the application and further development of a **systems-based theoretical concept,** which enables a holistic approach to the complex relationships between socio-economic and policy drivers of AEFS, sustainability of farming systems and governance settings. There are several conceptual approaches aiming at such a challenge. To present the SES concept with reference to other theoretical frameworks this section is organized as follow:

- Firstly, a comparative analysis of different theoretical frameworks for analysing social-ecological systems is performed. We discuss main differences and objectives between the SES by Ostrom (2009) and other frameworks such as ecosystem services and rural livelihood;
- Secondly, we will present the SES framework proposed by Ostrom and its related core concepts in detail;
- Finally, strengths, weaknesses and major criticisms to SES framework are discussed.

2.3.1. SES and other theories about human societies and ecosystems

For the interactions between human societies and ecosystems, a number of concepts have been developed that can be compared to the SES framework. Some authors have already done such a comparison: i.e. Pegasus[3] project (Dwyer *et al*., 2015; Maréchal *et al*., 2016; Binder *et al*., 2013, Barreteau *et al.,* 2016). According to these reviews, there are at least 16 frameworks for analysing the interactions between social and ecological processes, 10 among them were compared by Binder *et al*. (Ibid). We will focus on three of them : Ecosystem Services (ESS), Sustainable Livelihoods Approach (SLA), and "Territoire". These three frameworks were chosen because they are the most relevant for agriculture issues and achieve a good balance between social dynamics conceptualization and ecological characterisations.

2.3.1.1. Ecosystem Services (ES)

Dwyer et al. (2015) recall that the initial concept of ESS differs ontologically from its current applications. Initially ES aimed at conveying the importance of, and value of, natural systems to society and the economy. However, current uses of ESS arguably coalesce around the application of valuation as a means to improve decision-making processes.

This is confirmed by Binder *et al*. (2013) position: « *The Ecosystem Services (ES) framework focuses on the integral, dynamic, and complex interactions of biotic and abiotic components providing the service that support life on earth* ». It has been mostly applied in the field of integrated management of the linkages between environment and human well-being, e.g., the Convention on Biological Diversity (United Nations, 1992) and the Millennium Ecosystem Assessment (MEA).

[3] Dwyer, J., Short, C., Berriet-Solliec, M., Gael-Lataste, F., Pham, H-V., Affleck, M., Courtney, P. and Déprès, C., (2015). *Public Goods and Ecosystem Services from Agriculture and Forestry – towards a holistic approach: review of theories and concepts* PEGASUS (program Public Ecosystem Goods and Services from land management – Unlocking the Synergies), 41p.

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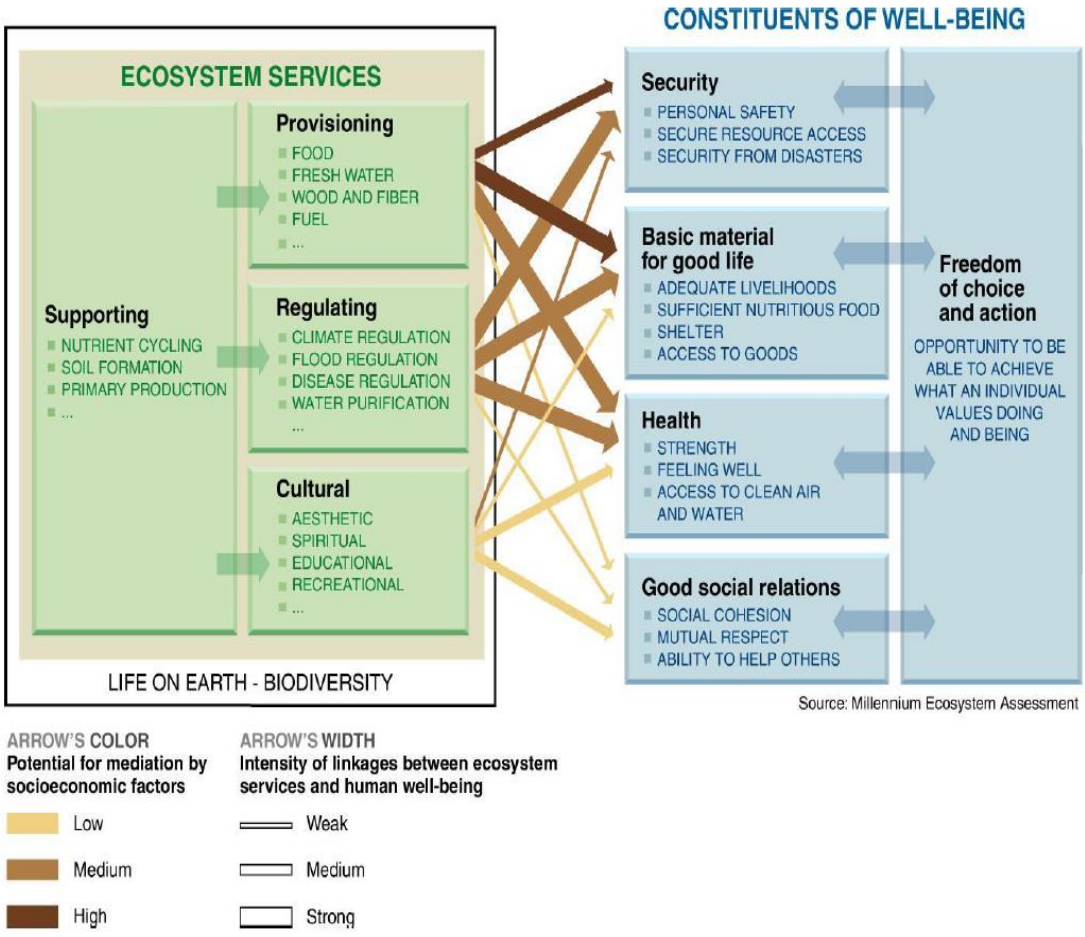

***Figure 5**: Ecosystem services framework (Berkes et al., 2014).*

This valuation objective in the context of political orientation is equally true in Europe. In order to give answer to Action 5 of the EU Biodiversity Strategy to 2020[4], a set of scholars recently published (Maes *et al*., 2018) a document providing *« operational guidance to the EU and the Member States on how to assess the condition (or the state) of Europe's ecosystems ».* This document is an endeavour to implement the ESS concept, as part of a European research program called "***M**apping and **A**ssessment of **E**cosystems and their **S**ervices"* (MAES). The report aims at giving key challenges for an EU analytical framework on ecosystems conditions.

The approach is based on the idea that « *the concept of ecosystem condition is linked to well-being through ecosystem services* » and « *that ecosystems need to be in good condition to provide a set of essential services which, in turn, deliver benefits and increase well-being* ». However, the set of indicators proposed concerns ecosystem conditions and not ecosystem services without any indication of how to move from the first to the second.

Nevertheless, the use of ESS in agriculture/farming systems allowed Zhang *et al*. (2007) to characterize a lot of ecosystem services and 'dis-services' to agriculture at different spatial scales (field to globe) such as pollination linked to cover crops (field and farms levels) and to riparian vegetation or vegetation cover in the watershed (Landscape and region levels) etc.

[4] That foresees that Member States will, with the assistance of the Commission, map and assess the state of ecosystems and their services in their national territory by 2014.

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Two types of positions towards ES could be distinguished (de Sartre *et al*., 2014). Numerous scientific papers question how to measure ES scientifically or how to incorporate them into policies. The main attempt to operationalise the concept consists of characterising the different services provided by an ecosystem (Maes *et al*., 2018).

On the other side, strong reservations of ES notion exist. This literature can be differentiated between:

- conceptual and methodological criticism whose purpose is to improve the effectiveness of ESS approaches. This first set of criticisms points to confusions in their uses between notions of structure, functions and services of ecosystems. This refers to a methodological difficulty: *« An ecosystem service is therefore an intermediary between natural capital and human benefit.[…] While the processes underlying ecosystem services have a clearly identifiable spatio-temporal dimension, the benefits are eminently more complex to characterize »*(Le Clec'h S *et al.,* 2014);
- more fundamental criticisms concern the ethical dimensions underlying the notion of services. They point to ES as an interesting notion if considered as a metaphorical concept, but its use in the current neoliberal context opens the door to marketability of nature.

Dwyer *et al*. (op cit.), after considering strengths and weaknesses of ES in Pegasus project, propose SES as a potential unifying approach between ecosystem services and public goods. This is specified as follow by Maréchal *et al*. (2016): *« The Social-Ecological Systems approach provides a wider compass by including human and social capital alongside natural capital in one holistic frame. It is not a replacement for the insights of both the public goods and ecosystem services concepts; rather it seeks to embrace the full set of dynamic relationships between natural assets and processes and human assets, actions and their respective drivers ».*

2.3.1.2. Sustainable Livelihoods Approach (SLA)

The SLA was one of the first efforts in addressing variables including a human-in-nature system. Its purpose is to analyse which combination of livelihood assets (e.g. diversification of the farming system) enables different livelihood strategies with sustainable outcomes (Berkes *et al*., 2014). Scoones (1998) takes over Chambers and Conway (1992) definition of SLA: "A *livelihood comprises capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shock, maintain or enhance its capabilities, assets while not undermining natural resource bases."*

Berkes *et al*. (2014) add that SLA approach was essentially centred on people and aimed at enhancing their livelihood and reducing poverty*: "It includes assessing key components of the livelihood system -named as "assets" or "capitals" including the following: 1) human capital, 2) social capital, 3) natural capital, 4) physical capital, and 5) financial capital […]. It also includes a description of the vulnerability context for the addressed system as well as local people's livelihoods strategies, and desired changes to achieve specific livelihoods outcomes"* (Berkes *et al*., 2014).

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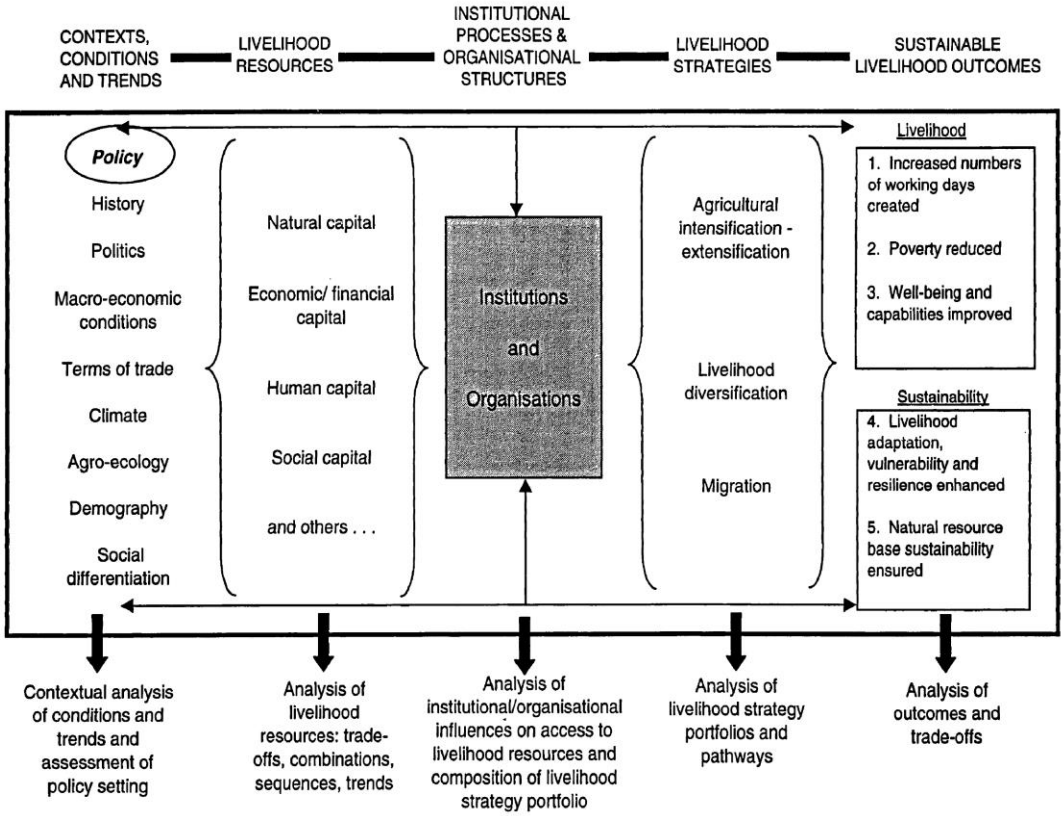

Figure 6. *Sustainable Livelihoods Approach (SLA) (Source: Scoones, 1998).*

During the 1990s, SLA became a mainstream international development paradigm (Schermer, 2005). The case studies approached with this framework demonstrate the crucial necessity of social capital for sectoral and regional networking. The experience gained with the SLA framework shows that it is an efficient tool to analyse the role of formal and informal institutions and institutional processes in livelihood maintenance and improvement (such as rules for labour sharing, tenure regime, credit arrangement, regulation and promotion of a set of livelihood strategies, determination of trade-offs, etc.).

In SLA, institutions and organisations are central. This framework gives a key position to institutional processes and organisational structures to translate policies into livelihood outcomes. This structure differs from the SES approach, which is centred on focal action situation. In the SES framework, an action situation captures interactions between different kinds of actors and their outcomes on the "milieu".

SLA and SES are quite close concepts. But social/human systems are differently conceptualized in the two frameworks: in SLA, social system is *"conceptualized as situated in a context of external factors, a set of livelihood resources (natural, economic, human, social, and other capital), a set of institutional processes that influence how the resources can be used to realize different livelihood strategies (such as agricultural intensification or extensification, livelihood diversification and migration")* (Binder *et al*., 2013). But dynamics of socio-systems are not conceptualized. In the SES framework, *"the social system is composed of resource users (actors) and the governance system that influences the actions of the users by defining rules as well as monitoring and sanctions mechanisms." And the social system is conceptualized textually by a number of variables organized in hierarchical levels such as "information sharing," "deliberation processes," and "self-organization activities" grouped under the label "interactions"* (Binder *et al*. ibid.).

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2.3.1.3. "Territoire" concept

Barreteau *et al*. (2016) propose to compare social-ecological system and "Territoire" concepts, coming from French speaking geographers' tradition. As the authors write, they do not translate this term to "territory" because in the broad Anglo-American terminology, it is linked to political and administrative senses (administrative boundaries). Whereas the "Territoire" concept touches upon social and ecological dimensions, like SES.

"*Defined in social geography as a spatial mediator of all social life (Di Méo, 1999),* "territoire" *is both a social and a lived space, including political and ideological dimensions of space*. "territoire" *is a reordering of space (...) it can be considered as the informed space of the biosphere*." (Barreteau et al., 2016). For these authors, such an approach allows environmental planning […] "*and feed discussion on the management of landscape dynamics inherited from both cultural and natural processes*".

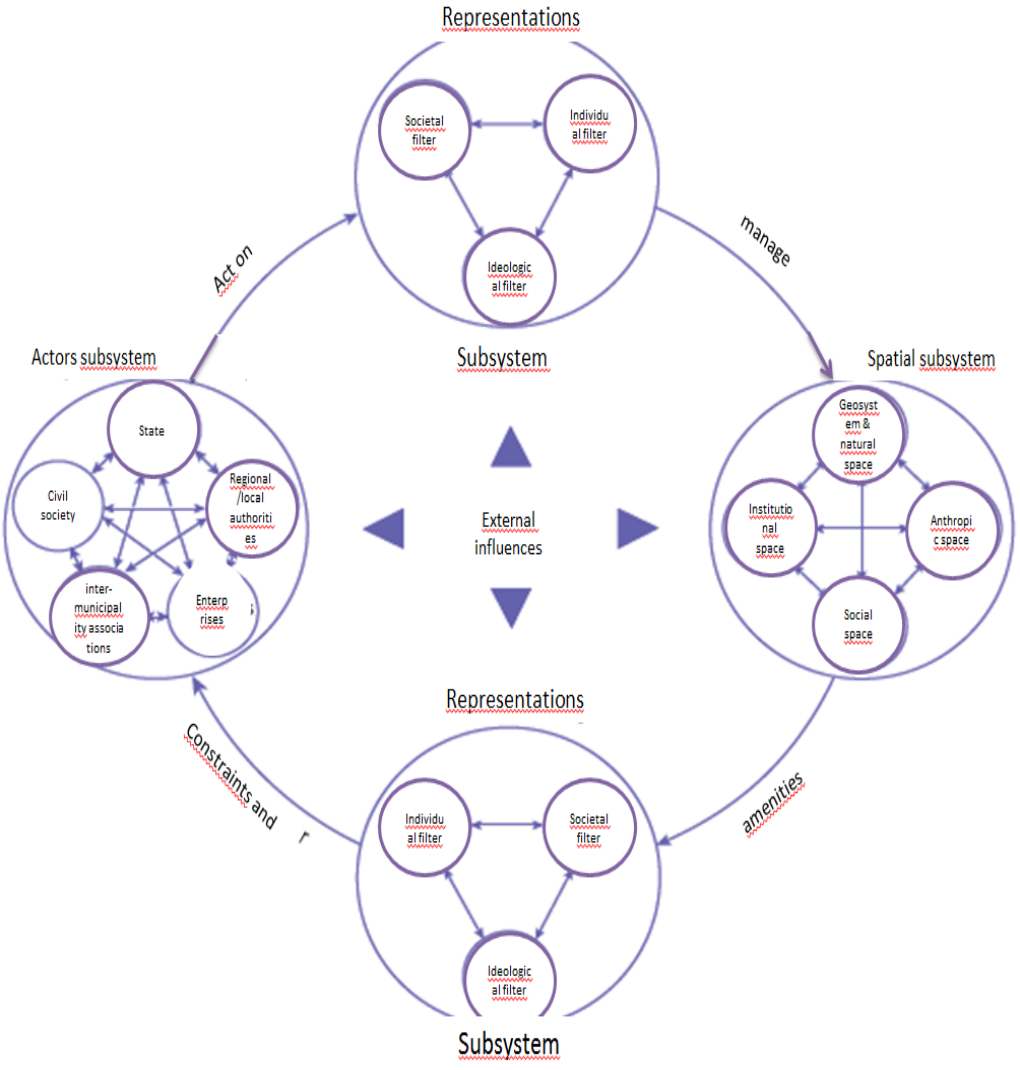

Figure 7. "Territoire" system: a set of interacting sub-systems where representations (social perceptions) are central (Source: Moine A. 2006).

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Note: this framework proposed by Moine (2006) is an example of "territoire" approaches. There are many others "territoire" "frameworks" that are not clearly constituted like SES but that belong to a long tradition in Geography. The evolution and the diversity of the concept are related to methodological approaches developed in geographical and cross-sectoral approaches and finally are linked to changes in social sciences themselves.

"Territoire" with its environmental and social sides, introduces with social interactions the dimensions of landscape and patrimony. A patrimonial object is inherited by history; and its presence, when perceived, engages the memory and the actions to create a "sense of place".

"Territoire" approach (

Figure **7**) refers mainly to "sense of place" which contributes to define identity of the place and reflects the actors' consciousness of environment. Sense of place is related to the meanings (representation sub-system between actors' sub-system and spatial sub-system) and attachment to a place held by an individual or a group and reveals an individual or a collective identity. The influence of the sense of place is important because it helps to provide answers about how actors are able to adapt to current evolutions (from very local to global stakes, e.g. from particular landscape management to climatic change).

"Territoire" is a place-based approach of power where social groups and actors interact with spatial dynamics through the filter of their social « representations » (point of view, ideology, sense of place). "Territoire" approach has a lot of similarities with SES framework and could offer a valuable aid to handle power interactions in place-based dynamics.

2.3.1.4. Comparison between SES, ES, SLA and "territoire"

Table 3 shows fundamental differences between SES, SLA, ES and "territoire". It differentiates the SES framework from other approaches. It shows three major differences justifying the choice for the SES framework in UNISECO:

1. Concerning dynamics of social systems: SES is the only approach structured in a complex set of variables characterizing the social system (via its governance and actors sub-systems). Nevertheless, we do not consider that the SES conceptualization is complete and will further elaborate on this point in UNISECO.
2. Concerning dynamics of ecological systems: the SES framework is the only one that considers dynamics of ecological systems both within a same scale and across different scales. *« SES provides a framework for selecting variables necessary to describe the dynamics in social and ecological systems and the interaction between them and it also suggests variables for analysing the potential sustainable development of a social-ecological system. »* (Binder *et al*., 2015). Nevertheless, as Binder *et al*. wrote, interactions between scales are mentioned, but not further conceptualized in the SES framework. This could be covered by using elements of the systems approach, which provides a framework for including scales. "Territoire" concept can provide help to this end.
3. Concerning the links between social and ecological systems: They are clearly stated in a balanced way in the SES framework whereas ES pays more attention to ecological systems and SLA to human systems. The SES framework is an effective way to support scenario development and to identify transition pathways toward sustainability. Nevertheless, questions remain about the functioning of sub-systems and their interactions. SLA method can help to find how institutions manage this aspect.

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***Table 3**: Comparison between complex approaches of human/environment interactions (based on Binder et al., 2013; Barreteau et al., 2016; Moine, 2006)*

	SES	SLA	Ecosystem Services	"Territoire"
Purpose	Provide a common language for case comparison, for organizing relevant variables to the analysis into a multi-tier hierarchy that can be unfolded when needed, and for facilitating selection of variables in a case study.	"Analyse which combination of livelihood assets enable the following of what combination of livelihood strategies with sustainable outcomes" (Binder & al 2013).	Analyse the integral, dynamic, and complex interactions of biotic and abiotic components of an ecosystem in relation to the supply of services this system provides to support life on Earth.	Analyse individual and collective practices and representations of humans in their environment.
Conceptualisation of the social system	composed of resource users (actors) and the governance system that influences the actions of the users by defining rules as well as monitoring and sanctioning mechanisms.	as situated in a context of external factors, a set of livelihood resources (natural, economic, social), a set of institutional processes that influence the use of resources to realize different livelihood strategies	as humans being the users of ecological system and acting as valuing agents. They translate basic ecological structures and processes into value-laden entities.	Holistic view, where identity and sense of place have major and structural effects on actors' relations, power distribution, practices and representations of actors
Conceptualization of the social system and its dynamics	by variables such as: "deliberation processes," "self-organization activities", "information sharing" grouped under the label "interaction"	Social dynamics are not conceptualized	Social dynamics are not conceptualized	Interactions between actors and their representations. Historical approach: Territoire = result of past actions, uses, and representations

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Conceptualisation of the ecological system	Anthropocentric perspective as resource system, e.g., water, forest, and corresponding resource units, e.g., water quantity, trees.	Anthropocentric perspective. It appears in two different parts of the framework. First as part of the context that comprises all social (political) and natural system factors that influence the livelihood. Second, as natural capital, one of the livelihood resources available for pursuing livelihood strategies.	"Ecocentric" perspective (Binder *et al*. opt cit.) focusing on ecosystem functions. To ensure the continued availability of ecosystem functions, the use of the associated goods and services should be limited to sustainable use levels.	Anthropocentric perspective, great importance of space
Conceptualization of the ecological system and its dynamics.	Considered by variables of the resource system and resource units such as growth rate, equilibrium properties, and productivity.	Ecological dynamics are not conceptualized.	Ecological dynamics are not conceptualized.	Biophysical and spatial dimensions but rather from a human perspective
Conceptualization of the interaction between the social and the ecological systems	Actors' use of resources impacting on the ecological system and may cause externalities in related SES, which feedback to the social system	Options of humans are affected by external boundary conditions among those are environmental assets.	The social system changes the services that can be provided by the ecological system.	Biophysical processes linked to social relations
Interactions between scales	Interactions between scales are mentioned but not conceptualized	Approach at local or regional scales	Can be applied at any scale, no interaction between scales are considered	Interactions between scales of decisions and actions, mainly dedicated to local level

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The reasons why the SES framework appears more suitable than the other approaches to assess transitions to agro-ecological farming in the UNISECO project, is due to the focus of actions situations in relation with transformation systems and products. Some dimensions of these other concepts are nevertheless of interest and will be used to enrich the SES framework for its use in UNISECO. For instance, the focus that the sustainable livelihood concept gives to understanding the strategies of stakeholders will be used to enrich the analysis of the actors' sub-system in UNISECO. "Territoire" is also an interesting concept for crossing spatial scales and for the importance given to actors' relationships and social perceptions. These dimensions are taken into account in the adapted SES framework proposed for UNISECO (see section 4 of this report). In this adapted framework, actors are explicitly considered in the actors' sub-system (A). This adaptation answers one of the criticisms towards SES.

2.3.2. SES: Definition and aims of the framework

NB: all words underlined and accompanied by a "*" are important concepts of SES, and are extensively defined in the glossary at the end of the document.

2.3.2.1. Current definition

The current definition of a Social-Ecological System (SES) is "an integrated complex system that includes social (human) and ecological (biophysical) sub-systems in a two-way feedback relationship" (Ostrom, 2009; Berkes *et al*., 2011).

From this definition, some properties of SES are inferred to define a SES as:

- A coherent system of biophysical and social factors that regularly interact;
- A system defined at several spatial, temporal and organisational scales;
- A set of critical resources (natural, socioeconomic, and cultural) whose use are regulated by a combination of ecological and social systems;
- A dynamic, complex system with continuous adaptations.

The SES framework is conceived to encompass uncertain and 'complex' situations where feedbacks occur in ways that are not necessarily predictable. The uncertainty, complexity and unpredictability are major challenges for the analysis of agro-ecological transition in case studies.

2.3.2.2. Objectives of SES framework and ethical principles

The SES approach of Ostrom is a transdisciplinary framework that on the one hand can be useful for any scientific discipline but on the other hand requires collaboration between them. It is conceived to understand why some systems collapse and why others work and produce sustainable outcomes. The overall objectives are the following: "*We need to build a theoretical foundation for explaining why some resource users are able to self-organize and govern the use of a resource over time in a sustainable manner and why others fail or never make the effort*. (…) *So, how can we start moving toward a diagnostic theory of common-pool resources? We provide an overview for approaches to building a diagnostic theory to address two interrelated theoretical puzzles: (1) How do resource users self-organize or create the conditions for institutional change to overcome collective-action dilemmas? and (2) What are the conditions that enhance the sustainability of resources and the robustness of institutions over time?*" (Basurto and Ostrom, 2008).

The designers of the framework aim to analyse and solve wicked problems*, namely problems for which it is impossible to define optimal solutions because of uncertainty about future environmental conditions and intractable differences in social values (Duckett *et al.*, 2016).

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Ostrom (2007) recalls that the governance of socio-ecological systems cannot be managed with a blueprint approach looking for, a unique top-down solution as a panacea* i.e. a kind of solution that would fit all. On the contrary, SES's approach needs:

- a nested framework to go beyond panaceas, because there is no panacea for all human situations. This Nested Framework aims at analysing interactions and outcomes of linked SESs. These SESs are non-linear in nature, cross scales in time and in space, and have an evolutionary character.
- social learning* in order to manage a common suitable and adaptive agreement. *"As structural variables change, participants need to have ways of learning and adapting to these changes"* (Ostrom, 2007).

The SES framework comprises a scientific aspect to study complexity on the one hand and, on the other hand, a social and ethical dimension according to this paradigm: *"Fundamental to the SES framework is the presumption that humans can make conscious choices as individuals or as members of collaborative groups, and that these individual and collective choices can, at least potentially, make a significant difference in outcomes"* (McGinnis, Ostrom, 2014). Concretely, such a position has consequences for UNISECO. It means that the SES systemic perspective must take into account the choices of actors and values to assess the sustainability of their actions one the hand and the way agro-ecological transition is implemented on the other hand.

2.3.3. SES framework in detail: historical landmarks and main evolutions

2.3.3.1. brief history of the SES concept

Ostrom was not the first to talk about social-ecological system. This concept was widely used in psychiatric sciences before 2000's. In fact, Stojanovic, T. et al (2016) mentioned that in the Oxford English Dictionary the earliest occurrences of the forms socioecologic, socioecological, and socioecology are in 1970, 1936, 1952 and showed that 86% of articles using social-ecological before 1990 were in psychology or public health related journals[5]. The same authors demonstrated that SES has taken a significant use in the area of environmental sciences since the 90's, becoming a concept to analyse the interactions between human societies and ecosystems.

Ostrom takes the idea of Berkes and Folke (1998) that SES materializes a prerequisite position considering humans *« as a part of, not apart from, nature »*. Ostrom's innovation in this movement was to propose an organized framework that facilitates a systematic and comparable reading of these interactions for any human action situation: *« All humanly used resources are embedded in complex, social-ecological system. SESs are composed or multiple sub-systems and internal variables within these sub-systems at multiple levels analogous to organisms composed of organs, organs of tissues, tissues of cells, cells of proteins, etc. »* (Ostrom, 2009)

Then she proposes to develop diagnostic methods *« to identify combinations of variables that affect the incentives and actions of actors under diverse governance systems ».*

The initial SES framework was designed for application to a relatively well-defined domain of common-pool resource* (CPR) management. However, Mc Ginnis and Ostrom (2014) noted that *« many SESs also generate public goods* and services, most notably the ecological or ecosystem services* on which many markets depend for their continued operation. »*

[5] A socio-ecological approach in social psychiatry refers, for example, to the study of a behavioral sequence of interactions between two persons or groups in a relatively isolated therapeutic community. (Clinical and participative observation) Hudolin W ed. (1984).

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2.3.3.2. The initial SES framework

SES framework is an expansion of a previous framework also conceived by Ostrom: Institutional Analysis and Development framework (IAD) (Kiser and Ostrom, 1982). IAD framework identifies an action arena, patterns of interactions and outcomes, and an evaluation of these outcomes for a particular action situation (Poteete *et al*., 2009). In comparison, SES is a broader framework.

Because there is no panacea to solve wicked problems, there is a need to characterize socio-ecological system giving importance to multi-scale approaches: actors*, governance*, resources systems* and resource units* (

Figure **8**). This interdisciplinary framework initially broke down the system into four internal dimensions or sub-systems (first tier variables).

The resource system (location, size, etc.) defined as a set of resource units

- The resource units (replacement rate, number of units…): component of a resource system extracted and exploited by a resource user.
- The governance system (organization and rules), i.e. public and private interactions undertaken to address challenges and to create opportunities within society.
- The users (number, knowledge, technology, etc.) Resource users (e.g. a fisherman, a fishing industry) extract resource units (e.g. lobster) from a resource system (e.g. a fishing zone).
- And two external dimensions, the economic and socio-political context as well as connected or non-connected ecosystems

These different sub-systems shape the framework in which the actors interact (processes of deliberation, conflicts, etc.). This framework in turn transforms the resources, the governance system and the users. A set of 2nd tier variables (and if needed of 3rd tier) is used to characterise each sub-system. These variables can be adapted to each case study.

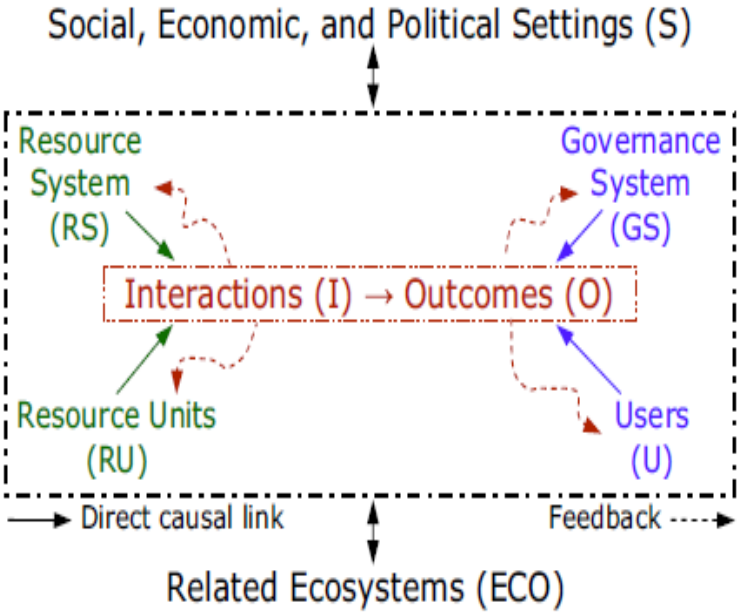

Figure 8. Initial SES framework (Ostrom, 2007 and 2009).

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To summarize:

- A SES is composed by interacting sub-systems. Sub-systems are top or first tier attributes of SES;
- Each sub-system is described by a set of second-tier variables which in turn can be described in more detail by third-tier variables or indicators (quantitative or qualitative) (Del Mar Delgado 2015).

2.3.4. The revised SES framework (McGinnis and Ostrom, 2010)

McGinnis and Ostrom (2014) proposed a modified SES framework (Figure 9), but its objective remains the same: « *The basic idea of SES is to be explicit in linking together the 'human system' and the natural system in a two feedback relationship*. » (Berkes et al. 2014).

The key changes concern:

- **the term « Actors » (A) which is more general replaces Users (U).** The term "actor" refers to anyone who has directly or indirectly an influence on the system. This term in the new terminology refers to the fact that "*the set of direct participants in processes of resource extraction is not identical to the set of participants consuming the product of labor*" (McGinnis and Ostrom, 2014). Moreover, according to us, the word "Actor" enlarges the set of participants potentially embedded in a SES and this category may concern also people who are not directly involved in the resources and governance sub-systems but who nevertheless are able to have an impact or role on them (i.e. local inhabitant, external wholesalers, external factory manager etc.);
- **"Focal action Situations" are added to "Interactions➔Outcomes"** in order to invite to characterize in a more dynamic way the SES. An "*action situation is structured by seven broad attributes including: (1) the set of participants confronting a collective-action problem, (2) the sets of positions or roles that participants fill in the context of this situation, (3) the set of allowable actions for participants in each role or position, (4) the level of control that an individual or a group has over an action, (5) the potential outcomes associated with each possible combination of actions, (6) the amount of information available to actors, and (7) the costs and benefits associated with each possible action and outcome*" (Poteete *et al*., 2009).

In our case, agro-ecological transition is the focal action situation to be studied according to this set of dimensions (specified in the section 4 of this report).

These changes are accompanied in McGinnis and Ostrom paper with an explanation about the necessity to take into account actors relationships with the explicit reference to the coexistence of multiple actors, instances and institutions involved in overlapping resources and governance systems:« Different sets of actors may be engaged in extracting or producing different types of resource units drawn from one or more resource systems, and their activities may be guided by rules drawn from overlapping governance systems »(McGinnis and Ostrom, 2014). For UNISECO analysis, this means that actors have to be clearly specified in the framework (as it is exposed in the table of actors in the section 4 of this report) in order to know who they are and what their relationships are.

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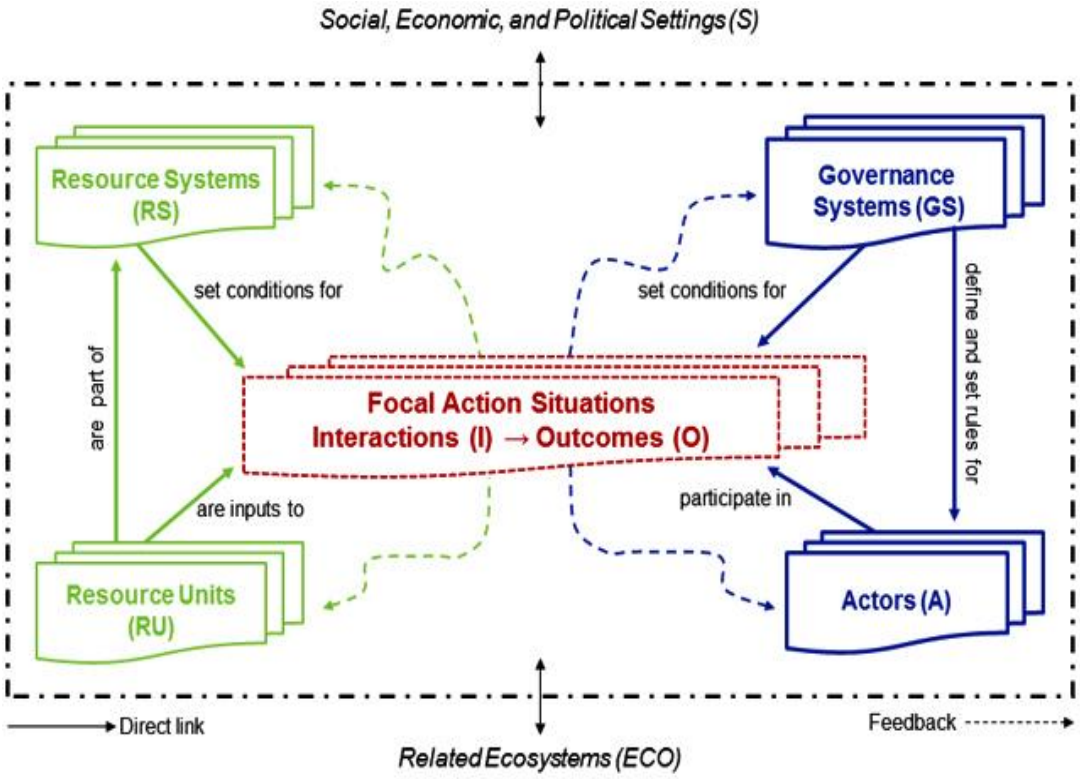

Figure 9. *Modified SES framework (M Ginnis and Ostrom, 2014).*

The evolutions proposed by McGinnis and Ostrom (2014) "*were made in the interests of generalizability by extending the SES framework to apply to complex SESs in which multiple sets of actors consume diverse resource units extracted from multiple interacting resource systems in the context of overlapping governance systems"* (Table 4). Despite these conceptual evolutions, the SES framework keeps immutable characteristics: "*The social-ecological systems lens draws on many concepts and approaches but in the form we are using, it always includes three key factors –multiple scales, multiple levels, and resilience."* (Berkes *et al*., 2014).

Table 4. *Main evolutions of the initial SES framework (extract from MacGinnis and Ostrom, 2014).*

The new framework incorporates the following changes from versions of the SES framework initially presented by Ostrom (2007, 2009, 2010): 1. Labels for first-tier categories are changed. 2. Actors (A) replaces Users (U), and each Ux is changed to Ax for second-tier attributes in that category. 3. Action Situations is added to the label for Interactions and Outcomes (as in Ostrom, 2010). 4. Multiple instances of first-tier categories may be included in applications. 5. […] Specifically, resource units are considered to be parts of (or drawn out of) broader resource systems, and governance systems define and set rules for actors. 6. Monitoring activities are included as a particular instance of the Action Situations category, with rules under which monitoring takes place remaining under Governance Systems. 7. Evaluative activities are included as another action situation, and Outcome Criteria are specified as such. 8. Changes in the list of relevant social, political, or economic settings include the addition of Technology as a potential source of exogenous shocks, and generalization of market incentives to any factors relating to markets and government resource policies to other potentially relevant governance systems.

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The concept of SES has been used in very diverse contexts and for very diverse purposes. These resulted in different adaptations and enrichments of the framework. One of the most relevant evolutions of the framework for UNISECO is proposed by Graham Marshall (2015) for food system research.

2.3.5. The SES framework for food system research

The bibliographic review on agro-ecology brought to light that agro-ecological transition involves the whole food system (Wezel *et al*., 2018) at different scales. In that respect[6], Marshall's SES framework can have application for any food system (from case studies where all farmers sell their products to wholesalers to those where farmers sell or process directly their products). Marshall's proposition (2015) is based upon the statement that SES framework does not sufficiently take into account the food system, the supply chains and the products themselves for food system research : "*The current version of the SES framework was designed to account for resource provision and appropriation activities but not for transformation activities, and thus has deficiencies as an instrument for diagnosing and understanding those food systems within which transformation activities play prominent roles*."

Marshall proposes to integrate food system in SES framework by adding two complementary subsystems, namely "Transformation System" (TS) and "Products" (P) (Figure 10). The Transformation sub-system is described with 10 second-tier variables and the Products sub-system with 8 variables (Table 5).

Transformation activities include processing, distribution and retailing of primary products of the resource system. They are activities in which value is added and which are often integrated with the market economy. So, significant interdependences could exist with the resource system of the primary production. Marshall considers that it is inappropriate, especially for agricultural products, to consider these transformations activities as exogenous to the SES of focal concern. Marshall discusses the need and the interest of such modification in a research project examining the challenge faced by Cambodian cattle-owning smallholders in accessing value chains for premium-priced beef. This modified framework maintains consistency with the standard SES framework, but it has the advantage to handle more efficiently sustainability problems related to the transformation activities and to the relationships between actors along the food system.

Moreover, while the standard SES framework has been largely used in developing countries context and mainly for CPR, the analysis of farming systems in Europe implies several changes due to the strong integration with the supply chains, the key role of formal policies (e.g. CAP) and the strong market orientation of the majority of farming systems.

[6] In UNISECO, food systems must at least be considered from the drivers and barriers they are likely to represent for agroecological transition dynamics. The analysis carried out will then enable to assess the importance of these drivers and barriers.

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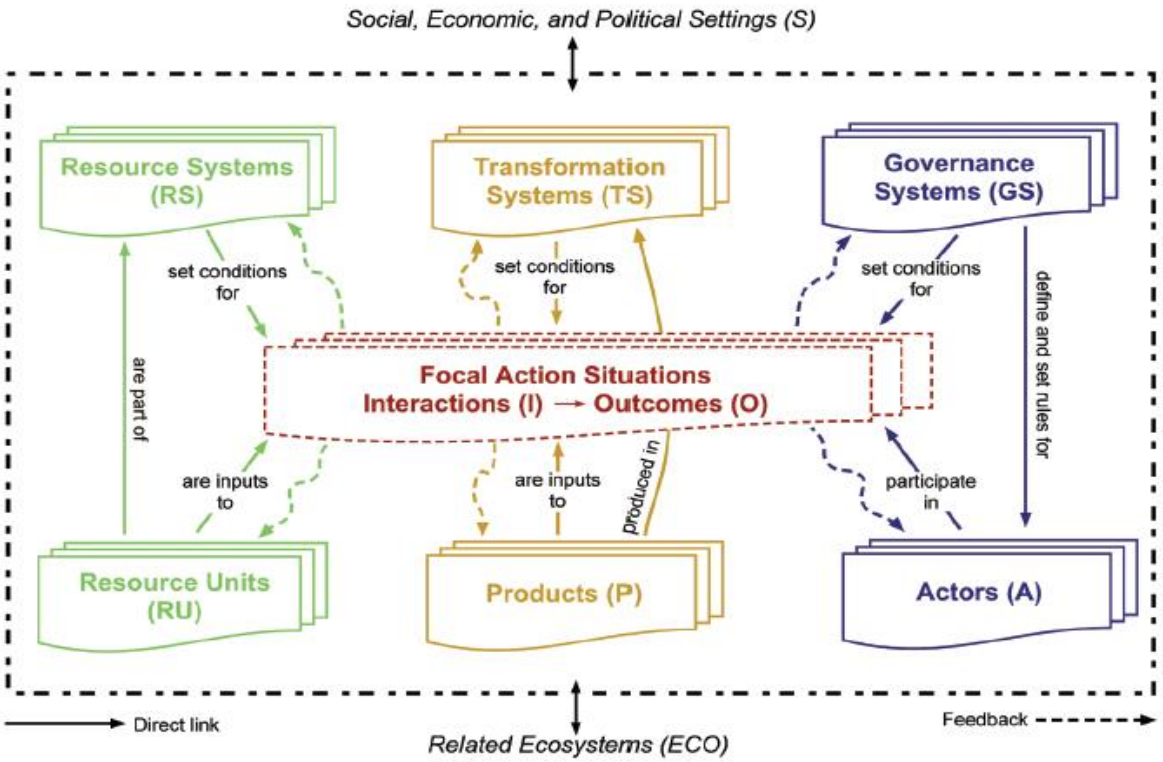

Figure 10. *The SES framework including food system (Marshall, 2015)*

To summarize:

The modified SES framework of Marshall (2015) is significant to operationalize the SES framework for agro-ecological transition of farming systems and we will mobilize it as a key feature to develop a relevant framework for UNISECO. Indeed, transformation activities of agricultural products are core drivers and barriers towards AEFS. It allows to understand the role of:

- Organization and logistics of the food system;
- Relationships between actors of the food system;
- Specifications of products, contractual requirements, labels of quality;
- Exigencies and constraints to ensure the technical processes of transformation;
- Consumers wishes, economic constraints, prices competition and market strategies.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773901.

Table 5. *First and second-tier attributes of the SES framework modified by Marshall (2015)*

Social, economic, and political settings (S)

S1- Economic development. S2 - Demographic, social and cultural settings. S3 - Political stability. S4 - Other governance systems. S5 - Other markets. S6 - Media organisations. S7 - Other technology and infrastructure. S8 - History

Resource systems (R)	**Transformation systems (T)**	**Governance systems (GS)**
R1 Sector	T1 Sector	GS1 Policy area
R2 Clarity of system boundaries	T2 Clarity of system boundaries	GS2 Geographic scale of governance system
R3 Size of resource system	T3 Size of transformation system	GS3 Size of population involved or affected
R4 Human-constructed facilities	T4 Human-constructed facilities	GS4 Regime type
R5 Productivity of system	T5 Productivity of system	GS5 Rule-making organisations
R6 Equilibrium properties	T6 Equilibrium properties	GS6 Rules-in-use
R7 Predictability of system dynamics	T7 Predictability of system dynamics	GS7 Property-rights systems
R8 Storage characteristics	T8 Storage characteristics	GS8 Repertoire of norms and strategies
R9 Location	T9 Location	GS9 Network characteristics
R10 Inputs	T10 Inputs	GS10 History
Resource units (RU))	**Product (P)**	**Actors (A)**
RU1 Resource unit mobility	P1 Product mobility	A1 Number of actors
RU2 Growth or replacement rate	P2 Growth or replacement rate	A2 Socio-economic attributes
RU3 Interaction among resource units	P3 Interaction among products	A3 History or past experiences
RU4 Economic value	P4 Economic value	A4 Location
RU5 Number of units	P5 Number of units	A5 Leadership / entrepreneurship
RU6 Distinctive characteristics	P6 Distinctive characteristics	A6 Norms (trust-reciprocity) / social capital
RU7 Spatial and temporal distribution	P7 Spatial and temporal distribution	A7 Knowledge of SES / mental models
RU8 Marketing characteristics	P8 Marketing characteristics	A8 Importance of resource (dependence)
		A9 Technologies

Action Situations: Interactions (I) ➔Outcomes (O)

Activities and Processes	**Outcome criteria**
I1 Harvesting	O1 Social performance measures
I2 Information sharing	O2 Ecological performance measures
I3 Deliberative processes	O3 Externalities to other SESs
I4 Conflicts	
I5 Investment activities	
I6 Lobbying activities	
I7 Self-organising activities	
I8 Networking activities	
I9 Monitoring and sanctioning activities	
I10 Evaluative activities	
I11 Transformation activities	
I12 Exchange activities	

Related Ecosystems (ECO)

ECO1- Climate patterns; ECO2 - Pollution patterns; ECO3 - Flows into and out of focal SES

This framework will be adapted for UNISECO and presented in section 3 about the operationalization of an adapted SES framework.

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2.3.6. Reservations and criticisms towards SES and difficulties of implementation

Many European research projects using the SES concept pointed out its fertility and its efficiency in managing complex situations. Nevertheless, the UNISECO team and other researchers note that there are yet some difficulties to overcome. Two kinds of critiques and limitations are formulated towards the SES framework:

- theoretical criticisms emphasize insufficient development of social aspects;
- practical criticisms concern the implementation of the SES framework.

2.3.6.1. Theoretical criticisms of Ostrom's framework

Power distribution and social learning

The main criticisms towards the SES theory are related to the potential lack of understanding of the power games occurring between the different stakeholders that it may interact in the system (Clément, 2013). It concerns political, social, economic and administrative power. Despite successive modifications of the framework, this weakness remains and the search of how trade-offs of common pool resources in the context of social learnings are negotiated seems to ignore the forces and lobbies that underlie these compromises: *"Compared to the institutional analysis and development (IAD) framework from which it derived, the SES framework includes a variable on the political-economic context, but tells little about power distribution"* (Clément 2013).

Indeed, while researchers use SES in a rather rigorous perspective in terms of resource units and systems, they are often less extensive about social and power relations: how relations between actors are impacting their access to resources, who are major players in designing governance rules and why? These comments align with the Habermas analysis (1987) that a "*systems approach alone is insensitive to social pathologies but is blind to pathologies of society caused by interactions of social, cultural, and economic realms such as the breakdown of bonds between the individual and community. Critiques add that this misses the question of what analysis aims for because sustainable futures almost always involve questions of politics and power"*. These reservations refer to the interest of a deeper social and psychological approach than what can be achieved by an interdisciplinary framework as SES: *"In a Foucauldian sense, discourses are both a vehicle and constitutive element of power, and can significantly drive institutional change by framing the way problems are perceived and potential solutions debated" (Clément, 2013).*

Some criticisms concern also the difficulties of SES framework to handle social-learning and creativity processes *"Here the main critique is that applying a systems approach is a kind of methodological determinism: choosing an approach that fits the requirements of systems modeling rather than an accurate representation of social entities" (Stojanovic, ibid.); "It is argued that this restricts models of social-ecological evolution, for example, failing to capture the potential role of creativity and imagination in dealing with sustainability issues"* (Davidson 2010).

SES and participative debates

Finally, these different criticisms could be related to that proposed by Clément (2013) and by Hajer and Versteeg (2005) concerning the structure of SES itself: *"But 'fixing' a common language raises another issue, namely the risk of closing debates on contested meanings and social constructions of reality. How a problem is framed determines the way in which solutions are selected"*. Thus, the way the SES framework is built is likely to emphasize elements that are not meaningful for people and risks to promote a vision that makes no sense for local people.

This criticism can be linked to the aforementioned ones about power and the key role of experts in social democracy: *"A system ontology may steer analytical preferences toward collaboration with*

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*disciplines that have quantifiable dynamics; theories of society that avoid questions of power; and highly aggregated data with little insight into the realm of the subjective." (*Glaser and Glaeser, 2011).

These criticisms are tempered by many of these « critical » authors who write that SES is nevertheless a useful tool to catch complexity rejecting panacea solutions which are considered as even worse approaches. It is also a tool open for modifications and specifications.

If these different observations are true when looking only at the SES framework, the missing factors pointed out by the scientific literature are nevertheless implicit in the SES variables[7]. However, the fact that they are not explicit prevents from tackling head-on these dimensions of social system. In order to make these more explicit and to include the objections mentioned above in our SES, we will adjust the SES framework.

For UNISECO modifications of the SES framework, we retain to take care of these two points:

- To handle in a more detailed way the relation of power between actors leading to GS6 Rules in use in the governance and actors sub-systems.
- In cooperation with WP7 (Multi-actor engagement) to develop an inclusive approach of actors and participatory processes respecting their knowledge avoiding to impose a SES diagnosis as the single legitimate point of view or position.

2.3.6.2. Difficulties in implementing the SES framework

Adapting and implementing the SES framework is by no means an easy task. In reference to previous experiences and projects, UNISECO will face several challenges and difficulties. In this section, we will review challenges and solutions stated in bibliography and research projects.

During the COMET-LA[8] project (aiming at identifying sustainable community-based governance models in the management of environmental challenges in Latin America), Del Mar Delgado-Serrano and Ramos (2015) noted several problems in the implementation of SES framework: *"However, when the 53 second-level variables were initially described in the case studies, we got very heterogeneous answers. The results showed important difficulties to use the framework and problems of applicability at local level. The variables were very differently understood in each case study and most of their descriptions were incomplete, included erroneous concepts, mixed ideas or overlapped information in different variables."*

Moreover, scholars in the COMET-LA program pointed to difficulties to operationalize and standardise the variables. They did not succeed in capturing similar criteria among different research groups. The SES framework was found to be more an analytical framework (Binder *et al.,* 2013), than a methodological one. The author points also that the SES framework is not operational enough to be implemented locally. In other cases, for example in the paper of Leslie *et al.* (2014) dedicated to fisheries, scholars succeeded in operationalizing the SES framework. The main lesson is that the operationalisation the SES framework should be finely adjusted to the problem to handle and shared by all users.

[7] For instance, power distribution is implicit to « GS9 Network characteristics », and lobbies are directly mentioned in variable: "I6 Lobbying activities". Power distribution could be also handled in the sub-system actors (A5 Leadership/entrepreneurship).

[8] COMET-LA: Community-based Management of Environmental Challenges in Latin America. Seventh Framework Programme of the European Commission (FP7-ENV2011-282845 COMET-LA) http://www.comet-la.eu/images/comet_la/generaldocs/2013-DELGADO-COMET-LA%20PRESENTATION%20ENGLISHred.pdf

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Table 6: *Some problems found in SES applications (Del Mar Delgado Serrano and Ramos, 2015)*

Code	Problem	Description
1	Uncertain reliability of statistics	There is reasonable doubts about the consistency and validity of the available statistics
2	Lack of data at local level	The existing data is generated to upper levels than the local one
3	No formal register of data	The information needed has not been measured or registered or these registers are not publicly available
4	Subjective information	The information derives from participants' opinion or perception and thus results can not be extrapolated
5	Difficulty to access and collect data	There are not easily available mechanisms or procedures to access or collect data (mainly biophysical and ecological)
6	Unclear or abstract concept for local stakeholders	The meaning of the concepts is not well understood for participants. It can also refer to new concepts or to concepts the participants are not familiar with
7	Uncertain limits	The variable measured has blurred boundaries
8	Difficulty to define categories	The concepts struggle to be delimited in categories
9	Difficulty to measure	Problems to quantify data with traditional research tools or mechanisms or lack of a range of possible descriptive values
10	Difficulty to integrate and organise information	The variables are not static, values vary with time, space, etc., thus integration and organization can be complex

In the COMET-LA project, research teams understood underlying concepts of SES such as governance structure, property rights, role of trust, and transactions in different ways. These differences led to misunderstandings that made case studies hardly comparable. They faced difficulties to explain how to assess SES and what is the relevance of the data collected. The lack of common references resulted in difficulties to carry out a comparative analysis of the different case studies. To overcome these problems Del Mar Delgado Serrano & Ramos (2015) proposed to add specific indicators to the second and third tiers variables proposed by McGinnis and Ostrom (2014). This work led to the formalization of 119 accurate variables at the third tier level.

Another major difficulty concerns the scientific analysis of the inter-relationships between subsystems and variables. Hinkel *et al*. (2015) showed that the SES framework *« does not capture interdependencies in complex commons where multiple types of actors carry out multiple activities that depend on and affect multiple RU and RS »* and does not represent the dynamic aspects of RU stocks and activities of actors. The PEGASUS project that used SES in case studies (e.g. Berriet *et al.*, 2016) pointed out similar problems with capturing the relations and interdependencies between the SES sub-systems.

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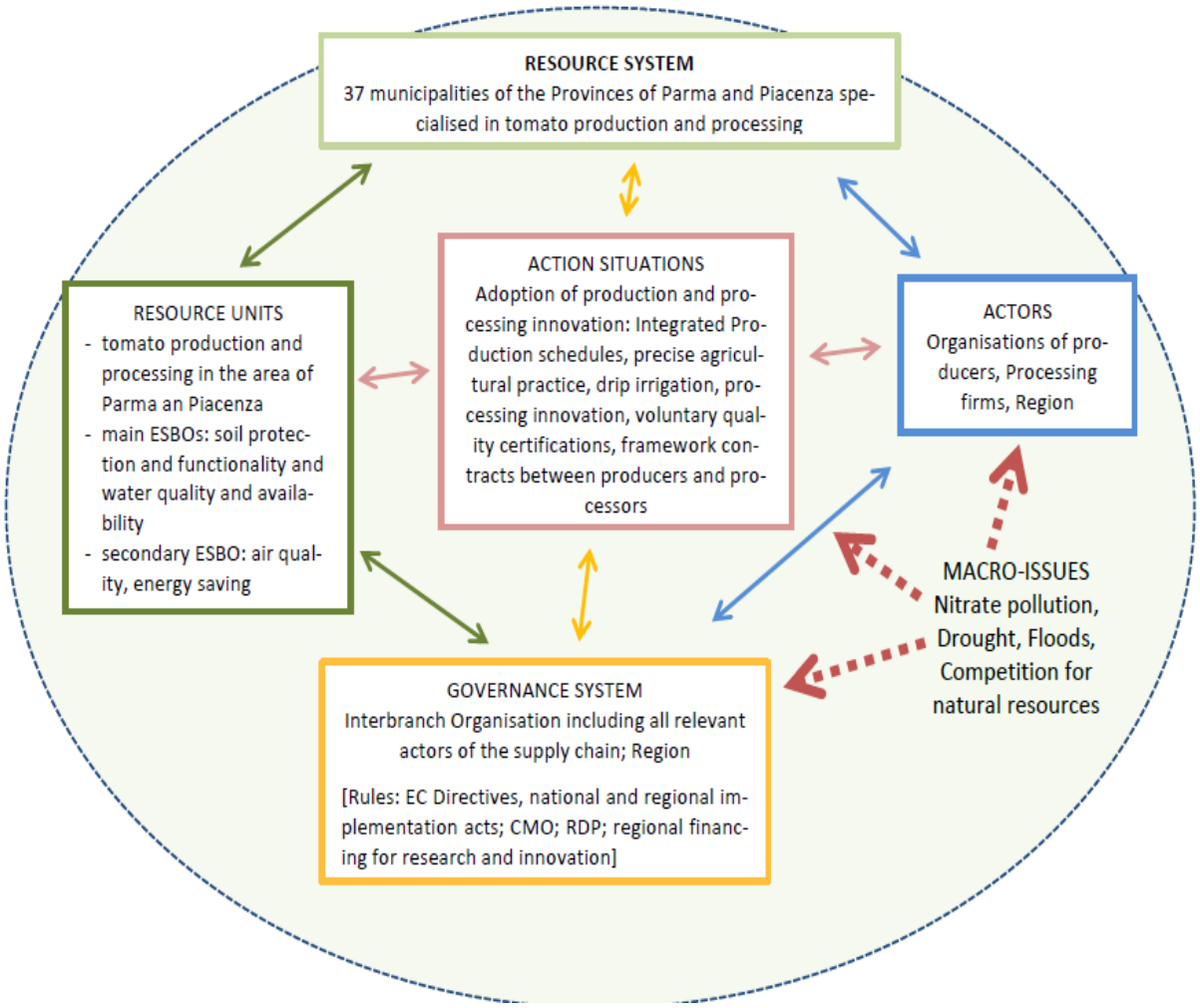

Figure 11. *SES in case studies from the PEGASUS project, ex. Tomato supply chain, Northern Italy.*

As scholars in PEGASUS wrote, it is quite difficult to restore a dynamic vision of the social-ecological system. Sub-systems shown in Figure 11 (case study, Tomato supply chain, Northern Italy) are in relation but the mechanisms of interactions between sub-systems and variables are not explicit.

To specify how relationships between variables will be established is a key challenge for an efficient implementation of SES framework. Authors, especially Poteete *et al.* (2009), refer to different methods (that will not necessarily be replicated in UNISECO):

- Modelling (agent-based models);
- Laboratory experiments (experimental economics);
- Empirically grounded case studies (statistical analysis, qualitative analysis and participative approaches);
- Use of the IAD (Institutional Analysis and Development) framework (Kiser and Ostrom, 1982) for institutional and governance analysis (Poteete *et al.*, 2009).

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To recap:

UNISECO will combine empirically grounded case studies with the use of decision support tools (Cool Farm Tool, SMART and COMPAS) to assess the performances of farms (WP3.2) and the use of Social Network Analysis (SNA) to identify the existing networks (WP5.2). This combination of approaches will considerably help to handle the problem of operationalisation and standardisation of the SES concept.

Finally, during the continuous operationalization of the SES framework there is a need to take care of the four main challenges identified in the PEGASUS project:

- the lack of a dynamic aspect in the framework, as it represents the situation at a given point in time;
- the substantial adjustments to the approach required for the case studies that did not consist of a clear geographical area;
- the difficulty to communicate the SES framework and terminology to stakeholders;
- the difficulty to deal with the scale of certain case studies which was such that the SES framework struggled with the complex situations involved;

SES concept is under permanent development, enrichment and evolutions, and a contribution to these enrichments is a challenge and an expected output for UNISECO.

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3. OPERATIONALIZATION OF AN ADAPTED SES FRAMEWORK AND GUIDELINES FOR ITS USE IN UNISECO

3.1. Specific Approach of the SES Framework for Analysing the Agro-ecological Transition of Farming Systems

In the literature, the SES framework was mainly used for the analysis of natural resource management. In the UNISECO project, the aim is to adapt the SES framework to allow analysing the transition of European farming systems towards agro-ecological farming and assessing their sustainability. The operationalization of SES for UNISECO is designed around the following core question: what are the actions initiated at different levels towards agro-ecological transition of farming systems and what are their performances? Figure 16 presents the different questions that each sub-system will aim at tackling. In the following paragraph, the adaptation of the SES framework to analysing and assessing agro-ecological transitions will be presented as well as the adapted list of selected variables for each of them.

In UNISECO Focal Action Situations relate to the actions, the rules and the possible collective organization undertaken towards agro-ecological practices and farming systems. Interactions (I) details these actions. Outcomes (O) is the sustainability assessment of these Interactions. The Outcomes box includes variables aiming at assessing the sustainability performances of the Focal Action Situations. It refers to different sustainability indicators. Firstly, at farm level, economic, environmental and social performances will be analysed in comparison with conventional farming systems through the use of the Decision Support Tools of WP3 (Cool Farm Tool, SMART and COMPAS). Secondly, at territorial level, WP4 (Assessment at territorial level) will provide an assessment of the implications of Focal Action Situations on territorial sustainability. To achieve this, different results of WP4 will be mobilized: Task 4.2 (Integration of environmental, social, economic benefits and impacts of status quo), Task 4.3 (Participatory scenario development of AEFS at EU level) and Task 4.4 (Territorial impact analysis (i.e. cost-benefits) of innovative strategies and incentives). Relevant complementary indicators in the Sustainability Assessment of Food and Agriculture systems (SAFA) (http://www.fao.org/nr/sustainability/sustainability-assessments-safa) will be assessed for their suitability in the farm level, territorial level and governance assessments and for inclusion in the decision support tools and modelling frameworks used in these assessments. A mapping exercise between SES variables and the sustainability indicators planned to be used in the assessments in WP3, WP4 and WP5 will be done to avoid major overlapping between the different WPs and to ensure a consistent basis for the integrated sustainability assessment in WP6.

In UNISECO, the Resource system (RS) will be the farming systems (from conventional to agro-ecological ones) in each case study. The Resource units (RU) will be both the production factors and the productions of the resource system (RS) so the agricultural productions at farm gate. The transformation and products sub-systems (TS and P) handle the organization of the transformation of agricultural products beyond farm gate.

The Actors (A) sub-systems will focus on stakeholders dealing with agriculture and agro-ecological issues (e.g. farmers, agricultural organizations, actors of the food system from producer to consumer, environmental NGOs, state representatives…): who the concerned actors are, what their interests and logics are and what their vision of agroecology is. The Governance (G) sub-systems will enable to analyse the rules and collective organisations governing the SES. Sub-systems Actors and Governance will be mainly described and analysed in WP5 (Task 5.2).

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Finally, Social, Economic and Political Settings (S) and Related Ecosystems (ECO) allow specifying important contextual factors.
By handling these different sub-systems, the SES framework enables the analysis of the sustainability performances of the studied farming systems but also to understand the drivers and barriers that foster and hinders agro-ecological transitions of farming systems. It thus enables the consideration of which institutional changes might induce agro-ecological transitions of farming systems.

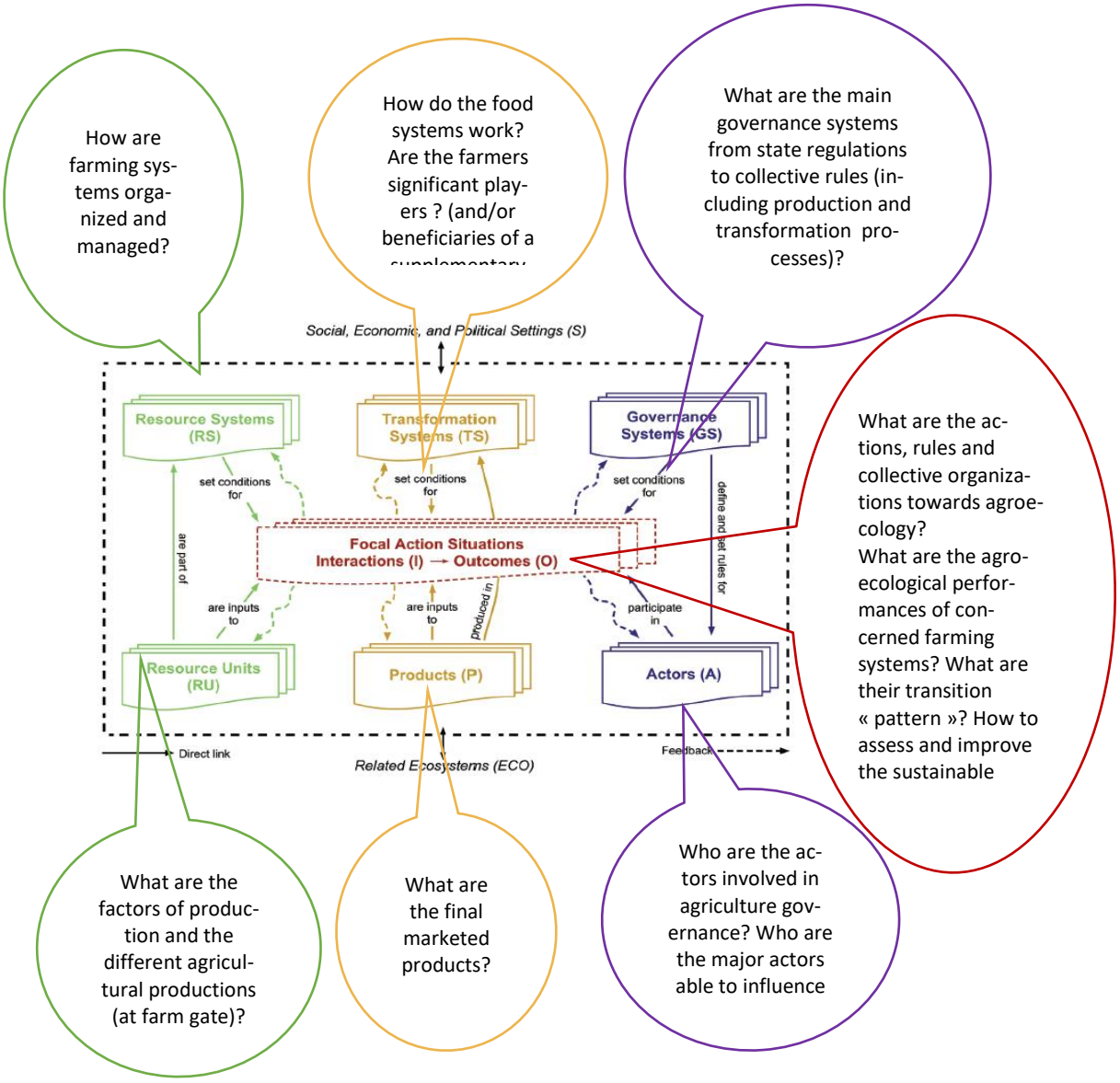

Figure 16. *Specific questions for each sub-system.*

The different work packages of UNISECO will contribution to the SES analysis and collecting data related to different sub-systems. Here are a few examples of some work packages contributions:

- WP3 (Assessment at farm level) for outcomes, resources and resource units sub-systems
- WP4 (Assessment at territorial level) sustainability impacts of the outcomes at territorial level. The conceptual framework needs to be linked with WP4 in two ways: Input from WP4 to the analysis of the external settings of the case study SES and assessment of the territorial sustainability implications of the outcomes / performance assessment

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- WP5 (Governance and policy assessment) for actors and governance sub-systems;
- WP7 (Multi-actor engagement) for participation of actors.

3.2. Modified SES Framework for UNISECO

Table 7 presents the Marshall SES framework (2015) with in red second-tier variables modified or suppressed for UNISECO. Table 8 presents the consolidated variables for UNISECO. The objectives of these modifications are:

- To adapt the SES framework to the specific issue of agro-ecological transition of agriculture;
- To handle the limits of the SES discussed in the previous chapter;
- To simplify and to operationalize the SES in the frame of UNISECO project and its different WP (WP3, WP4, WP5, WP6, WP7).

The UNISECO adapted SES framework to assess sustainability and to handle drivers and barriers of agro-ecological transition is presented in the following paragraphs for each sub-system (see 3.4 Guidance on the detailed UNISECO SES framework). It is organized as follow:

- Name of the variable (Marshall classification) (Figure 16);
- Description of the variable for UNISECO;
- Additional comments;
- Example of use;
- Data collection (format and sources).

The analysis of the SES of each case study refers to WP 3 Task 3.1 (description and assessment of the SES in the case studies), which informs subsequent tasks in WP3, WP4 and WP5 and the synthesis of an integrated sustainability assessment of AEFS in WP6 (Task 6.2) as well as WP2.4 (practical validation of the conceptual framework and recommendations for future applications) and their corresponding deliverables:

- D 3.3 Story maps of the SES of each case study (summary of each case study) (month 17);
- D3.4 Report on key barriers of AEFS in Europe and co-constructed strategies to overcome them (month 23)
- D4.2 Report on participatory scenario development of AEFS (month 26)
- D3.5 Report on sustainability trade-offs of innovative management strategies, market incentives and policy instruments at farm level (month 27)
- D3.6 Update Story Maps on lessons learnt from each case study (month 28)
- D4.3 Report on territorial impacts of the diffusion of AEFS under scenarios (month 30)
- D 6.2 Synthesis report of the integrated sustainability assessment (month 33);
- D 2.3 Report on practice-validated SES framework for sustainability assessment of farming systems and recommendations for future applications (month 36).

The template presented below has to be filled in for each case study and has to be supplemented by:

- A figure showing the main interactions between variables;
- A case study analysis describing the SES (5 to 10 pages) and explaining the interactions between variables.
- The sustainability assessment (Box Outcomes in Focal Action Situation) is not yet finalised. As explained above a mapping exercise between SES variables and sustainability indicators to use in the assessments in WP3, WP4 and WP5 will be done further to finalise a list of indicators at farm level, territorial level and governance assesments.

To help each partner to achieve the SES analysis of his case study this report contains an example of the use of the SES framework: the agro-ecological transition of the agriculture of the PDO Bleu du Vercors Sassenage cheese (Vercors, France).

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Table 7. *Selected and modified variables of the Marshall (2015) SES framework.*

Social, economic, and political settings (S) S1- Economic development. S2 - Demographic, social and cultural settings. S3 political stability S4 - Other governance systems. S5 - Other markets. S6 - Media organisations. S7 - Other technology and infrastructure. S8 – History		
Resource systems (R)	**Transformation systems (T)**	**Governance systems (GS)**
R1 Sector :	T1 Sector	GS1 Policy area
R2 **Perimeter** and clarity of system boundaries	T2 ~~Clarity of system bounda~~Clarifications of T1 sector	GS2 Geographic scale of governance system
R3 ~~Size of resource system~~ **Number and size of farming systems**	T3 Size of transformation system	GS3 Size of population involved or affected
R4 Human-constructed facilities	T4 Human-constructed facilities	**GS4 Rules and regulations: property rights systems** (G5 to GS9 are now sub-variables of GS4
R5 Productivity of system	T5 Productivity of system	~~GS5 Rule-making organisations~~
R6 Equilibrium properties **of farming systems**	T6 Equilibrium properties	~~GS6 Rules-in-use~~
R7 Predictability of system dynamics	T7 Predictability of system dynamics	~~GS7 Property-rights systems~~
R8 Storage characteristics	T8 Storage characteristics	~~GS8 Repertoire of norms and strategies~~
R9 Location	T9 Location	~~GS9 Network characteristics~~
R10 Inputs	T10 Inputs	~~GS10 History~~ G5 monitoring and sanction
Resource units (RU))	**Product (P)**	**Actors (A) (descriptive variables for each actor)**
RU 0: types of products (farm gate)	**P0: diversity of Products (processed products)**	**A0 Description and role of the actors in the system**
RU1 Resource unit mobility	P1 Product mobility	A1 Number of actors
RU2 Growth or replacement rate	P2 ~~Growth or replacement rate~~ Substitutability of the product)	A2 Socio-economic attributes
RU3 Interaction among resource units	P3 Interaction among products	A3 History or past experiences
RU4 Economic value	P4 Economic value :	~~A4 Location~~ : information not so crucial
RU5 Number of units	P5 Number of units	A5 Leadership / entrepreneurship
RU6 Distinctive characteristics	P6 Distinctive characteristics	A6 Norms (trust-reciprocity) / social capital **FUSION WITH A7 "mental model**
RU7 Spatial and temporal distribution	P7 Spatial and temporal distribution	A7 Knowledge of SES / mental models/Norms
RU8 Marketing characteristics	P8 Marketing characteristics	~~A8 Importance of resource (dependence)~~ Vision of agro-ecology ~~A9 Technologies~~
Action Situations: Interactions (I) ➔ Outcomes (O)		
Interaction = Activities and Processes		**Outcome criteria**
I1 Harvesting I2 Information sharing I3 Deliberative processes I4 Conflicts I5 Investment activities ~~I6 Lobbying activities~~ fusion with I8 ~~I7 Self-organising activities~~ Fusion with I8 Networking activities I9 Monitoring and sanctioning activities ~~I10 Evaluative activities~~ Fusion with I 9 ~~I11 Transformation activities~~ redundant with TS I12 Exchange activities		O1 Social performance O2 Ecological performance measures O3 ~~Externalities to other SESs~~ economic performance O4 Externalities to other SESs
Related Ecosystems (ECO) ECO1- Climate patterns; ECO2 - Pollution patterns; ECO3 - Flows into and out of focal SES		

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Table 8. *Consolidated selected and modified variables of the Marshall (2015) SES framework (Variables renumbered as some variables of the initial framework have been deleted).*

Social, economic, and political settings (S) S1- Economic development. S2 - Demographic, social and cultural settings. S3 – political stability S4 - Other governance systems. S5 - Other markets. S6 - Media organisations. S7 - Other technology and infrastructure. S8 – History		
Resource systems (RS)	**Transformation system (TS)**	**Governance system (GS)**
R1 Sector	T1 Sector	GS1 Policy area
R2 Perimeter and clarity of system boundaries	T2 Clarifications about T1 sector	GS2 Policy area : Non-Governmental organisations
R3 : Number and size of farming systems	T3 Size of transformation system	GS3 Decision making structures
R4 Human-constructed facilities	T4 Human-constructed facilities	GS4 Rules-in-use- property rights
R5 Productivity of system	T5 Business relationships along the transformation system	GS5 Monitoring and sanctions
R6 Equilibrium properties of farming systems	T6 Equilibrium properties	
R7 Predictability of system dynamics	T7 Predictability of system dynamics	
R8 Storage characteristics	T8 Storage characteristics	
R9 Location	T9 Location/Geographical distribution	
R10 Input	T10 Inputs	
Resource units (RU)	**Products system (P)**	**Actors (A)**
RU 0: types of products	P0: Diversity of Products	A0 Description and role of the actors in the system
RU1 Resource unit mobility	P1 Product mobility	A1 Number of actors/purposes/actions
RU2 Growth or replacement rate	P2 Substitutability of the product	A2 Socio-economic attributes
RU3 Interaction among resource units	P3 Interaction among products	A3 History or past experiences
RU4 Economic value	P4 Economic value	A4 Leadership / entrepreneurship
RU5 Distinctive characteristics	P5 Number of units	A5 Knowledge of SES / mental models Norms
RU6 Spatial and temporal distribution	P6 Distinctive characteristics	A6 Vision of agro-ecology
RU7 Marketing characteristics	P7 Temporal distribution	
	P8 Marketing characteristics	
Action Situations: Interactions (I) ➔ Outcomes (O)		
Interaction/Activities and Processes		**Outcome criteria**
I1 Harvesting I2 Information sharing and self-organising activities I3 Deliberative processes I4 Conflicts I5 Investment activities I6 Networking and Lobbying I7 Evaluative activities and monitoring and sanction activities I8 Exchange activities		O1 Social performance O2 Ecological performance measures O3 Economic performance O4 Externalities to other SESs
Related Ecosystems (ECO) ECO1- Climate patterns; ECO2 - Pollution patterns; ECO3 - Flows into and out of focal SES		

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3.3. An Example of a SES Case Study: Bleu du Vercors-Sassenage a PDO cheese (France)

To operationalize the SES framework adapted for UNISECO project[9] we test it on a case study: Bleu du Vercors-Sassenage, a PDO (Protected Designation of Origin) cheese aiming at safeguarding the dairy and cheese activities of le Vercors and maintaining the economic viability of farms. The specification rules for this PDO cheese are based on the use of local resources (meadows, alpine pastures, dairy breeds, local know-how) and reveal a dynamics towards an agro-ecological agriculture.

This example could be seen as a partial premise of the description and the assessment of a SES in the case studies as planned in Task 3.1 (Description and assessment of the SES in the case studies) and to finalize in a story map (D3.3 Story maps of the SES of each case study).

The Bleu de Vercors-Sassenage cheese and its related agriculture have experienced great changes over the past thirty years (S8). The cheese "Bleu du Vercors Sassenage" had the official label of origin PDO since 1998. Its differentiation is based on a territory and even more a « terroir » (a part of the Natural Regional Park du Vercors, a unique recipe for the cheese and local breeds for cattle (P6) (Montbéliarde, Abondance and Villard-de-Lans or "villarde"). This patrimonial approach for maintaining the local farming systems is a major rupture with the mainstream agriculture in which the farmers were involved during the 20th century (S8, T2). It tends henceforth, to be a showcase for vercorian mountain products (RU0, P8).

The agro-ecological transition of PDO Bleu du Vercors and its farming systems involves all the subsystems of the SES framework (Figure 17):

- Focal action situation
- Resource system and resource units referring to farming systems
- Transformation systems and products referring to the food system;
- Governance system and actors referring to the rules and decision process;
- Social, economic and political settings.

3.3.1. The natural regional park of Vercors

The Vercors Park is characterized by an area of high nature value and important touristic frequentation (Figure 18). The park institution (A5) plays a crucial role in biodiversity and landscapes preservation and in the promotion of green tourism (A1, A2). The agricultural advisor of the Park participates to the local governance of agricultural development (A2, GS2).

The park area covers the well-defined Massif du Vercors that stands 1000 meters above the surrounding plains and valleys (R2). During the last 30 years, peri-urbanization that has been sprawling in the valley around the main towns like Grenoble, Romans, Valence is now beginning to change the landscape of the plateau (S2b). Urban pressure is now considerable in the north part of le Vercors around ski resort stations and near surrounding cities: the price for building land is 700 times more expensive than ordinary meadows price (S2c). Moreover, this happens in a place where people, particularly farmers, have one of the lowest income level of both Isère and Drôme departments (S1c). This pressure on land is related both to a demographic increase (S2a) with the arrival of neo-rural

[9] This case study has been mainly written as an example for the application of the SES framework in Task 3.1 Description and assessment of the SES in the case studies (and Task 3.3 In-depth analysis of drivers and barriers in AEFS and co-construction of innovative strategies). As the indicators for the sustainable assessment of AEFS are not yet finalized it doesn't highlight the guidance of the SES conceptual framework for the other relevant Tasks in UNISECO.

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inhabitants working in near cities and to winter and summer visiting tourists. The increase in house prices hinder the local lowest social categories to buy their own ones.

For agricultural land, we observe also two evolutions of land uses: abandonment of slopes with scrublands dynamics and intensification of flat areas (temporary meadows and high level of fertilization).

3.3.2. The PDO Bleu du Vercors-Sassenage

With a production of around 350 tons of cheese per year and a low number of farmers (around 70 including 10 farmers processing their milk in their farms, the others deliver their milk to the cooperative Vercors-Lait or for some to private companies), Bleu de Vercors-Sassenage (R2) is one of the smallest French PDO (R3). The PDO's area covers 27 municipalities located only on the Vercors plateau and is entirely included in the perimeter of the Regional Park of Vercors.

After a relative wealthy period during the 20th century the volumes of Bleu produced in dairy farms decreased sharply, from the 1980s to the 1990s (S8), suffering competition from other industrial blue cheeses (P2). The dairy cooperative "Vercors-Lait", established in 1956, belonged to a private group until 2003 when the farmers took over the management. The co-op headquarters are at Villard-de-Lans, in the heart of the mountain massif of Vercors (department of Isère). Currently Vercors-Lait processes the milk of 35 farms including 11 organic farms. The cooperative markets directly its products through three stores, one at the headquarters and two in the nearby towns of Grenoble and Romans. The co-op employs about 32 people.

Vercors-Lait is the only co-op that processes and markets the cheese "Bleu du Vercors-Sassenage" which has had an official label of origin (protected designation of origin - PDO) since 1998. It also produces a wide range of local cheeses (Vercorais, Saint-Marcellin, Saint-Félicien) and some of them are certified organic. Nearly 550 tons of cheeses are produced each year including 255 tons of Bleu du Vercors and almost six million litres of milk are collected. Smaller quantities of Bleu are produced by around 10 farmers in their farms and by a limited number of private dairies (Figure 19). Due to insufficient markets for the co-op's own products, 35% of the milk is sold to an industrial cooperative and a private company. The values upheld by the cooperative and communicated to consumers are the safeguarding of the dairy and cheese activities of the Vercors and maintaining the economic viability of farms. These values combine a passion for the farming profession and the unique mountain terroir products produced in a "gentle, reasoned and environmentally friendly manner".

The farmers producing some Bleu du Vercors on their farm obtain a good price for their milk. As for the co-op, it has paid farmers a slightly higher rate than standard prices (around 20% higher than departmental price in 2017) for the last three years only and yet, providing this small price premium remains a major challenge. In terms of end products, the co-op has refocused on producing a wide range of products grouped together under the brand "Vercors-Lait" cheese because the initial strategy of producing only the Bleu du Vercors Sassenage cheese was not successful. The co-op diversifies its products for local and tourist consumers.

The new strategy of the cooperative, which includes products for local consumers and tourists, represents a major change compared to the narrow prior strategy of producing a single PDO product linked to its terroir. This new model involves equally the design and the implementation of a whole food system able to manage the supply chain from farmers to consumers.

The co-op is working in this way by developing both direct marketing and strategic partnerships with distributors and retailers such as restaurants and cheese retailers.

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3.3.3. Barriers and related drivers towards agroecology

The analysis of the SES Bleu du Vercors-Sassenage allows the identification of three barriers towards agroecology.

The first one is an economic barrier. In a competitive economic setting, milk price paid to the farmers remains insufficient. The goal of providing fair prices to farmers continues to be challenging and the managers of the co-op continue to regard the premium as “fragile”. With such uncertainty the maintaining of some farms is ”fragile” (O2) and farmers are not willing to take the risk of reducing the fodder autonomy of their farm by implementing extensive practices in favour of biodiversity and environment (A6). The relatively low and uncertain milk valorisation requires a strong technical-economic performance in the management of fodder surfaces. Environment and biodiversity are often perceived as a luxury in the current economic context (A6). This point of view of the farmers’ cooperative is opposed to the environmental approach of NGOs, which share, nevertheless, farmhouse producers’ viewpoint (I4).

Farmers delivering their milk to dairies have a crucial need to produce high quantity of quality forages with an economic efficiency. To achieve this, they establish temporary meadows and intensify their agricultural practices (I1). Nevertheless their practices remain based on organic manure with limited use of chemical fertilizers (30 to 50 units of Nitrogen/year on intensive meadows, R10) and almost no pesticides. On flat areas, the manure application rates could be high (up to 40 tons/ha/year). Farmers producing farm cheese are not facing such economic constraints and are more open to develop more extensive practices. Providing fair prices to farmers depends on the successful development of the strategy of the cooperative (and of other dairies). It is the main driver towards a more agroecological and sustainable agriculture.

The second one is a social and governance barrier. The governance dealing with local agriculture and products is separated in three levels of governance. The first one concerns the valorisation and the marketing of products involving mainly the SIVER (interprofessional union of Bleu du Vercors-Sassenage) and the cooperative Vercors-Lait. The second one is related to environment and biodiversity preservation in agricultural and natural lands. It includes several experts of the Natural Regional Park, environmental NGOs and on a very secondary basis some farmers (GS3, GS4c/d). They work on the design and implementation of agro-environmental measures. The third one concerns technical advices for farmers involving agricultural advisors and farmers. The agricultural advisors of the NRP Vercors are involved in these three levels of governance. He ensures unformal links between these different levels of governance but these levels have different visions of what the main priorities for agriculture are: biodiversity preservation and extensive use of permanent meadows for NRP and environmental NGOs, fodder autonomy and intensification of the use of meadows with development of temporary grasslands for farmers and agricultural advisors, quality of animal feeding and strong efforts on the marketing of PDO Bleu. It produces strong controversies about agricultural land uses and fundamental oppositions. It won’t be efficient to move towards an unique place of governance for agriculture but a shared knowledge of the visions, priorities and strategies is a necessity. The issue is not to oppose intensive and extensive grasslands but to manage with a mutual understanding a sustainable equilibrium between them (O1).

Finally, the last barrier is related to climate change. The production of hay meadows and pastures are lower for several years due to climate change (droughts). In response, farmers develop temporary meadows with species drought-resistant. To obtain a good production level for these costly solutions to produce forage, farmers tend to increase their fertilization. Climate change will continue and there is a need to design efficient and sustainable solutions.

Beyond panaceas and blue print approach, drivers towards agroecology are diverse and related to different sub-systems of the SES framework: resource and transformations sub-systems, actors and

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governance sub-systems, economic setting and related ecosystems. There is a clear need for adapted solutions to the specific SES of Vercors and for each farmer to his own particular situation.

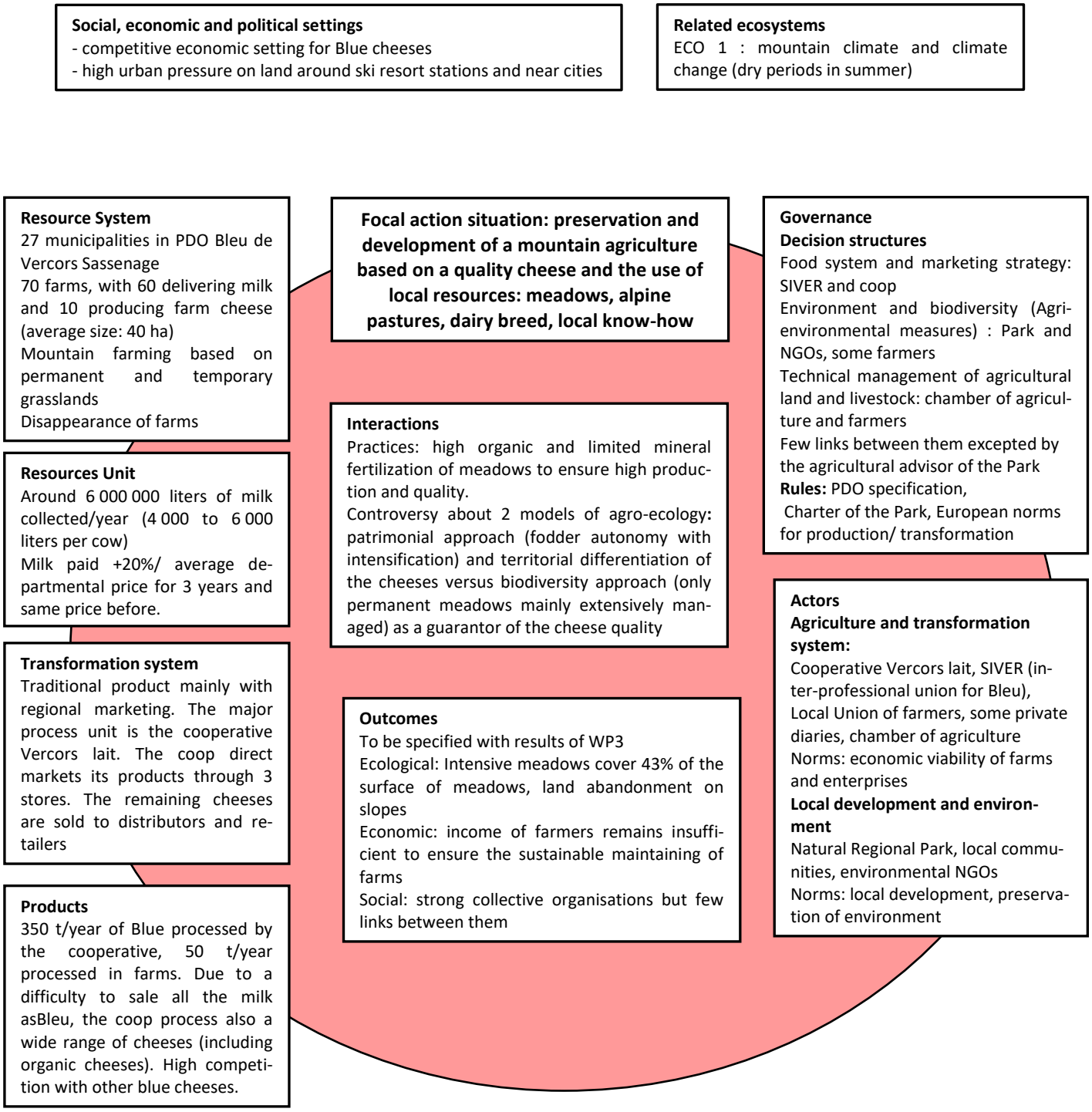

Figure 17. *The SES PDO Bleu du Vercors-Sassenage.*

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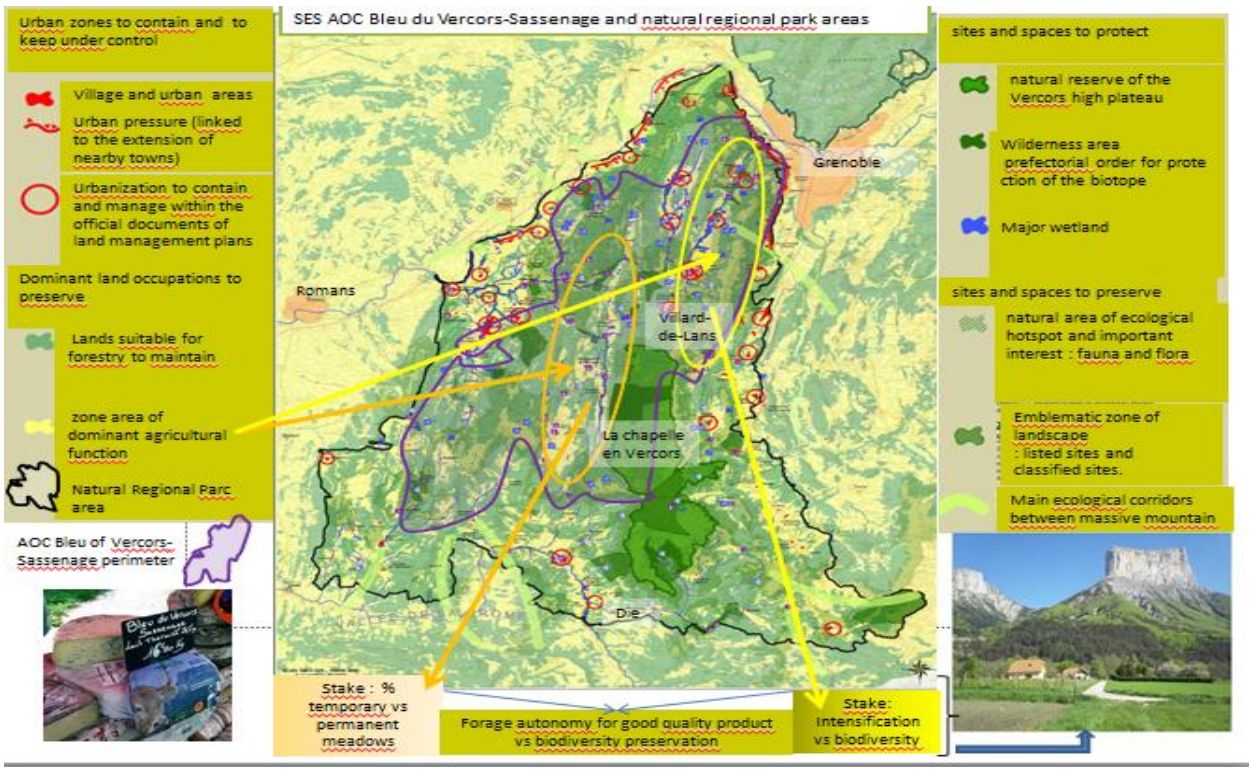

Figure 18. *The PDO Bleu du Vercors Sassenage and the natural regional park du Vercors areas.*

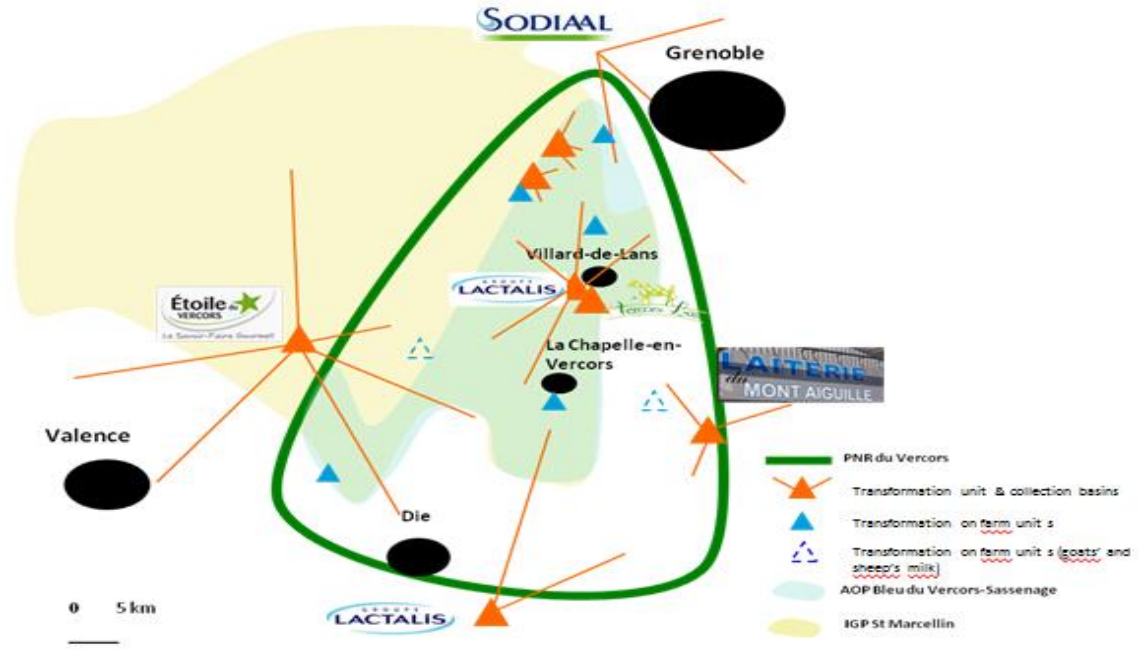

Figure 19. *The main milk collection basins and transformation units in SES Vercors (Source: Poisson, 2012).*

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3.3.4. Detailed list of variables: PDO Bleu du Vercors-Sassenage

3.3.4.1. Focal action situation

Description in one sentence of the action situation towards agro-ecological farming systems	Preservation and development of a mountain agriculture based on a quality cheese (Bleu du Vercors Sassenage) and the use of local resources (meadows, alpine pastures, dairy breed, local know-how)

Interactions

Interactions (I)	Description
I1 Harvesting	I1a Concrete practices of production *The preservation and development of a mountain agriculture based on the valorisation of a quality cheese (PDP Bleu du Vercors-Sassenage) is based on:* • *A combination of intensive management of flat meadows (high organic and limited mineral fertilization to ensure high production and quality of forages) and extensive management of remote or steep meadows and pastures. The trend is an increase of the intensification process (expansion of temporary meadows) and land abandonment in slopes* • *The maintaining of the use of alpine pastures mainly for dry cows and heifers (and sheep)* • *The preservation of a local breed of cattle (La Villarde), and its presence in each farm producing milk for the Bleu* • *The preservation of the local know-how for agriculture and cheeses processes* • *The processing of a diversity of cheeses next to the Bleu du Vercors to respond to local market needs* • *the implementation of a whole food system able to manage the supply chain from farmers to consumers based on local and regional market and a low number of intermediaries (the coop directly markets its products in 3 stores).*
I2 Information sharing and self-organising activities	Learning processes *Technical advices from advisors of the chamber of agriculture and of the Park, knowledge sharing between farmers*
I3 Deliberative processes	Decision level/stake ***Three levels of decision structures:*** • *Food system and marketing strategy: SIVER (inter-professional union for Bleu) and coop* • *Environment and biodiversity: Park and NGOs, some farmers* • *Technical management of agricultural land and livestock: chamber of agriculture and farmers* *Few links between them excepted by the agricultural advisor of the Park*
I4 Conflicts	Main conflict and actors involved *Controversy about 2 models of agro-ecology :* • *patrimonial approach (fodder autonomy with intensification of grasslands) and territorial differentiation of the cheeses: farmers delivering their milk to the cooperative and dairies* • *biodiversity approach (only permanent meadows mainly extensively managed) as a guarantor of the cheese quality: farmers processing the Bleu in their farms and environmental NGOs* *Controversy about the recipe of Bleu: raw milk (organic farms and producers on farmhouse) vs thermised milk (cooperative and private dairies).*
I5 Investment activities	Capacity of farmers or groups (for each sector) *Quite low for farmers because PDO milk does not have a sufficiently high added value* *Prudent for the cooperative due to the fragility of the economic balance, currently investment in the expansion of the building with very significant public supports*

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Interactions (I)	Description
I6 Networking and Lobbying	*Creation of the brand "Vercors-Lait" by the cooperative to promote a wide range of products* *Networking of the Park* *A project for the structuring of a local supply for holiday centers and school canteens*
I7 Evaluative activities and monitoring and sanction activities	*Quality criteria for products, controls for agri-environmental contracts*
I8 Exchange activities	*Research and development : involving farmers, agricultural advisors and scholars for improvement of biodiversity management*

Outcomes

In UNISECO, the outcomes at farming system level will be assessed with 3 Decision Support Tools (DST): Cool Farm Tool (CFT), SMART and COMPAS. At territorial level, WP4 (Assessment at territorial level) will provide an assessment of the implications of Focal Action Situations on territorial sustainability. Relevant complementary indicators in the Sustainability Assessment of Food and Agriculture systems (SAFA) (http://www.fao.org/nr/sustainability/sustainability-assessments-safa) will be assessed for their suitability in the farm level, territorial level and governance assessments (not available for Bleu du Vercors).

Outcomes of AEFS (O) Variables	Description
O1 Social performance measures	Quality of living standards for the farmers and also for the whole case study SMART outputs *Qualitative assessment: strong collective organisations but few links between them*
O2 Ecological performance measures	SMART and Cool Farm tool outputs *Qualitative assessment: intensive meadows cover 43% of the surface of meadows, land abandonment on slopes*
03 economic performances	Economic viability of AEFS COMPASS outputs *Qualitative assessment: income of farmers remains insufficient to ensure the sustainable maintaining of farms*
O4 Externalities to other SES	Only if relevant, economic, environmental or social externalities : no information

3.3.4.2. Resource system (RS)

Resource systems (RS) Second-tier variables	Description
R1 Sector	Types of agricultural productions FADN typology : *Specialist milk (45)*
R2 Perimeter and clarity of system boundaries	Place-based case study /network based case study Physical, administrative, policy or project boundaries *Place-based case study: The PDO area covers 27 communes located only on the Vercors plateau (departments of Isère and Drôme). This is the only French PDO cheese entirely included in a Natural Regional Natural Park (RNP). The production area is then "of a rare homogeneity"*
R3 : Number and size of farming systems	Number of farms, Average size of farms (ha, number of animals) *The PDO gathers about 70 farms of an average size of 40 ha. (20 to 40 dairy cows), half of which are in organic farming (AB). Around 10 farmers process their milk in their farms, other deliver their milk to the cooperative Vercors-Lait or to private companies.*
R4 Human-constructed facilities	Facilities for agricultural production *In general farms buildings are now modern and efficient*
R5 Productivity of system	Yield (t/ha or product per animal) and if possible economic value (Euro/t) *Production of milk per cow* *4000-6000 litres per year.*

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Resource systems (RS) Second-tier variables	Description
R6 Equilibrium properties of farming systems	Evolution of the number, type and size of the farming systems; *Strong decrease of the number of farmers* *Evolution of main land uses: two dynamics: abandonment of slopes with scrublands dynamics and intensification on flat areas (temporary meadows). Also urbanization of agricultural land around ski resort stations and near surrounding main cities.*
R7 Predictability of system dynamics	Capacity to estimate the future evolution and dynamics of the resource system *In spite of the economic difficulties of mountain farming (low milk price in the past years), there is a long tradition of cooperation between producers since the first quarter of the 20th century. It is an asset resulting now in an efficient collective organization (the cooperative Vercors-Lait) and in PDO product (le Bleu du Vercors-Sassenage). These collective actions are above all a strong willingness of farmers to decide and to manage their future.*
R8 Storage characteristics	To store resource units (at farm level or at collective level for a group of farmers *The milk is collected every day*
R9 Location	Geographical location of the farming systems: qualitative description. *The AOC Bleu is entirely included in Natural Regional Vercors Park* *This a mountain area with farms concentrated on flat areas* *Homogeneous distribution of the farms on the territory*
R10 Input	fertilizers, pesticides, concentrates, forages, water energy, … (in T/y or in €/y per farm or per ha) or qualitative evaluation of land management *Agricultural practices remain based on organic manure with limited use of chemical fertilisers (30 to 50 units of Nitrogen/year on intensive meadows) and almost no pesticides. On flat area, the manure application rates could be high (up to 40 tons/ha/year).* *Some farms buy forages to feed their cows. Concentrates are purchased outside the area.*

3.3.4.3. Resource units (RU)

Resource units (RU) Variables	Description
RU 0: types of productions	Present the diverse agricultural products of the SES (in a quantitative or qualitative way) *Cheese for 10 farms, milk for the other.* *Around 6 000 000 litres of milk collected per year with 1 500 000 litres of organic milk*
RU1 Resource unit mobility	Specify mobility of resources both for transformation and for marketing and specify where agricultural products are processed: inside/outside the farm; inside/outside the SES *Cf. above*
RU2 Growth or replacement rate	Qualitative assessment: are the quality and/or the yield of the products evolving? *The production of hay meadows and pastures are lower for several years due to climate change (droughts). In response, farmers develop temporary meadows with drought-resistant species.*
RU3 Interaction among resource units	Interactions between productions and between land uses. *There is a competition between temporary meadows (more productive, more expensive to implement and with less biodiversity) and permanent meadows (less productive, higher level of biodiversity). The area of temporary meadows increases*
RU4 Economic value	Selling price for producers: quantitative data (€/unit for each product) and qualitative assessment *Now for about 3 years, the price of the milk paid to farmers delivering their milk to the cooperative is* around 20% higher than departmental price in 2017 (370 to 375 euros for 1000 litres paid by the cooperative and 300 to 310 euros in average in the department). We have no information for the price paid to farmers delivering their milk to private companies. For farmers processing their milk in cheese the price remains largely higher and profitable
RU5 Distinctive characteristics	**Distinction which can allow to distinguish categories in the resource** *Organic and conventional milk*
RU6 Spatial and temporal distribution	**Main spatial and temporal distribution of production** *Nothing to report*
RU7 Marketing characteristics	How and to who are sold the products by the farmers? *See transformation system and products*

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3.3.4.4. Transformation system (TS)

Transformation system (TS)	**Description**
T1 Sector	general characteristics of the transformation sub-system *Type 3: Traditional and typical products (origin labelled products) mainly with regional marketing*
T2 Clarification of T1 sector	Clarification of T1 sector *Around 10 farmers produce farm cheese for direct selling* *Cooperative Vercors-Lait direct markets its products through three stores, one at the headquarters and two in nearby towns of Grenoble and Romans. The remaining cheeses are sold to distributors and retailers such as restaurants and cheese retailers. The market is mainly local and regional.* *Private cheese dairies work as the cooperative Vercors lait*
T3 Size of transformation system	Volume produced and value of sold products ➔ *about 30t/year of Bleu du Vercors-Sassenage PDO cheese produced on farmhouse by farmers* ➔ *350 t/year of Blue cheese processed in the cooperative Vercors-Lait for a total of 600 t/year of diverse cheeses* *In comparison with other French PDO cheeses Bleu du Vercors Sassenage is a very small PDO (less than 500t/year for the Bleu du Vercors compared to more than 60 000 t/year for PDO Comté, a famous cheese.* *The retail price for Bleu du Vercors is around 20 euros/kg, this is an average price for PDO cheese*
T4 Human-constructed facilities	Logistics and facilities to collect the products from the farm to their storage or processing place *Cheese dairies to process the milk into cheese. The buildings of Vercors lait use renewable energy (wood)*
T5 business relationships along the transformation system	*Farmers producing farm cheese for direct selling establish their price and as this cheese is rare the selling price is high* *For the farmers delivering their milk to the cooperative the price of the milk is depending on the economic results of the cooperative.* *The business relationships between the cooperative and distributors are pure market relationships depending on the demand for Bleu du Vercors*
T6 Equilibrium properties	*In the recent period we observe a disappearance of small transformation units. The period is favourable to both farm cheese and medium size transformation units as cooperative Vercors-Lait*
T7 Predictability of system dynamics	Capacity to estimate the future evolution and dynamics of the transformation system *The current strategy of the cooperative associating Bleu du Vercors and a diversity of cheeses to respond to the local demand of consumers seems an efficient and sustainable strategy*
T8 Storage characteristics	Importance of the storage in the cost of production high, medium, low *Medium because the maturing of the Bleu du Vercors remains not too long (at least 3 weeks while 6 months for other cheeses)*
T9 Location/Geographical distribution	-If relevant could be used to specify some geographical information about the location to store, process or sell products *To collect milk in mountain in isolated farm and to process it in small dairies are too costly for private operators established outside the local area*
T10 Inputs	-to specify other inputs than agricultural products *No significant input (excepted energy for the buildings and the cheese process)*

3.3.4.5. Products (P)

Products system (P)	**Description**
P0 diversity of Products	List of the different processed products *Due to a difficulty to sale all the milk in Bleu du Vercors, the cooperative Vercors-Lait (and private cheese dairies) produces a wide range of local cheeses (Bournette, Vercorais, Vercorette, St Félicien, St Marcellin, Brique, Petit frais du Vercors, yoghurt, skimmed milk) and some of which are certified organic*
P1 Product mobility	Only if relevant

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<table>
<tr><th>Products system (P)</th><th>Description</th></tr>
<tr><td>P2 Substitutability of the product</td><td>Bleu de Sassenage cheese is a very specific product: so low substitutability... However, it belongs to the blue-veined cheeses manufactured and there are a lot of competitors in this sector. Thus for the consumer the product without being substitutable is easily replaceable by another blue cheese. There is a need for an efficient marketing strategy: "We should now find something more innovative that positions it relatively to other blues and gives it an identity that could be exported out of the territory" (SIVER)
<table>
<tr><th>Substitutability

Competition</th><th>LOW
Specific products</th><th>HIGH
Mainstream products</th></tr>
<tr><td>Low (few competitors)</td><td>no</td><td>No</td></tr>
<tr><td>High (many competitors)</td><td>Bleu du Vercors Sassenage</td><td>No</td></tr>
</table></td></tr>
<tr><td>P3 Interaction among products</td><td>Competition or complementarity between products
Strong complementarity between products processed in the SES : for example,
-the cooperative is promoting the creation of a local products store featuring Bleu with a range of other cheeses, as well as many other products.
-Research of complementarity of PDO label and Vercors Park brand for many local products ➔ but risk of confusion for the consumer
-a project to structure a local supply for holiday centres and school canteens (Health Food Territory program)</td></tr>
<tr><td>P4 Economic value</td><td>Final economic value of the products and breakdown of the added values between he farmers and intermediaries
Now for about 3 years, the price of the milk paid to farmers delivering their milk to the cooperative is around 20% higher than departmental price. There is no information for the price paid to farmers delivering their milk to private enterprises. For farmers processing their milk in cheese the price remains largely higher and profitable.</td></tr>
<tr><td>P5 Number of units</td><td>Volume processed /transformation Unit
Cf TS1</td></tr>
<tr><td>P6 Distinctive characteristics</td><td>P6a) Distinctive characteristics of the processed products for the consumer:
-PDO Bleu du Vercors Sassenage,
-Possible use of Park brand for other agricultural and local products</td></tr>
<tr><td>P7 Temporal distribution</td><td>Only if relevant, i.e. if there are seasonal variations of distribution
Not relevant</td></tr>
<tr><td>P8 Marketing characteristics</td><td>Market position of the products
The customers of Bleu du Vercors-Sassenage and other complementary cheeses remain local and touristic.
The promotion of the PDO bleu is organized collectively with the support of the SIVER and of the natural regional park. The festival of the Bleu on the territory of the Park constitutes a major activity of promotion</td></tr>
</table>

3.3.4.6. Governance (G)

Governance system (GS)	Description
GS1 Policy area : Governmental organizations (or agency linked with)	Relevant policies areas for the SES organized by geographic scale *EU : CAP plus European legislation about organic products and labels of origin (INAO)* *National legislation and government: agricultural and environmental policies* *Regional government: Council of Rhône-Alpes Region: financial support for the cooperative* *Local communities: Intermunicipalities des Quatre Montagnes, municipality of Villard-de-Lans,* *Regional Park of Vercors: policies in favour of tourism to develop rural accommodation at the farm, financial support for the cooperative*

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Governance system (GS)	Description
GS2 Policy area : Non-Governmental organisations	Relevant policies areas for the SES organized by geographic scale *Environmental NGO's (regional level) Ligue de protection des oiseaux, Greenpeace* *Farmers organisations (departmental and local levels), SIVER (defence of Bleu AOP)* *private and cooperative companies related to transformation system: cooperatives SODIAAL and Vercors-Lait*
GS3 Decision making structures	Relevant decision making structures (including network structures) concerning agriculture and agroecology ***Decision structures*** *Food system and marketing strategy: SIVER and coop* *Environment and biodiversity (Agro-environmental measures) : Park and NGOs, some farmers* *Technical management of agricultural land and livestock: chamber of agriculture and farmers* *Few links between them excepted by the agricultural advisor of the Park*
GS4 Rules and regulations: property rights systems	*G4a) the Bleu du Vercors-Sassenage is protected by a label of origin (PDO) based on local breed of cows, a recipe for cheese, a terroir* *G4d) Access and uses of common pastures are regulated in each local community by traditional rules and in the High Plateaux Reserve of Vercors by an environmental regulation* *G4e) Respect of the competition rules: the rule to sale products for public catering is defined by the French Code of Public Procurement contract*
GS5 monitoring and sanction	Only if some more general information than in focal action situation is useful to mention *The specifications of the PDO Bleu du Vercors are regularly discussed and modified. These debates are the place for conflicts and controversies as we explained that in the sub-system "focal action situation".*

3.3.4.7. Actors (A)

Actor	Variable	Description
State and European Government	**A0 Description and role of the actors in the system**	DRAAF (administration representing the Sate at regional level)
	A1 Number and type of relevant actors/purposes/ actions	
	A2 Socio-economic attributes	National public fund management (and partly for European funds) authority and control,
	A3 History or past experiences	Accompanying agricultural development projects
	A4 Leadership / entrepreneurship	+++: on contribution of funds + project content
	A5 Norms / social capital Knowledge and mental models	European and national norms and laws; Compliance with competition laws.
	A6 vision of agro-ecology	Agro-ecology as defining in French national law: weak-agroecology and implementation at field level, European partnership for innovation and groups of farmers towards agro-ecological transition
Actor	**Variable**	**Description**
Regional Government	**A0 Description and role of the actors in the system**	Regional Council, in charge of the management of regional European funds (EARDF)
	A1 Number and type of relevant actors/purposes/ actions	
	A2 Socio-economic attributes	Public EARDF funds co-financing on project in PSADER program (Agricultural and Rural Development Strategic Project)
	A3 History or past experiences	Subsidies for agricultural development in Rhône-Alpes

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	A4 Leadership / entrepreneurship	++: financial support for local projects ++: objectives and priorities of local projects
	A5 Norms / social capital Knowledge and mental models	Regional supply chains/ local agriculture, European orientations Adjustment to regional policies
	A6 vision of agro-ecology	Emphasizes economic sustainability of agriculture and its contribution to local development
Actor	**Variable**	**Description**
Local level authorities	**A0 Description and role of the actors in the system**	Natural regional parc of Vercors
	A1 Number and type of relevant actors/purposes/ actions	Sustainable development of the territory. Preservation and management of biodiversity Participation to local governance of dairy farms development
	A2 Socio-economic attributes	Public co-financing + provision of agricultural advisor
	A3 History or past experiences	Preservation of environment and local development purpose: local heritage, eco-tourism, the Villarde breed of cow…
	A4 Leadership / entrepreneurship	+++: actions in favor of environment and local development +++: design of projects and obtaining public subsidies at departmental and regional levels
	A5 Norms / social capital Knowledge and mental models	Respect of local collective heritage Development based on local resources Contribution of dairy farms to local development
	A6 vision of agro-ecology	Agroecology as a complex agriculture including both environmental friendly practices, local know-how and resources (bleu de Sassenage cheese, local dairy cow breed) and implementation of agroecology both at territorial and food systems levels
Actor	**Variable**	**Description**
Local level authorities	**A0 Description and role of the actors in the system**	Intermunicipalities of « Vercors 4 Montagnes »
	A1 Number and type of relevant actors/purposes/ actions	Participation to local governance of dairy farms development, Economic and political support to the farmers' cooperative
	A2 Socio-economic attributes	Public
	A3 History or past experiences	Maintaining economic activities and social life present on the territory
	A4 Leadership / entrepreneurship	+++ purchase of the dairy buildings to relieve the cash flow of the cooperative 2007
	A5 Norms / social capital Knowledge and mental models	Local development and responses to the needs and wishes of inhabitants
	A6 vision of agro-ecology	Mainly motivated by traditional farming activities
Actor	**Variable**	**Description**

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Agricultural and products organisations	**A0 Description and role of the actors in the system**	SIVER (interprofessional union of « bleu »)
	A1 Number and type of relevant actors/purposes/ actions	Defence and management organization (ODG) of the PDO
	A2 Socio-economic attributes	No information
	A3 History or past experiences	Initially an interprofessional union of Bleu du Vercors-Sassenage,
	A4 Leadership / entrepreneurship	+++ for promotion of Bleu de Vercors-Sassenage
	A5 Norms / social capital Knowledge and mental models	Regulations related to PDO specifications
	A6 vision of agro-ecology	No information
Actor	**Variable**	**Description**
Farmers delivering their milk to the cooperative	**A0 Description and role of the actors in the system**	Strong defence of local production
	A1 Number and type of relevant actors/purposes/ actions	60/70
	A2 Socio-economic attributes	Individual farms
	A3 History or past experiences	farmers were mobilized to work with the Park; they created in 1970 the APAP (Association For the Promotion of the Park Vercors' Farmers)
	A4 Leadership / entrepreneurship	+++: on decision concerning requirement specifications for PDO cheese + in natural regional park
	A5 Norms / social capital Knowledge and mental models	Maintaining and viability of their farms Quality and quantity of forages to feed their dairy cattle
	A6 vision of agro-ecology	Improvement of feed autonomy of farms is a priority. This autonomy could be achieved in an agro-ecological way by the efficient use of organic manure without important use of chemicals: "[If] I mow early, I know that I gain in quality, but I lose in quantity. But will it go anyway or will I have to buy hay after? " In mountain areas 'it is not possible to impose on producers additional constraints for environmental reasons and because the PDO does not bring yet a significant added value to the price milk of the co-operators.
Actor	**Variable**	**Description**
Farmers producing Bleu du Vercors in their farm	**A0 Description and role of the actors in the system**	
	A1 Number and type of relevant actors/purposes/ actions	10
	A2 Socio-economic attributes	Individual farm
	A3 History or past experiences	Farmers also mobilized in the past with other farmers
	A4 Leadership / entrepreneurship	++: lower power than farmers of the cooperative in the collective organization for the cheese (SIVER)

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	A5 Norms / social capital Knowledge and mental models	Maintaining and viability of their farms easier due to higher prices for their milk (direct sales of processed cheeses) Face to face relationships with consumers and inhabitants Preservation of biodiversity and traditional practices
	A6 vision of agro-ecology	Extensive practices (low level of fertilization, late hay cutting date) to maintain biodiversity. Such type of practices are consistent with their farming activities
Actor	**Variable**	**Description**
Supply chain actors 1	**A0 Description and role of the actors in the system**	
	A1 Number and type of relevant actors/purposes/ actions	Vercors Milk: dairy cooperative - 34 members - 18 employees - € 5 million turnover
	A2 Socio-economic attributes	Cooperative
	A3 History or past experiences	Created in 1956, very active player for bleu de Vercors Sassenage After having belonged to a large dairy industrial group for several years, dairy farmers team up to take over management in 2003
	A4 Leadership / entrepreneurship	Belongs to the local farmers (excepted the buildings belonging to local communities
	A5 Norms / social capital Knowledge and mental models	To increase the milk prices paid to the farmers Maintaining the activity of the only cheese processing cooperative of the Vercors (a collective tool for farmers envisaged as a common pool resource
	A6 vision of agro-ecology	Three major stakes: a terroir to preserve, a local breed of cow to promote, a unique recipe of cheese. This patrimonial viewpoint leads to something that is not explicitly agroecology but refers to a preserved and extensive agriculture
Actor	**Variable**	**Description**
Agricultural advisors of the chamber of agriculture	**A0 Description and role of the actors in the system**	Support and advices for farmers: technical issues for dairy farm management, juridical aspect
	A1 Number and type of relevant actors/purposes/ actions	4/5 Defence of farmers interest and agricultural development, technical advices, political representation of farmers
	A2 Socio-economic attributes	Public
	A3 History or past experiences	Long history in advising farmers & in political representation to public authorities
	A4 Leadership / entrepreneurship	
	A5 Norms / social capital Knowledge and mental models	Agricultural advisors are in favor of temporary grasslands: for them they are more productive than permanent meadows.
	A6 vision of agro-ecology	Vision close to Vercors Lait and farmers delivering their milk to the cooperative
Actor	**Variable**	**Description**

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Tourism offices	**A0 Description and role of the actors in the system**	Development and promotion of tourist products
	A1 Number and type of relevant actors/purposes/ actions	In partnership with the SIVER an event was built for cultural appropriation of the Bleu cheese and development of tourism: the "Bleu" festival, each year in summer since 2001)
	A2 Socio-economic attributes	Unknown
	A3 History or past experiences	
	A4 Leadership / entrepreneurship	Promote the Bleu in the tourist offers
	A5 Norms / social capital Knowledge and mental models	Promotion of territory and its products
	A6 vision of agro-ecology	No reference to agroecology

3.3.4.8. Social, economic and political setting (S)

Use this part to specify the economic, social and political context both at the national, regional or case study levels. Assessment at territorial level in WP4 will contribute to provide relevant data. Mention only relevant information for the SES studied.

Social, economic and political setting (S)	**Description**
S1- Economic development.	*Economic sectors and employment per sector in the area (official statistics for Vercors mountain (2014 - INSEE)* • *Tertiary sector (Tourism): 71% (France 78%)* • *Industries: 4.8% (France 12.5%)* • *Agriculture: 19% (France 2.5%)* *Income per capita : median standard of living 20/21000 € (low slice)*
S2 - Demographic, social and cultural settings	***In the case study:*** *S2a) Demographic trend* *Annual variation of population: +0.88% (France + 0.49%)* *Population aging index (over 60 years old): 59.9% (France 49.9%)* *S2b) Urban extension vs agricultural occupation:* *Agricultural land prices in €/ha* *2010: 1900€/ha (0.19€/m²)* *2016: 5880€/ha (0.6€/m²)$* ⇨ *Prices ×3 in 6 years* ***Price of land to build in €/m²*** *150 to 350 euros/m² for building land that means 700 times more expensive than ordinary meadows price (year 2016)* ➔***Very high urban pressure on land and increase of agricultural land price***
S3 - Political stability.	*National level: Nothing to report but lower political will towards agroecology since 2017* *Regional level: Nothing to report but lower regional political will to support natural regional parks and higher interest towards economic sustainability of mountain agriculture* *Local level: Nothing to report*
S4 - Other governance systems	*The territorial coherence scheme (document of land planning)of the nearby agglomeration of Grenoble has consequences on local land pressure*
S5 - Other markets	*Here redundancy with S1*
S6 - Media organisation	If relevant, to specify special interest and activities of medias towards the case study and/or the action towards agroecology: *Local medias and medias of the nearby town of Grenoble (newspapers, local TV, internet, …) are keen for news about the Bleu du Vercors*
S7 - Other technology and infrastructure.	To specify only relevant technology and infrastructure not yet mentioned: *No information*

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S8 - History	*1956: Creation of Vercors-Lait cooperative* *1998: Creation of the AOC* *2003: Lactalis abandons (for profitability reasons) its only dairy of the Vercors and the cooperators buy the buildings* *2007: milk crisis, sale of buildings to intermunicipalities of Vercors, coop becomes tenant, public aid (funds) to the coop* *Since the goal is to straighten things out gradually without excessive risk taking, with different actions, new fabrications, promotion, development of direct sales, etc.*

3.3.4.9. Related ecosystems (ECO)

Concern wider links between the case study and other ecosystems (from the case study to related ecosystems and vice-versa). Assessment at territorial level in WP4 will contribute to provide relevant data (modelling with BioBaM and SolM).

ECO	Description
ECO1- Climate patterns;	*Located at more than 800m of altitude, mountain climate (early autumn, short summer, winter loaded with snow), climate change modify snow resource and increases dry periods in summer (farmers face locally shortage of water for livestock and shortage of forages. To reduce the impact on livestock they introduce temporary meadows with species drought-resistant.*
ECO2 - Pollution patterns;	Consequences of SES agricultural activities on air quality, water quality and soils pollution: *Agricultural practices remain extensive and localized water pollution due to manure and livestock waste is not impacting related ecosystems.*
ECO3 - Flows into and out of focal SES	If relevant to specify ECO2 or ECO1: *no information*

3.4. Guidance on the Detailed UNISECO SES Framework: List and Definition of Variables

3.4.1. Focal action situation

Focal Action Situation refers to the actions, rules and the possible collective organization undertaken towards agro-ecological practices and farming systems. They have to be analysed in a very detailed way with the help of the variables Interactions (I) and their performances will be assessed with the set of variables outcomes (O) (resulting from WP3).

In UNISECO, this sub-system aims at analysing the following core questions: What are the actions, rules and collective organizations towards agroecology? What are the agro-ecological performances of concerned farming systems? What are their transition “patterns”?

This sub-system is of major importance because it focusses on actions towards agro-ecology. Be aware that there are some inevitable redundancies with some variables in the other sub-systems (especially governance sub-system).

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Description in one sentence of the action situation towards agro-ecological farming system:	

Interactions (I)

Interactions (I) Variables	**Description**	Additional comments	Example of characterisation	Data collection (format and sources)
I1 Harvesting	Describe in a detailed way the changes of agricultural practices and the innovations implemented to move towards agro-ecological farming systems.	Farm level Variable related to R 10 (inputs)	Changes of practices in agricultural land: fertilization, pesticides, land uses, number of hay cuts, grazing pressure, … Changes of practices in livestock rearing Changes in farm management, cuts dairy farms: Number of cows/ha, in stabulation in each season, how many times a land is grazed and mown Changes in food system organization	Interviews and surveys in farms (during WP3 interviews) (with detailed geographical approach)
I2 Information sharing and self-organising activities (	learning processes, exchanges of information,	Types, place and between which actors… Identify the main places where innovations are discussed and captured by farmers	Unformal network to discuss new agricultural practices, local advisory council, field visits, …	Farmers and localactors interviews (consistency with WP3 and WP5), debates during MAP
I3 Deliberative processes	Description of the process and of the involved actors allowing to: exchange information, examine key issues and take decisions towards agro-ecological transition		Agro-ecological farmers are organized in a group to take common decisions, to discuss what it happened in their farms and to find public money to support their activities	Farmers and local actors interviews (consistency with WP3 and WP5), debates during MAP
I4 Conflicts	Description of the main conflicts and controversial matters and actors involved	Why, interests and actors involved, resources concerned Identify if there are some conflict, if they are huge or slight	Strong conflicts about land management between mayors and dairy farmers in the French Northern Alps. The use of hay meadows is a controversial matter: for some farmers there is a need to increase their organic fertilization to improve food autonomy of farms. For some other farmers and for environmental NGO's the fertilization should be reduced to maintain flora biodiversity.	Farmers and local actors interviews (consistency with WP3 and WP5), debates during MAP

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Interactions (I) Variables	Description	Additional comments	Example of characterisation	Data collection (format and sources)
I5 Investment activities	Building of resource capacities (including human capacities)	Concrete investment done or planned/importance of public funds	Building of a collective artisanal cheese dairy Project of a new wood energy local sector with a wood-fired generator Investment in training for farmers	Farmers and local actors interviews (consistency with WP3 and WP5), debates during MAP
I6 Networking and I6 Lobbying activities	Actors involved, main ideas supported and effectiveness of networking and lobbying activities	Understand what are the main lobbying forces, the ideas they promote and their translation in action	Important influence of conventional farmers group to discourage young farmers to take part to agro-ecological dynamics Some agro-ecological farmers are to national Network on agro-ecological practices The natural regional park supports to agro-ecological dynamics (with public funds and with a large local communication	Farmers and local actors interviews (consistency with WP3 and WP5), debates during MAP
I7 Evaluative activities and monitoring and sanction	How are the changes towards agroecology monitored, evaluated? Which practices, resources and impacts are evaluated? Are there any sanction and which?	No evaluation, external evaluation, auto-evaluation, evaluation by the public financing body, evaluation by the buyer of the products Could concern changes in agricultural practices, quality of products, economic, environmental and social impacts, …	Due to public support the changes of agriculture practices are assessed by an independent expert. In case of non-compliance with the commitments the farmers will lose any public support	Farmers and local actors interviews (consistency with WP3 and WP5), debates during MAP
I8 Exchange activities	Development of new collective activities. To avoid any redundancy with variable information sharing)	To avoid any redundancy with variable information sharing specify here exchanges of goods, services, work, … Specify how these exchanges are organized: unformal exchanges, contracts, common organization,	Exchanges of equipment to implement agro-ecological practices	Farmers and local actors interviews (consistency with WP3 and WP5), debates during MAP

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Outcomes (O)

Outcomes box includes variables aiming at assessing the sustainable performances of the Focal Action Situations. It refers to different sustainability indicators. Firstly, at farm level, economic, environmental and social performances will be analysed in comparison with conventional farming systems through the use of the Decision Support Tools of WP3: cool farm tool (biodiversity impacts, sources of GHG emissions and water use), SMART (farm sustainability, ecological, social, economic, empowerment and participation), COMPAS (economy). WP4 will assess sustainability impacts of large-scale implementation of agro-ecological approaches (and other scenarios) at territorial level (BioBaM and SolM models). Suitable indicators measuring changes in the SES variables will be selected from SAFA sustainability indicator framework.

Outcomes of AEFS (O) Variables	Description	Additional comments	Example of characterisation	Data collection (format and sources)
O1 Social performance measures	Quality living standards for the farmers and also for the whole case study	The performances of AEFS compared to conventional farming systems will be assessed by WP3 tools Here add qualitative comments to describe the dynamics and the causal relationships	Satisfaction expressed by farmer about his life condition, Efficient empowerment of agro-ecological farmers now involved in different network to be recognized at local level Increase of the attractiveness of the territory due to the landscapes features conservation in the farms	**WP3 and eventually complementary interviews**
O2 Ecological performance measures	Biodiversity. Water quality Landscape structures and diversity Erosion stake	The performances of AEFS compared to conventional farming systems will be assessed by WP3 tools Here add qualitative comments to describe the dynamics and the causal relationships	As agro-ecological farmers are reducing nitrogen and pesticides uses a significant reduction of water pollution is expected (or had occurred)	**WP3**
03 economic performances	Economic viability of AEFS	The performances of AEFS compared to conventional farming systems will be assessed by WP3 tools Here add qualitative comments to describe the dynamics and the causal relationships	Due to the development of a new short supply chain based on local products, the prices of farmers products are higher	**WP3**

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O4 Externalities to other SES	Only if relevant, economic,environmental or social externalities		Exchange of know-how between agro-ecological farmers of the case study and other farmers outside	**Overall knowledge**

3.4.2. Resource system (RS)

In UNISECO, resource systems are the farming systems.

Core question: How are agro-ecological farming systems organised and managed?

If useful specify differences between conventional and agro-ecological farms.

Use of mainly qualitative and statistical data to describe and classify the farming systems of the case study. Main data for farming systems will be available in WP3 surveys.

If relevant and if data are available specify differences between conventional and agro-ecological farming systems

Resource systems (RS) Second- tier Variables	**Description**	**Additional comments**	**Example of characterisation**	**Data collection (format and sources)**
R1 Sector	Types of agricultural productions	FADN typology, if possible % of each type. Specify also the existence of specific agriculture: organic farming,… http://ec.europa.eu/agriculture/rica/pdf/site_en.pdf FADN typology (14 types of farming): 5 Specialist COP (cereals, oilseeds and protein) 16 Specialist other field crops 35 Specialist wine 36 Specialist orchards - fruits 37 Specialist olives 38 Permanent crops combined 45 Specialist milk 49 Specialist cattle 48 Specialist sheep and goats 20 Specialist horticulture 50 Specialist granivores 60 Mixed crops 70 Mixed livestock 80 Mixed crops and livestock Specify also other activities like agro-tourism, pluri-activity on farms	**FADN typology:** Specialist milk: 70% of farms Mixed livestock: 20% Specialist COP: 10% Or classification adapted to your data (i.e.): Dairy farms: 70% Beef and sheep farms: 20% Grain farms: 10% 12% of the farms are organic	Statistical data

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Resource systems (RS) Second- tier Variables	Description	Additional comments	Example of characterisation	Data collection (format and sources)
R2 Perimeter and clarity of system boundaries	Place-based case study /network based case study Physical, administrative, policy or project boundaries	Specify the perimeter of the SES and the clarity of the boundaries No clear boundary for network based case study (or large areas) Explain how you define the boundaries of the SES	Local, regional or national extension Place based case study: ex. Leader+ project, Natura 2000 area, Bio-district, PDO area, … Network based: ex. network of farmers exchanging practices with the help of Internet and/or farms visits	Survey, soon mentioned in the template for candidate case studies, sometimes could need some clarifications
R3 : Number and size of farming systems	Number of farms, Average size of farms (ha, number of animals)	If relevant please specify differences between conventional and agro-ecological systems	300 farms in the area, around 20 farms engaged towards studied agro-ecological dynamics Small farms, between 5 to 20ha, in average 15ha, no difference between conventional and agro-ecological farms	Statistical data, Survey for WP3
R4 Human-constructed facilities	Facilities for agricultural production:	inside (agricultural buildings) and outside the farm level (collective irrigation system, roads and path networks)	Most of the farms buildings are modern and efficient Remote area and absence of facilities to collect products and to access to services. A collective system for hay sun drying is in project (to be used by agro-ecological farmers)	Legal data bases and survey for WP3
R5 Productivity of system	Yield (t/ha or product per animal) and if possible economic value (Euro/t)	A qualitative assessment: is very important: specify productivity of system and economic value in comparison with standard values	Grain production (70 quintals/ha) and selling prices comparable to national average Grain production approximatively 10% lower in agro-ecological farms than in conventional farms, same selling prices	Legal data bases if available and survey for WP3

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Resource systems (RS) Second- tier Variables	Description	Additional comments	Example of characterisation	Data collection (format and sources)
R6 Equilibrium properties of farming systems	Evolution of the number, type and size of the farming systems; Evolution of main land uses	Associate quantitative (but simple) diagnosis to qualitative comments	From 2008 to 2018 the number of farms decreased of 40% and their average size increased from 15 ha to 22 ha Small farms' abandonment with land being taken over by large farms No difference between conventional and agro-ecological farms	Official databases
R7 Predictability of system dynamics	Capacity to estimate the future evolution and dynamics of the resource system	Qualitative assessment including explanations about the driving factors and the consequences	The trend towards the reduction of the number of farms will continue Risk of having milk production abandoned (due to low milk prices) and replaced by meat production or crops. Cultural agricultural landscapes potentially threatened due to the decrease of agriculture No difference for the moment but farmers engaged towards agro-ecological practices expect public support for their practices and higher prices for their products for the medium term	Survey and/or available studies
R8 Storage characteristics	To store resource units (at farm level or at collective level for a group of farmers	Redundant with R4 for agriculture thus not relevant for our framework		
R9 Location	Geographical location of the farming systems: qualitative description		Mountain area with farming systems concentrated on flat areas Homogeneous distribution of the farms on the territory	

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Resource systems (RS) Second- tier Variables	Description	Additional comments	Example of characterisation	Data collection (format and sources)
R10 Input	fertilizers, pesticides, concentrates, forages, water energy, … (in T/y or in €/y per farm or per ha)	Use of the quantitative data collected for WP3 A complementary qualitative assessment is useful	Farming systems with high level of input of pesticides, higher than national average and farmers not aware about that. Reduction of the use of pesticides in agro-ecological farms, about 30% lower than conventional farms	These data will be available in WP3 for the sample of surveyed farms

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3.4.3. Resource units (RU)

Resource units (RU) are both the production factors and the productions of the resource system (RS).

Core question: What are the main factors of production and the different agricultural productions (at farm gate)?

If useful specify differences between conventional and agro-ecological farms.

Use of mainly qualitative and statistical data to qualify the agriculture productions of the case study. Main data for farming systems will be available in WP3 surveys

Resource units (RU) Variables	**Description**	**Additional comments**	**Example of characterisation**	**Data collection (format and sources)**
RU 0: types of products	Present the diverse agricultural products of the SES (in a quantitative or qualitative way)	Variable redundant with R5 (productivity of the system) add only complementary information	Milk: in average 5000kg/cow/year and 100 000 kg/farm/year Wine: hl/ha; hl/farm Cereals: average quintals/ha/y and average/farm Lower productivity in agro-ecological farms around 15%	Statistical data, survey for WP3
RU1 Resource unit mobility	Specify mobility of resources both for transformation and for marketing and specify where agricultural products are processed: inside/outside the farm; inside/outside the SES		Milk processed locally but outside the farms Local cheese difficult to sell outside the production area (low reputation) Cereals and meat processed outside the SES	
RU2 Growth or replacement rate	Qualitative assessment: are the quality and/or the yield of the products evolving?	Only if a problem of replacement of the resources has been identified	Yield crops are decreasing for 5 years due to climate change or soil depletion	
RU3 Interaction among resource units	Interactions between productions and between land uses.	Mainly qualitative assessment	Competition between permanent grasslands and crop production in favor of crops Cessation of livestock farming in favor of crop production Trend to process products at farm level for direct selling especially for agro-ecological farmers	Survey for WP3
RU4 Economic value	Selling price for producers: quantitative data (€/unit for each product) and qualitative assessment	Information to know if products have a high medium or low added-value	Milk paid 0.55€/kg to the farmers, this is 0,25 €/kg more than standard national price. Same prices for agro-ecological and conventional farmers	

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Resource units (RU) Variables	Description	Additional comments	Example of characterisation	Data collection (format and sources)
RU5 Distinctive characteristics	Distinction which can allow to distinguish categories in the resource To avoid any redundancy with P6 (distinctive characteristics of processed products), the logic is here to specify only the distinctive characteristics at farm gate	Quality labels, special varieties and animal breeds,	Standard products Organic products Label of origin High local reputation for farm cheese Traditional and local dairy cow breed	Interviews
RU6 Spatial and temporal distribution	Main spatial and temporal distribution of production	If relevant specify: - seasonal distribution of the products, - multiannual trends -eventually spatial distribution of the products	Milk mainly produced in summer in alpine pastures Increase of milk production for ten years (around + 30% in 10 years)	interviews
RU7 Marketing characteristics	How and to who are sold the products by the farmers?	Assess the economic model and kind of market production is linked to.	Direct sales to consumers Sales to private enterprises with multi-year contract Sales to a cooperative	Interviews and survey for WP3

3.4.4. Transformation system (TS)

Transformation sub-system is the food system including the different transformation operations from the farm gate to the consumers: collection of products, transformation, distribution and marketing.
Core questions: How do the food systems work?

The main focus is on the transformation systems for agro-ecological farms if they are involved in a specific transformation system. If relevant, specify differences between agro-ecological and conventional farming systems
NB: transformation systems could be very complex, especially for agri-food commodities with numerous intermediaries and processes for the products. In this case, this is not necessary to detail the transformation system (in type 6, 7 and 8 variable T1).

Transformation system (TS)	**Description**	**Additional comments**	**Example of characterisation**	**Data collection (format and sources)**

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Transformation system (TS)	Description	Additional comments	Example of characterisation	Data collection (format and sources)
T1 Sector	general characteristics of the transformation sub-system	For each product specify the main food system (if there are several food systems for a product indicate a qualitative assessment (or a quantitative if data are available) of the share between them. Specify differences between agro-ecological and conventional farms	Use the following simple typology of food systems source Fleury & al., 2008: 1: short supply chain (face to face marketing) 2: traditional and typical products (origin labelled products) mainly with regional marketing 3: traditional and typical products (origin labelled products) mainly with national or international marketing 4: standard products with geographical attributes for the consumers (bread from the Loire region) 5: new type of product with specific channel of distribution (please specify) 6: standard products of local consumption 7: standard products with a regional or national market 8: standard products with an international market	Interviews with local experts of agriculture and transformation system
T2 Clarification of T1 sector	Clarification of T1 sector	Qualitative description of the transformation system from the collection at farm gate to distribution to consumers	The products are directly sold by farmers in local markets The products are purchased at farm gate by a private company and after are processed outside the area for industrial uses.	Interviews with local experts of agriculture and transformation system
T3 Size of transformation system	Volume produced and value of sold products	Qualitative or quantitative information according to available data (less relevant for types 6,7,8 of variable T1)	Local collective organization of farmers to process their milk. Around 2,000,000 litres of milk processed in 200 t of cheese sold to local retailers	Interviews with local experts of agriculture and transformation system
T4 Human-constructed facilities	Logistics and facilities to collect the products from the farm to their storage or processing place	To inform mainly for the first levels after the farm level (especially for types 6,7,8 of variable T1)	Silo for grain storage at 10 km of the case study area.	Interviews with local experts of agriculture and transformation system

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Transformation system (TS)	**Description**	**Additional comments**	**Example of characterisation**	**Data collection (format and sources)**
T5 business relationships along the transformation system	Description of the business relation along the system. Emphasize the first level between farmers and the first intermediary especially for types 6,7 and 8	Pure market relationships, oral or signed contracts specifying the price paid and/or the quantity the purchased quantity, partnerships to decide the price, …	The farmers sell their products to diverse private companies who fix the price and decide the quantities purchased Farmers are organized with a co-operative who sell the processed products on the market. The price of the raw product paid to farmers vary according to the prices obtained by the cooperative	Interviews with local experts of agriculture and transformation system
T6 Equilibrium properties	Evolution of the number, type and size of the transformation systems	Qualitative description	From 2008 to 2018 we observe the development of numerous short supply chains (Type 1) For 15 years the economic size of the standard supply chains (Type7 is increasing with more and more intermediaries and an evolution towards international market (Type 8)	Interviews with local experts of agriculture and transformation system
T7 Predictability of system dynamics	Capacity to estimate the future evolution and dynamics of the transformation system	Qualitative assessment including explanations about the driving factors and the consequences	-the trend towards the enlargement and the internationalization of transformation system will continue (Type7➔Type 8) - it seems that the local market is saturated and that there is no place for new local supply chain	Interviews with local experts of agriculture and transformation system and available studies
T8 Storage characteristics	Importance of the storage in the cost of production high, medium, low	Redundant with T4, thus not relevant for our framework		
T9 Location/Geographical distribution	-If relevant could be used to specify some geographical information about the location to store, process or sell products	Links with T3 and T4		Interviews with local experts of agriculture and transformation system and available studies
T10 Inputs	-to specify other inputs than agricultural products	To fill in only if relevant	The transformation process is very energy and/or water-intensive	Interviews with local experts of agriculture and transformation system and available studies

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3.4.5. Products (P)

Products sub-system refers to the processed products outside the farm: wine, cheese, meat, …

Core questions: What are the final products marketed? Are the farmers the main beneficiaries of the added value?

NB: transformation systems could be very complex, especially for agri-food commodities with numerous intermediaries and processes for the products. In this case this is not necessary to detail the different processed products (in type 6,7 and 8 variable T1)

Products system (P)	Description	Additional comments	Example of characterisation	Data collection (format and sources)
P0: diversity of Products	List of the different processed products	Link with T1 => underline the most added value products	Ex. For wine: wine in bulk = % production standard wine in bottle = % prod Premier Cru: Value of production Grand cru: Value of production	Official data base or interviews
P1 Product mobility	Only if relevant		The processed product (fresh cheese) is difficult to conserve and its transportation is very time-sensitive	Interviews with local experts of transformation system and products

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<table>
<tr><th>Products system (P)</th><th>Description</th><th>Additional comments</th><th>Example of characterisation</th><th>Data collection (format and sources)</th></tr>
<tr><td>P2 Substitutability of the product</td><td>Describe if the product is easily replaceable or not by another one of the same category. To do this it must be answered to these two questions: 1) Is the product specific or not and 2) Is there a lot of competition for this kind of product?
<table><tr><td>Substitutability Competition</td><td>LOW Specific products</td></tr><tr><td>Low (few competitors)</td><td></td></tr><tr><td>High (many competitors)</td><td></td></tr></table></td><td></td><td>Bleu de Sassenage cheese is a very specific product: so low substitutability... But it belongs to the blue-veined cheeses manufactured and there are a lot of competitors in this sector. Thus, for the consumer the product without being substitutable is easily replaceable by another blue cheeses. There is a need for an efficient marketing strategy: "We should now find something more innovative that positions it relatively to other blues and gives it an identity that could be exported out of the territory" (SIVER)
<table><tr><td>Substitutability Competition</td><td>LOW Specific products</td><td>HIGH Mainstream products</td></tr><tr><td>Low (little competitor)</td><td></td><td></td></tr><tr><td>High (lots of competitor)</td><td>Bleu du Vercors</td><td></td></tr></table></td><td></td></tr>
<tr><td>P3 Interaction among products</td><td>Competition or complementarity between products</td><td></td><td>In such short supply chains to have a diversity of vegetables is a market advantage</td><td>Interviews with local experts of transformation system and products</td></tr>
</table>

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Products system (P)	Description	Additional comments	Example of characterisation	Data collection (format and sources)
P4 Economic value	Final economic value of the products and breakdown of the added values between the farmers and intermediaries	There is no request for a detailed analysis of the breakdown of the added value and of the added costs during the process of transformation For some transformations systems (types 6, 7 and 8) it could be very difficult to assess the final price	The milk is processed in several standard products (butter, yogurts, skimmed milk) sold on the national and international markets. It's not possible to assess these economic aspects (but as mentioned in RU4 the price for the farmer is the national average price). The Selling price excluding taxes - cost price price of finished product – producer Selling price	Interviews with local experts of agriculture and transformation system
P5 Number of units	Volume processed /transformation Unit	Qualitative assessment and if you have available data	Grains processed in a very large factory	Interviews with local experts of agriculture and transformation system
P6 Distinctive characteristics	Distinctive characteristics of the processed products		Label (organic, PDO), unique know-how, Famous wine to the whole Europe	Interviews with local experts of agriculture and transformation system
P7 Temporal distribution	Only if relevant, i.e. if there are seasonal variations of distribution		Cheeses processed only in summer on alpine pastures from January to the end of May	Interviews with local experts of agriculture and transformation system
P8 Marketing characteristics	Market position of the products	If useful to specify P6 distinctive characteristics of the products	Milk without any specific attributes but local consumers prefer it	Interviews with local experts of agriculture and transformation system

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3.4.6. Governance system (GS)

Governance (G) sub-system refers to institutional rules and regulations with a multi-level perspective. A special attention will be paid on power distribution. Include governmental and other organizations that contribute to the management of the SES, include any specific rules and covers how rules and regulations are made, agreed and applied;

The main inputs for this sub-system will be achieved in WP5: task 5.2 (analysis of governance structures including a Social Network Analysis) and Task 5.3 (Participatory analysis for downscaling market and policy incentives). Secondarily some complementary data could be necessary; this will be specified during the design of the methodology of WP5.

Core question: What are the main governance systems from state regulations to collective rules (for the whole SES from the farming systems to the transformation systems).

To operationalise this sub-system we introduce significant changes to the initial SES framework. Our proposal is based both on Pegasus project and a paper dedicated to lobster fisheries (Partelow and Boda, 2015).

Be aware that this sub-system is partly redundant with sub-system focal action situation. Here the objective is to specify in a detailed and holistic way the governance sub-system which affects the focal action situation.

Governance system (GS)	**Description**	**Additional comments**	**Example of characterisation**	**Data collection (format and sources)**
GS1 Policy area : **Governmental organisations (or agency linked with)**	Relevant policies areas for the SES organized by geographic scale	List the relevant policies areas and specify their importance and where are detailed information about them (analysed or not in WP5)	**Several scale governance systems:** EU : CAP plus European legislation about organic products and labels of origins) National legislation and government: agricultural and environmental policies (the national water law is of main importance in this area because this law limits in this area the use of nitrogen at a maximum of 60 N/ha/an) Regional government: local leader project funded by FEADER regionalized Local communities: policies in favor of tourism mobilized to develop rural accommodation at the farm	Interviews and WP5 results
GS2 Policy area : **Non-Governmental organisations**	Relevant policies areas for the SES organized by geographic scale	As these actors are described in more details in the sub-system actors there is no need to have an extended presentation	**Numerous departmental and local NGO's:** environmental NGO's (regional level) farmers organisations (departmental and local levels, environmental NGO's and hunters NGO's(local level), private and cooperative companies related to transformation system: a private company of super-markets the local Private mill	Interviews and WP5 results

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GS3 Decision making structures	Relevant decision making structures (including network structures) concerning agriculture and agroecology		Local Steering committee N2000 Steering committees at regional and departmental levels for landscape planning Several networks are existing, they more or less related to SES dynamics: • Environmental education network to increase inhabitants awareness of environmental issues • Farmers networks Local development networks	Interviews and WP5 results
GS4 Rules and regulations: property rights systems	Describe them when affecting the action situation. If relevant specify: G4a) property rights for access to land, rights of production, … G4b) constitutional rules (meta-rules) G4c) Collective choice rules G4d) Operational rules and norms G4e) Commercial regulations		G4a) Local cheese is protected by a label of origin Land access is difficult for neo rural because old native families are the main landowners G4b) Law and official regulations concerning water, environment and safety of products G4c) In the case study the concerted governance of agriculture is in general organized by the chamber of agriculture and the territorial collectivity. Despite this rule, some collective organisations of farmers could be established for specific purposes G4d) Access and uses of common pastures are regulated in each local community by old rules G4e) Respect of the competition rules The rule to sale products for public catering is defined by the French Code of Public Procurement contract	Interviews, WP5 results and overall knowledge
GS5 monitoring and sanction	Only if some more general information than in focal action situation is useful to mention		There are several controls relative to agri-environmental measures and respect of regulations concerning water quality. Official sanctions are foreseen	Interviews, WP5 results and overall knowledge

3.4.7. Actors (A)

The Actors (A) sub-system refers to the list of relevant actors in the field of agriculture and agro-ecological transitions governance. The actors to consider are the farmers as well as other stakeholders dealing with agriculture and agro-ecological issues. This covers actors involved for a range of reasons including livelihoods, market, environment, local development, policy regulations, e.g. agricultural organizations, environmental NGOs, state representatives, market organisations…).

It is of main importance to distinguish relevant categories of farmers (I.e. conventional and "agro-ecological") and not to consider farmers as a uniform category. If useful a multi-levels perspective (i.e. local, regional and national levels) could be distinguished.

As for the governance sub-system the main inputs for the Actors sub-system will be achieved in WP5.

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To operationalise this sub-system we introduce also significant changes to the initial SES framework. Our objective is to have a view of each type of actors.

Core questions: Who are the actors involved in agriculture governance? Who are the major actors able to influence others? What are their strategies and mental models?

The following tables are adaptations of Actors sub-system (A) of the original SES framework. The variables have to be fulfilled for each actor whose, moreover, logics and points of view about agro-ecological transition need to be analyzed in a qualitative way.

For each category of actors, you can add lines to specify inside this category.

Actor	Variable	Description
Additional comments	A0 Description and role of the actors in the system	Name, purpose…
	A1 Number and type of relevant actors/purposes/ actions	at the SES scale if relevant and if available
	A2 Socio-economic attributes	Private, public para-public, economic role and
	A3 History or past experiences	main past actions and/or development path
	A4 Leadership / entrepreneurship	Influence on the other actors (Very influent: +++, moderate influence: ++; low influence: +, no influence: 0
	A5 Norms / social capital Knowledge and mental models	Qualitative comments: i.e. very involved in local development, with a large social network, ….
	A6 vision of agro-ecology	Qualitative comments: i.e. In favor of weak agroecology (efficiency or substitution), strong agroecology (redesign), works for special issue (biodiversity, income of farmers, …) Explicit and concrete actions towards …
Actor	Variable	Description
Actor	Variable	Description
Example of Characterization: Natural Regional Park du Vercors	A0 Description and role of the actors in the system	Natural regional parc of Vercors
	A1 Number and type of relevant actors/purposes/ actions	Sustainable development of the territory. Preservation and management of biodiversity Participation to local governance of dairy farms development
	A2 Socio-economic attributes	Public co-financing + provision of agricultural advisor
	A3 History or past experiences	Preservation of environment and local development purpose: local heritage, eco-tourism, the Villarde breed of cow…
	A4 Leadership / entrepreneurship	+++: actions in favor of environment and local development +++: design of projects and obtaining public subsidies at departmental and regional levels
	A5 Norms / social capital Knowledge and mental models	Respect of local collective heritage Development based on local resources Contribution of dairy farms to local development

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	A6 vision of agro-ecology	Agroecology as a complex agriculture including both environmental friendly practices, local know-how and resources (bleu de Sassenage cheese, local dairy cow breed) and implementation of agroecology both at territorial and food systems levels
Actor	Variable	Description
Local level authorities	A0 Description and role of the actors in the system	
	A1 Number and type of relevant actors/purposes/ actions	
	A2 Socio-economic attributes	
	A3 History or past experiences	
	A4 Leadership / entrepreneurship	
	A5 Norms / social capital Knowledge and mental models	
	A6 vision of agro-ecology	
Actor	Variable	Description
Agricultural and products organisations	A0 Description and role of the actors in the system	
	A1 Number and type of relevant actors/purposes/ actions	
	A2 Socio-economic attributes	
	A3 History or past experiences	
	A4 Leadership / entrepreneurship	
	A5 Norms / social capital Knowledge and mental models	
	A6 vision of agro-ecology	
Actor	Variable	Description
	A0 Description and role of the actors in the system	
	A1 Number and type of relevant actors/purposes/ actions	
	A2 Socio-economic attributes	
	A3 History or past experiences	
	A4 Leadership / entrepreneurship	
	A5 Norms / social capital Knowledge and mental models	
	A6 vision of agro-ecology	

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3.4.8. Social, economic and political setting (S)

Use this part to specify the economic, social and political context both at the national, regional or case study levels. Assessment at territorial level in WP4 will contribute to provide relevant data. Mention only relevant information for the SES studied.

Social, economic and political setting (S)	Description	Additional comments	Example of characterisation	Data collection (format and sources)
S1- Economic development.	Economic sectors and employment per sector in the area, Income per capita	Indications of the main economic and social characteristics of the Case study	In the case study area the distribution of employment across sectors is (in comparison with national values) : Agriculture: 20% (5%) Industry: 10% (30%) Tourism: 50% (30%) Other services: 20% (35%) Winter tourism and secondly summer tourism is the main economic activity The regional income per capita (55 000 euros/y) is higher than national income (40 000 euros/y)	Official data, Eurostat, interviews
S2 - Demographic, social and cultural settings	**In the case study:** Demographic trend Urban extension, Agricultural land prices in €/ha Price of land to build in €/m² its evolution	Demographic trend gives element of pressure on lands and demand for products	The local population is increasing (: + 8% from 2008 to 2018 and +4% at national level No quantitative data available for land prices but urban pressure is very high without any land planning document to protect agricultural areas In Var department the price of agricultural land is around 1,2 €/m² whereas building land is 208 €/m² => high competition	Official data, Eurostat, interviews
S3 - Political stability.	National level Regional level Local level	Specify only relevant information	Long term for 20 years regional and local political stability National context very fluctuant between right and left parties having different point of view on agroecology and environment preservation	Interviews
S4 - Other governance systems	Only if relevant		A regional steering committee is in charge of land planning policies. Not direct link with agriculture but positive indirect links (efficient reduction of urban pressure on agricultural land)	Interviews and overall knowledge

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Social, economic and political setting (S)	Description	Additional comments	Example of characterisation	Data collection (format and sources)
S5 - Other markets	Main non-agricultural sectors linked with agriculture and offering existing or potential markets (i.e. tourism, handicraft, ….	These existing and potential markets could be local or not	Internet market is increasing with numerous websites looking for organic products New tourism offer linking farm visits, food tasting and outdoor sports	Interviews
S6 - Media organisation	If relevant, to specify special interest and activities of medias towards the case study and/or the action towards agroecology		At national level mainstream medias develop strong criticisms towards agriculture. This local initiative in favor of agroecology is often presented in regional newspapers as a positive experience	Interviews and overall knowledge
S7 - Other technology and infrastructure.	To specify only relevant technology and infrastructure not yet mentioned		Highway cutting in two the area	Geographical data and overall knowledge
S8 - History	Recent history (past 30 years) of the case study area (not relevant for network case study	Avoid too much details and highlight relevant information to understand current dynamics	For 20 years the local area is characterized by actions towards nature preservation, firstly on wild areas and for 5 years on agricultural land	Local histories and literature

3.4.9. Related ecosystems (Eco)

Concern wider links between the case study and other ecosystems (from the case study to related ecosystems and vice-versa). Assessment at territorial level in WP4 will contribute to provide relevant data (modelling with BioBaM and SolM).

ECO	Description	Additional comments	Example of characterisation	Data collection (format and sources)
ECO1- Climate patterns;	Existing and potential impacts of climate change on SES (and vice versa if relevant).	If some data are available Try to assess the possible problems or opportunities related to climate change	Related to climate change for ten years droughts have increased. To face the problem farmers intensify their activities with abandon of poor and dry meadows and implementation of new irrigation systems	Existing scientific studies
ECO2 - Pollution patterns;	Consequences of SES agricultural activities on air quality, water quality and soils pollution	If some data are available	Intensification of the use of pesticides inside the case study occurs a high risk to pollute surface and underground water on a large area	Existing scientific studies

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ECO	Description	Additional comments	Example of characterisation	Data collection (format and sources)
ECO3 - Flows into and out of focal SES ;	If relevant to specify ECO2 or ECO1	If some data are available Describe the main flows having positive (biodiversity (ecological network, connected landscapes structures, bird migrations…) or negative influence on the SES (pollution of air or water coming into the SES	Air pollution in Rambouillet area is due to car traffic in Paris (60km to the north)	Existing scientific studies

4. ACKNOWLEDGEMENTS

This report is compiled for the H2020 UNISECO project which received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 773901.

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2 - HNV-link

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3 - Communities, Conservation & Livelihoods

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4 - Sustainability Assessment of Food and Agriculture systems (SAFA)

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APPENDIX 1. DETAILED LIST OF CONCEPTS RELATING TO SES

Action situation: *A*ction situations are processes how actors interact, decide and impact decisions on resource units, production, and the other sub-systems

According to description given by Mc Ginnis and Ostrom (2014), in action situation *« actors in positions make choices among available options in light of information about the likely actions of other participants and the benefits and costs of potential outcomes.»* Hence*, « Action situations take as inputs the values of the SES top-tier categories at time t and generate changed values of at least some of those factors at time t + 1."*

In other words "*actions situation"* (or focal action situation) is the core that stabilizes or generates changes in the social-ecological system in interaction with structural/institutional factors.

Actor characteristics:

1) Is considered as an actor anyone who has directly or indirectly an influence on the system he is linked to. Thus « actor » includes users or consumers of a product or service and even the behaviour of third parties who are not direct users or consumers.
2) Actor characteristics are based upon the characterisation of their social belonging (who are they from), their roles (what kind of actions do they do), their reasons (what are the justification of their actions), their influence (what is the importance of their action in the SES) and their relationship/network (who are the main other actors they deal with).

Adaptive governance: It is a steering policy interaction to guide management of resources in a manner that is able to recover or adjust to changes so as to maintain or improve to a desirable state. The adaptive governance approach is especially relevant for social-ecological systems, whose dynamics is not well captured by a static approach.

The concept pays special attention to present and also absent actors in the governing bodies (to be sure that a wide representation is effective) and to actors inspiring new or innovative ideas.

Commons (Dardot and Laval, 2014): The commons are material or immaterial goods whose management escapes or are supposed to escape simple private or state appropriations and the strict laws of the market.

Remark: this term is particularly complex to define because it is linked to social, economic and political history of each country and even of each community in a country. Moreover, the use of this term is not politically neutral. Its use in social sciences underlies the desire for a reaffirmation of non-commercial common properties in the face of private capitalist property on the one hand and the feeling of bankruptcy of the state's rules on the other hand.

Commons Pool Resources (CPR) (Poteete *et al.,* 2009)**:**

CPR are a type of resources that is neither public nor private property. In many contexts, external imposition of user fees is impracticable or undesirable. Individuals with access to shared resources can achieve a sufficiently efficient allocation through social norms reinforced by the implicit threat of decentralized sanctions. They can develop formal rules or rely on informal rules, practicing what Ostrom calls self-governance (Cardenas and Sethi, 2016).

Four types of goods may be distinguished: (1) private goods for which one person's consumption subtracts from the availability of consumable benefits to others and exclusion is relatively easy; (2) common-pool resources for which subtractability occurs but exclusion is difficult; (3) club goods, for which subtraction is relatively minimal but exclusion is easy; and (4) public goods for which con-

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sumption is not subtractable and nor is exclusion possible. Both dimensions are considered as continua where each good or service is placed according to the legal, institutional, political context.

Characteristics of goods	Excludable	Non-excludable
Rival in consumption	Private goods	Common pool resources
Non-rival in consumption	Club goods or toll goods	Public goods

Figure 1. Appendix 1*. Characteristics of goods according to their status (Source: Dwyer et al. (2015) according to Ostrom).*

Common-pool resources share the characteristic of costly exclusion with public goods and subtractability with private goods. Common pool resources include both natural and human-made systems and can be managed under any of a wide variety of property-rights regimes: government ownership, private ownership, community or common-property ownership, or no ownership or open access.

Examples of common-pool resources: forests, fisheries, groundwater basins, irrigation systems, grazing lands, mainframe computers, government and corporate treasuries, and the Internet.

Examples of the resource units derived from common-pool resources: timber, fish, water, fodder, computer-processing units, information bits, budget allocations... The rules used to govern common-pool resources are also public goods in that they affect all users whether or not they conform to the rules and one person's conformance is not subtractive.

Ecosystem services Pegasus Program (Maréchal *et al*., 2016)**:** The benefits to human society from ecosystems*« Ecosystem Services (ESS) was coined as a term to describe functional roles played by components of ecological systems, which need to be recognized and valued (in more or less concrete ways) in decision-making and resource allocation ».* A SES could be managed to increase its provision of ecosystem services.

Feedback Loops: The process by which system outputs are returned to the system as an input, either to oppose the initial input (negative feedback), or to enhance it (positive feedback).

Governance: Public and private interactions undertaken to address challenges and to create opportunities within society. Governance thus includes the development and implementation of the principles, rules, norms and enabling institutions that guide public and private interactions (Armitage et al. 2009).

Successful governance requires a nested hierarchy of procedures, with rules that organize basic routine activities, collective decision-making procedures to change these rules to a higher level, and mechanisms of constitutional choice at the top. (Cardenas and Sethi, 2016)

Institutional Analysis and Development (IAD): IAD framework identifies an action arena, patterns of interactions and outcomes, and an evaluation of these outcomes for a particular action situation. It refers to the premises of the CPR and SES approaches of Ostrom. (Figure 2 Appendix 1)

In IAD framework (Kiser and Ostrom, 1982) an "*action situation is structured by seven broad attributes including:*
(1) the set of participants confronting a collective-action problem,
(2) the sets of positions or roles participants fill in the context of this situation,
(3) the set of allowable actions for participants in each role or position,
(4) the level of control that an individual or group has over an action,

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(5) the potential outcomes associated with each possible combination of actions,
(6) the amount of information available to actors, and
(7) the costs and benefits associated with each possible action and outcome" (Poteete *et al*., 2009).

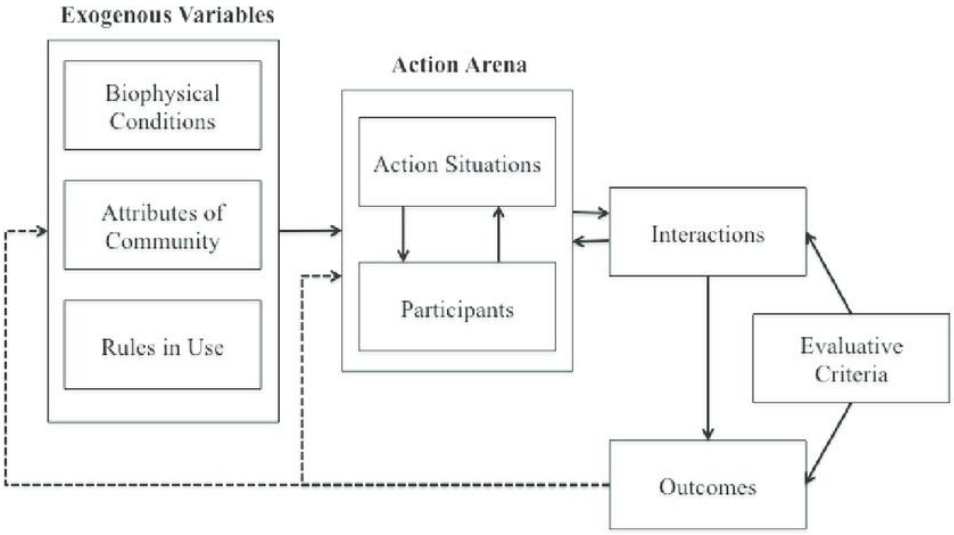

Figure 2. Appendix 1. *the Institutional Analysis and Development Framework (IAD) (Kiser and Ostrom, 1982).*

Institutional economics: A set of works that have in common the question of the role played by institutions in economic coordination. In the later 20th new institutional economics try to integrate later developments of by focusing on the social and legal norms and rules , transaction costs, property rights, underlying economic activity. Elinor and Vincent Ostrom are main contributors of new institutional economics.

Institutions: The formal (rules, laws, constitutions, organizational entities) and informal (norms of behaviour, conventions, codes of conduct) practices that structure human interactions (Armitage et al. 2009). In the management of a SES informal institutions are at least as important as formal ones.

Multiple scales: "Scale" refers most often to time and to space, specifically whether an event (like a fishery opening) occurs over a short or long time (temporal) scale, or whether an activity (like fishing) takes place over a small or a large space (spatial) scale. (Berkes *et al.,* 2014).

Following Gibson *et al*. (2000), Cash *et al.* (2006) define « scale » as the spatial, temporal, quantitative or analytical dimensions used to measure and study any phenomenon and « levels » as the units of analysis that are located at different positions on a scale.

Multiple levels: Parallel to the idea of scale is that of 'level' –basically a specific point along a scale (or a 'unit of analysis' within a scale) […] A multi-level approach is important in allowing us to examine different levels at which conservation interventions can be made. We will seek to understand the interplay of drivers. (Berkes *et al*., 2014)

Networks: The interconnections among people and organizations within a SES. Networks may structure themselves around resources use, administrative responsibility and/or other functions and may be connected to other networks (Armitage *et al*., 2009).

Panacea: Ostrom *et al*., 2009 recall the Oxford English Dictionary definition *''a remedy, cure, or medicine reputed to heal all diseases; a universal remedy''*. These authors specify that *« the core aspect of panaceas is the action or tendency to apply a single solution to many problems »*.

They oppose this unique vision that refers to blueprint approaches promoting recommendations

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supposed to be applicable in any situation to solve environmental problems: i.e. government ownership, privatization, community property…

The criticism of panacea refers to a theoretical research position and a considerable attention should be paid not to use SES as a panacea!

Public goods

(extract from Dwyer *et al.*, 2015)
« The concept of public goods was developed in a neoclassical economic theoretical context by Samuelson (1954) and Musgrave (1959). These authors identified the existence of certain goods demanded by society which were not readily traded or exchanged in markets, and linked this phenomenon to specific inherent qualities of these goods – non-excludability and non-rivalry in consumption, as mentioned earlier. These characteristics were identified as contributing to situations of market failure, where despite societal demand for them, provision through the normal market mechanisms was anticipated to be insufficient. Economists and policy analysts have used the (positive) concept of a "public good" within a normative approach, in order to consider when public or state intervention in markets may be justified. »

Resource system (RS): One of the sub-systems of the SES framework. MacGinnins and Ostrom (2014) co-define it with the sub-system resources units as a set of resources units exploited by resources users. The resource system is rather « defined » by its components (see SES Framework).

Resource units (RU): like resource system, resource units are defined by a set of second and third tier variables. More generally the concept of resource could be defined as the set of material goods or services which exploitation depends on the way human organizations regard and value them.

Social learning: "The collaborative or mutual development and sharing of knowledge by multiple stakeholders (both people and organizations) through learning-by-doing. (Armitage et al., 2009)

Self-organization: In adaptive co-management, self-organization involves the emergence of formal and informal networks, working in a collaborative and creative process, often drawing on a range of knowledge sources and ideas (Armitage et al. 2009).

Resilience:*"the buffer capacity or the ability of a system to absorb perturbations; the magnitude of the disturbance that can be absorbed before a system changes its structure by changing the variables and processes that control behaviour"* (Berkes and Folke, 1998) The idea of resilience is to be able to maintain the overall function and structure of a system of humans and nature, despite unexpected shocks to that system(Berkes *et al.*, 2014)

Transaction costs: *"Transaction costs are the costs of the resources used to: define, establish, maintain, use and change institutions and organisations; and define the problems that these institutions and organisations are intended to solve*" (Marshall, 2013).

Wicked problems: Problems that have no definitive formulation, no stopping rule, and no test for a solution: *« This term denotes problems for which it is impossible to define optimal solutions because of both uncertainty about future environmental conditions and intractable differences in social values »* (Duckett *et al*., 2016).

For Duckett *et al*. (2016) six categories are defining a wicked problem: 1. Indefinable (formulation of the problem is itself problematic); 2. Ambiguously bounded (inter and intra-connectedness of issues); 3. Temporally exacting; 4. Repercussive (solutions always confronted to value conflicts); 5. Doubly hermeneutic (link subjects changing practices); and 6. Morally consequential (paradox between demand of action and resistance to change).

Transition towards agroecology is for sure a wicked problem.

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