

An innovative method to assess the sustainability of pastoral systems in their territories (PSSAF)

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Keywords

Pastoralism, territory, sustainability, assessment

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Summary

The future of pastoral systems and their interactions with territories are the subject of considerable debate in the scientific literature and are still insufficiently documented. Assessing the sustainability of pastoral systems and their interactions with the sustainability of territories is thus a complex task. We proposed in this study a method to assess the sustainability of pastoral systems within their territories. After reviewing the literature, we conducted interviews with pastoralism experts in France and in Africa on the subject of sustainability in general and pastoral systems in particular. We designed our grid according to the principles-criteria-indicators approach and included 10 principles grouped into three major fields: 'Availability of resources in the territory', 'Properties of the system', and 'Extended sustainability'. Understanding the strategies used in pastoral systems enabled us to propose a set of specific criteria per principle. Finally, we compared our grid with other methods used to assess sustainability.

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■ INTRODUCTION

Pastoralism is the use of rangelands through mobility for livestock production (FAO, 2001). Worldwide, pastoralism supports 20 million households and ensures 10% of world meat production (FAO, 2001). Rangelands with spontaneous vegetation are the key resources for pastoralism. This agricultural production system is mainly encountered in areas where cropping is not reliable, such as arid lands or mountains of the Mediterranean basin, the Middle East and sub-Saharan Africa.

In the European countries of the Mediterranean basin, pastoralism is affected by environmental issues. Grazing on rangelands enables open landscapes, including both habitat and biodiversity, and is also one way to control forest fires. In addition, rangelands provide cheap feed and ensure a link with the territory, thus valorizing animal products guaranteeing economic returns to livestock farmers. In this manner, pastoral systems contribute to sustainable development. Nevertheless, the economic viability of pastoral farms is faced with uncertainties.

In arid lands of West and East Africa, pastoralism is not only a livestock production system but also a livestock-based livelihood strategy and a way of life with its own sociocultural norms and values (Ayantunde et al., 2011). Today's changing contexts raise the issue of the sustainability of pastoral systems. They face demographic, economic, sociopolitical and climatic pressures which drive many pastoralists to switch to non-livestock-based livelihood strategies (Barbier and Lopez-Ridaura, 2010). Despite the central function of livestock in reducing poverty and supporting food security in these countries (FAO, 2011), the sustainability of pastoralism is questioned.

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However, assessing sustainability of pastoral systems is still a major scientific issue. Concerning pastoral systems in Africa's arid lands, Ayantunde et al. (2011) stressed the need for a holistic approach to address the sustainability of pastoral systems, whereas many attempts have been made to address it from a single perspective. In the Organization for Economic Cooperation and Development (OECD) countries, many approaches have been developed to evaluate production systems from an environmental perspective, using methods such as the life cycle assessment (Van der Werf and Petit, 2002; Pierr, 2003). Some holistic approaches have recently been developed by researchers, with *ex ante* assessment of projects or scenarios (Terrier et al., 2010), or diagnoses of current situations (Lopez-Ridaura et al., 2002; Ripoll-Bosch et al., 2012).

In France, the IDEA⁴ method was the only multisectorial analysis identified by Guillaumin et al. (2009) in a review of available methods for extension services to evaluate the contribution of ruminant production to sustainable development. This method is based on the attribution of a sustainability score to a set of indicators, combining environmental, social and economic dimensions. The scores are attributed with respect to an ideal mixed crop-live-stock system. But the method is still not entirely satisfactory since it focuses on the farm and the land cultivated around it. Relations between the farm and the pastoral area over which the livestock moves are not taken into account. A diagnosis on the sustainability issues of each pastoral system needs to be performed in order to encourage debate between stakeholders without an *a priori* model of sustainable pastoralism.

The sustainability of a system can be assessed in several ways (Hopwood et al., 2005). Two main approaches are described in the literature. The first uses the definition of sustainability as a starting point for the construction of an assessment grid. In this case, the aim is to define sustainability using the scientific literature, official texts and/or participatory methods, and to use this definition as the basis. The second approach defines the object to be assessed as the basis for constructing the grid (Lopez-Ridaura et al., 2002). It consists in defining the systems, determining their main stakes, constraints and objectives, and using them to build the grid. We combined the two approaches in order to be i) as exhaustive as possible with respect to the sustainability concept, and ii) as close as possible to the specificities of pastoral systems.

Methods to develop a principles and criteria framework

Starting from a review of the literature on sustainability assessment, we built a framework based on 'principles' and 'criteria' that we called the Pastoral Systems Sustainability Assessment Framework (PSSAF), for further development of grids to enable a diagnostic approach of sustainability stakes for pastoral systems in their territories. Principles refer to the main topics that structure our assessment of sustainability. They can be used systematically for all kinds of systems but also reveal our point of view on sustainability (Boutaud and Brodhag, 2006). Given that a grid needs to be system specific, defining the criteria allows the introduction of items that are specific to the systems. In a final step, indicators represent the concrete information and data to be collected. These indicators must be specific to the territory as they depend on the socioeconomic and biophysical context as well as on the availability of data for each territory.

In order to develop principles, we first used knowledge of a pool of experts on pastoral systems. We then confronted our view on

pastoral systems to results/observations on sustainability in various fields in the literature (e.g. animal sciences, economics and social sciences).

To build the criteria, we used the literature and information collected during interviews with experts; 10 interviews were conducted with experts in research or development institutions in Senegal, and 15 in France. We selected the researchers based on their disciplinary approach (to ensure multidisciplinary points of view), and only in the French speaking scientific community (to make sure nuances could be expressed and understood during interviews). We included both private and public development organizations [consulting firms, non-governmental organizations (NGOs), government services] to ensure a wide range of discourse about pastoral systems wherever their location. This enabled us to achieve a high level of understanding of pastoral systems, and their technical, social and economic strategies. The range of experts we interviewed enabled us to highlight crucial strategic elements of pastoral systems, to assess the relevance of the 10 principles, and define the criteria for each principle.

RESULTS

Framework of three fields to be analyzed and ten principles

A territory provides certain resources (availability) for farming systems (Figure 1). A system must control access to resources (accessibility), has to cope with external shock (vulnerability), and finally has more or less influence on the territory (impacts). These elements were considered with the aim of maintaining the production system and ensuring its renewal. Moreover the aim of our grid was to enable assessment in the sense of the diagnosis of a system. We defined the main structure by referring to several theoretical corpuses on sustainability assessment through three fields of analysis:

- 'Availability of resources in the territory';
- 'Properties of the system';
- 'Extended sustainability'.

The fields chosen for the assessment grids had the advantage of allowing a transversal approach including the classic three pillars of sustainable development (economic, social and environmental). Within each field of analysis, we defined several principles based on our point of view on sustainability (Figure 2).

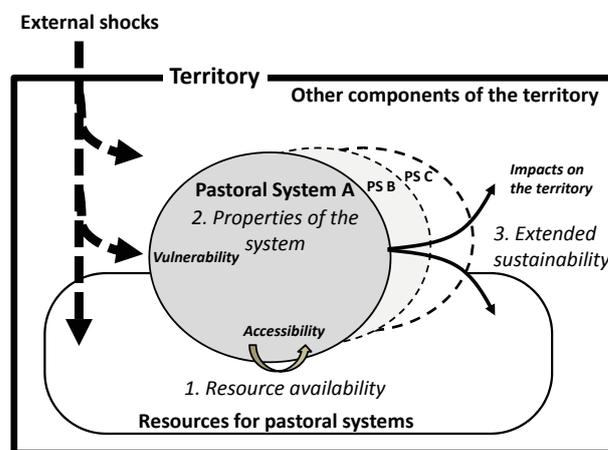


Figure 1: The object to be analyzed: a pastoral system in its territory.

4. Indicateurs de durabilité de l'exploitation agricole, i.e. farm sustainability indicators

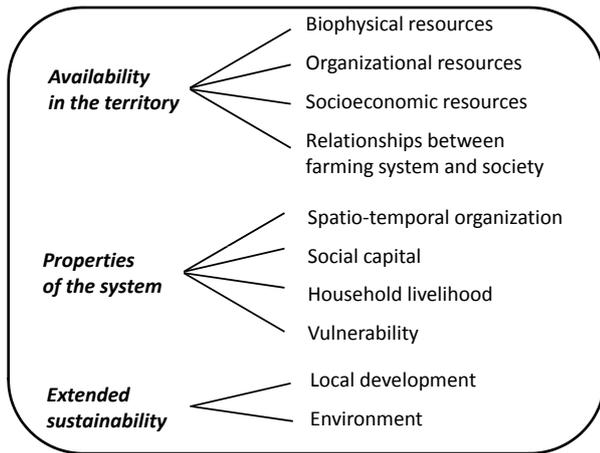


Figure 2: Ten principles grouped into three fields of analysis.

Availability of resources in the territory

Addressing the sustainability of systems at a territorial scale means analyzing factors that enable the renewal of the systems. Natural sciences mainly focus on the links between the human system and the biophysical environment, and consider environmental sustainability as the mainstay of natural capital (Goodland, 1995). In this approach, the environment is viewed as a resource for human systems so that one needs to preserve it. This approach led us to consider several components of the territory as resources for farming systems (Thompson and Nardone, 1999). This may concern the links between a farming system and its biophysical environment (as an ecosystem) but also its links with the territory as a whole, including economic and social interactions. We then considered the productive activity of the systems as well as their social and cultural dimensions. Here we defined a territory as “an area used and managed by human societies” (Brunet et al., 1992). We organized territorial resources in three categories of principles: i) biophysical, ii) organizational and iii) socioeconomic resources. Finally, under Availability of resources in the territory, we chose to introduce the notion of relationship between farming systems and society. Here we stressed the importance of assessing the cultural and political links between a farming system and the society in which the system is embedded.

Properties of the system

In parallel with the concept of resource availability, we analyzed the Properties of the system, firstly on the access to available resources and secondly on the vulnerability of the system. The notion of accessibility is a way of accounting for the capacity of a system to use available resources. Sen (1983) highlighted the need to distinguish between the availability of resources and their accessibility for the systems through system entitlements; individuals' entitlements are the economic, social, political characteristics that determine their access to goods and services (Bertin, 2003); they are also called capabilities by McKenzie (2004). In our approach to farming systems, we defined the capabilities of farming systems and their access to resources through the spatial organization and the economic and social capital. By Properties of the systems we meant the characteristics linked to the management of vulnerability. The vulnerability concept is frequently used to address the issues of sustainability and adaptation to global changes. In addition, it can be used to analyze socioecosystems (Décamps, 2007). The aim was to understand how a system reacts when it is affected by an external shock but also to measure its capacity to adapt to

more regular changes. We believe it is vital to consider this point in a rapidly changing world.

Extended sustainability

Finally, the sustainability of pastoral systems could refer to the balance between the outputs of the farming systems (environmentally and socioeconomically). We applied the concept of Extended sustainability developed by Terrier et al. (2010). We thus considered the different dimensions of how systems could contribute to the sustainability of territories. The field Extended sustainability concerned the assessment of the contribution of farming systems to the sustainability of territories. This implied assessing the contribution of farming systems to the biophysical environment (Zhang et al., 2007) as well as to local development. Determining their influence on local development required assessing their contribution to the conservation of rural life in a given territory, i.e. their social and economic consequences.

Definition and specificities of pastoral systems

To build the criteria associated with these principles, we used the definition of the specific object to be assessed, the pastoral system. We chose contrasted situations as analytical support (the South of France, North Africa, sub-Saharan Africa) and used a common definition of pastoral systems, i.e. extensive production systems based on herbivorous livestock rearing, on spontaneous resources (Daget and Godron, 1995). In sub-Saharan Africa, pastoralists rely mainly on spontaneous resources, sometimes providing cereals as supplementary feed during a drought, or crop residues after harvest (Homewood, 2008). In Mediterranean systems, spontaneous resources are used as often as possible, but during winter forage and cereals are very often provided as supplementary feed (Bourbouze and Lazarev, 1991).

Spontaneous resources vary considerably and are tightly linked to climate conditions. This sensitivity to climatic variations has major consequences for pastoral systems which have to cope with the temporal and spatial variability of resources and are generally organized around the growth pattern of the resource concerned. This means that the system requires large amounts of land if cheap resources are to be exploited all year round and may require two main types of strategies: i) mobility and ii) the management of resources of several different origins that depend on different forms of land tenure. Our aim was to design a grid able to assess pastoral systems using these two strategies.

The first specificity of pastoral systems, mobility, is linked to the spatial and temporal variability of resources. Several schemes have been developed to portray mobility (Adriansen, 1999; Homewood, 2008) in different regional contexts and including a wide range of durations and amplitudes. Regardless of the scale of mobility (within the farm, within the territory or between territories), we considered mobility as a way to cope with unpredictable events (Wiese et al., 2008; Adriansen, 1999). In practice, beyond seasonal variability of resources, extreme variability (for example drought) is often managed by pastoralists through mobility. This temporal and spatial flexibility is an advantage for pastoral systems in unpredictable conditions (Davies, 2008).

The second specificity of these systems is managing a variety of feed resources that differ not only in terms of botanical composition but also in terms of land tenure. The role played by land ownership varies considerably depending on the system concerned. For external resources, a wide range of land-tenure systems exists. Pastoralists have to cope with these different types of tenure (Thébaud and Batterbury, 2001) and they generally maintain long-term relationships with land managers to ensure regular access to the main

resources they need for their animals, but they may also need to develop rapidly other alliances for instance in case of extreme events or in the face of high uncertainty. Then in each social context, pastoralists need to belong to social networks to be efficient. Based on this definition and the specificities of pastoral systems, we proposed a set of appropriate criteria.

Criteria to characterize the three principles of sustainability of pastoral systems

Criteria related to Availability of resources in the territory

The main spontaneous resources for pastoral systems are range-land and water (Table I). They vary in time and space and involve several possible resource tenures. Their availability is critical for the survival of pastoral systems (Bouche, 2011). Among biophysical resources, we include both functional characteristics and resource renewal and their spatial distribution within the territory (Homewood, 2008). This implies assessing ecosystem dynamics (functioning and renewal) and the range of resources available in the territory (Von Wehrden et al., 2012).

Concerning organizational resources (Table I), some are linked with the management of pastoral resources (Thébaud and Battersbury, 2001). Land tenure, access rules, knowledge and social relationships must be considered to assess sustainability. The second part of organizational resources is not linked to the management of pastoral resources but to the variety of professional networks. These networks may be a major component of the sustainability of pastoral systems because of the role they play in day-to-day activities of the systems (health and technical services, marketing) but also their role in the need for change.

Socioeconomic resources were analyzed to evaluate the basic needs of a family (Table I). These included food security as well as quality of life. Unlike studies on food security in the literature, which are mainly based on household or individual food security (Maxwell and Frankenberger, 1992), we assessed global availability at the territorial scale combined with accessibility principles. The quality of life and welfare is far more complex and is specific to local contexts. Consequently, we suggest that grid users select the factors they consider the most important for the territory concerned, which may assess socioeconomic needs (education and health) as well as the quality of the natural environment.

Given that society is increasingly concerned with sustainable development, the relationship between society and farming systems needs to be identified as a precondition of sustainability. We analyzed this relationship as a potential territorial resource for farming systems based on social recognition of the systems and, as a consequence, politicians' commitment to ensuring the survival of pastoral systems in their own territories (Hesse and Thébaud, 2006).

Criteria related to Properties of the system

We addressed here the implicit Properties of the system (Table II), i.e. the accessibility of resources for the system (spatio-temporal organization, social capital, family resources) as well as the ability of the system to cope with uncertainty (level of vulnerability). Access to biophysical, organizational or socioeconomic resources, depends on several principles and related criteria. Maintaining mobility is crucial for the majority of pastoral systems worldwide. The sustainability of mobility can best be assessed by identifying constraints to mobility (access to pastures, family organization). Concerning spatial organization, many pastoral systems are located in remote areas far from resources that are important for professional and personal use. Criteria describing physical links or access to resources were defined here.

We defined social capital as a means of empowering families. Empowerment implies having access to social networks and related goods and services (Adger, 2003). We thus defined a way to characterize the rights of access and the position of the social group.

Table I

Principles and criteria applied to 'Availability of resources in the territory'

Principles	Domain of criteria	Main criteria
Biophysical resources	Vegetation	Functional diversity of spontaneous resources Renewal of spontaneous resources Secure area (spontaneous or cultivated)
	Water	Supply regularity Quality
	Spatial distribution	Existing infrastructures Land occupation Secure areas
Organizational resources	Management of pastoral resources	Access conditions Governance rules Knowledge transmission and renewal Relations between stakeholders
	Professional networks	Network range Dynamics and transformation Access conditions
Socioeconomic resources	Food security	Product range Regularity Price balance Product origin
	Quality of life	Socioeconomic Environmental
Relations between farming system and society	Recognition by society	Recognition of cultural heritage Likelihood of product consumption
	Political commitment	Inclusion of pastoral system in territorial projects Legislative framework Involvement of pastoral system representatives in political networks Support in case of emergency

Table II
Principles and criteria applied to
'Properties of the system'

Principles	Domain of criteria	Main criteria
Spatio-temporal organization	Mobility	Mobility factors Changes in access conditions Match with family life
	Personal and professional activities	Work organization Location in relation to resources Transport means Ability to preserve products
Social capital	Access right	Access conditions
	Social group characteristics	Internal dynamism System legitimacy in the territory
Household livelihood	Self-consumption	Food autonomy Regularity and periodicity
	Income	Income level Income functions Regularity and periodicity Income structure
Vulnerability	Exposure/sensitivity	Level of dependence / factor Fragility of the system Ability to anticipate
	Adaptive capacity	Buffering capacity / factor range Leeway/theme

Next, analyzing households implies assessing the ability of the system to ensure food security and create income. We thus included food autonomy and the regularity of food supply, since some pastoral systems are based on self-consumption strategies. Concerning the generation of income, we identified the different sources on the farm: livestock production and other activities. Multiactivities and complementary sources of income play a role in the accessibility of external resources for the system as well as in the adaptive capacity of the system (Scoones, 1998).

We proposed the principle of vulnerability by referring to the theoretical corpus of knowledge in the literature (Gallopín, 2006; Smit and Wandel, 2006). As a result, we based this principle on three criteria: exposure to disturbances, sensitivity, and adaptive capacity. Exposure to disturbances and sensitivity were treated together as suggested by Smit and Wandel (2006). To assess criteria related to the Properties of the system when faced with external disturbances, we suggested for instance analyzing the strength of the links that connect the system with the external factor concerned (these factors vary with the territory and will consequently need to be defined for

each new application of the grid). To assess the adaptive capacity of the system (Darnhofer et al., 2010) we used the concept of buffering capacity. We hence analyzed the capacity of the system to cope with a range of disturbance, possibly by temporarily modifying its functioning before returning to its original condition.

Criteria related to Extended sustainability

Concerning the impacts of a pastoral system on the environment, first principle in this field, several factors need to be mentioned (Table III). As these vary with the territory concerned, we did not write up a ready-to-use list but instead suggested two domains in which they can be classified: influences on pastoral resources, such as spontaneous renewable resources, and general influences (e.g. water, air). Here the aim was to draw up an inventory of different variables (around a specific topic) for a particular territory (de Wit et al., 1995; Payraudeau and van de Werf, 2005) to analyze their connection with pastoral systems and to classify them according to their domain of influence.

Concerning the second principle in the field Extended sustainability, pastoral systems can influence local development in different ways. The aim here was to evaluate the role of pastoral systems in maintaining rural dynamics in a territory. The evaluation could concern influences related to livestock production but also influences related to the survival of a society in the territory (Manoli et al., 2010). The location of pastoral systems in remote areas logically led us to include the demography issue, employment, and services as factors involved in the sustainability and development of territories. Specifically concerning the influences of livestock production activities, we suggested analyzing both their influence on wealth production and on market chain dynamics.

Table III

Principles and criteria applied to
'Extended sustainability'

Principles	Domain of criteria	Main criteria
Influences on the environment	Influences on pastoral resources	Pastoral resources structure, dynamics and productivity
	General influences	Other resources, dynamics
Influences on local development	Demography	People density
	Employment	Livestock related employment and others
	Services	Livestock related services and others
	Wealth production	Market value Cultural heritage value

DISCUSSION

The approach presented here (PSSAF) has a particular way of addressing the sustainability of systems. The field Availability of resources in the territory describes the territory (its biophysical and socioeconomic dimensions) and its capacity to host pastoral

systems. It is not limited to a stable situation but it assesses the possibilities for renewal based on the organization of the resources by stakeholders. This field has to be filled out only once for any given territory in a given period. The field Properties of the system covers the structural and functional characteristics of a system and its technical and economic performances. It has to be filled out for each system identified in the territory because the systems do not all share the same characteristics in terms of production, social groups and activities. Lastly, the field Extended sustainability specifies the impacts of each system on the territory. At this point, each system is assessed through its (positive or negative) externalities and its relative importance needs to be defined (e.g. number of families, total number of animals).

An original aspect of PSSAF was that we tried to avoid using a normative-technical approach (Barbier and Lopez-Ridaura, 2010). The only technical point concerning the system was the mobility criterion, which we considered to be a major condition for such systems to be classified as pastoral. In the absence of mobility, such systems lost their 'pastorality'. We designed the grid to enable a diagnostic analysis of systems in a particular territory, not to provide a model or to compare systems in different territories. As a consequence, this method allows studying a range of different pastoral systems, highlighting their weaknesses only from the point of view of their sustainability. This resulted in a large number of criteria, i.e. 54 for 10 principles. Its practical implementation is thus more time and labor consuming than IDEA (16 objectives for 41 indicators). But our objective was different: the designers of IDEA provided a more normative method to assess the capacity of farms to achieve the objectives proposed (Zahm et al., 2008). To this end, they established scores for several indicators and could consequently make comparisons. PSSAF is closer to EDAMA⁵ (Terrier et al., 2010) or EVAD⁶ (Chia et al., 2009), which are also time and labor consuming to implement (EDAMA: 32 themes and 61 indicators; EVAD: 13 principles and 81 criteria). The objectives of these methods are closer to ours, i.e. to perform a diagnosis of sustainability.

As a structured list of principles and criteria, PSSAF can be used by several kinds of stakeholders as it stands. Concerning its implementation, we suggested two alternatives, both based on the postulate that indicators need to be specific to the situation to be analyzed. The first is to use the grid containing principles and criteria as a support for discussion between the actors of a territory. Considering the wide range of stakeholders involved in the development of territories (e.g. collectivities, individuals, companies), this could be a very interactive way to encourage actions for sustainable development at territorial level. In this case, the aim is to reach a shared view of the sustainability of a territory and to encourage recommendations that result from actors' discussions concerning the choice of indicators. It is a way of promoting participatory approaches like MESMIS⁷ in the case of natural resources management in Mexican and Latin America contexts (Lopez-Ridaura et al., 2002), or EVAD in the case of analyses of an aqua cultural territory (Chia et al., 2009), which have been successful.

The second alternative consists in a development agent using the grid with its principles and criteria. The agent could be a consultant, or an NGO or administrative agent. In this case, the aim is then to build a set of specific indicators for a particular territory and to use it to perform a territorial diagnosis. A trial was conducted

between Luberon Natural Regional Park (PNRL) in France and the Center for Studies and Realization in Pastoral Mediterranean Alps (CERPAM) to test the ability of the grid to fulfill this function, i.e. perform a territorial diagnosis. PNRL and CERPAM have long been partners in the search to define and implement the best development policies of these areas. Their aim is to promote local development and environmental preservation of zones designated as protected areas (natural regional parks, biosphere reserves, Natura 2000 policies) and they felt that PSSAF was able to help them structure their diagnosis and therefore choose between several policy options. The analyses concerned the Luberon and the Lure mountains, where three pastoral systems coexist: Mediterranean ewes raised for meat, pre-Alpine ewes raised for meat, and dairy goats and ewes. A CERPAM and a PNRL agent started identifying sustainability indicators for their territories (e.g. quantitative or qualitative data, synthetic indicators, expert intuition). The experience confirmed the relevance of the method for expert analysis of sustainability as they were able to propose a first set of indicators after two days of work. Result analysis of this implementation of the grid will be the subject of a future paper.

The present global approach enables multiscale screening of the sustainability of pastoral systems in a given territory. Compared with other methods of assessing sustainability, PSSAF originality lies in the structure of the grid, which is not based on the usual three dimensions of sustainable development but on the relationships and links between the system and the territory, as well as on the properties of the systems. This makes it possible to use a cross-disciplinary approach to assess pastoral activities and their ability to ensure the sustainable development of territories.

REFERENCES

- Adger W.N., 2003. Social capital, collective action, and adaptation to climate change. *Econ. Geogr.*, **79** (4): 387-404
- Adriansen H.K., 1999. Pastoral mobility as a response to climate variability in African drylands. *Danish J. Geogr.*, **1**: 1-8
- Ayantunde A.A., de Leeuw J., Turner M.D., Said M., 2011. Challenges of assessing the sustainability of (agro-)pastoral systems. *Livest. Sci.*, **139**: 30-43
- Barbier J.M., Lopez-Ridaura S., 2010. Evaluation de la durabilité des systèmes de production agricoles : limites des démarches normatives et voies d'amélioration. Colloque ISDA 2010 Innovation et développement durable dans l'agriculture et l'agroalimentaire, Montpellier, France, 28-30 juin 2010
- Benchérif S., 2011. L'élevage pastoral et la céréaliculture dans la steppe algérienne. Evolution et possibilités de développement. Thèse Doct., AgroParisTech, Paris, France, 269 p.
- Bertin A., 2003. Glossaire des termes utilisés dans l'approche par les capacités. In : D'un développement viable à une liberté durable. Université Montesquieu-Bordeaux IV, Pessac, France, 29 p.
- Bouche R., 2011. Mediterranean pastorality: sustainable know-how in search of development. In: New trends for innovation in the Mediterranean animal production (Eds. Bouche R., Derkimba A., Casabianca F.). Wageningen Academic Publishers, Wageningen, Netherlands, 243-254 (EAAP publication No 129)
- Bourbouze A., Lazarev G., 1992. Typologie dynamique des systèmes pastoraux en Méditerranée. In : Actes 4^e Congrès int. des terres de parcours (Eds. Gaston A., Kernick M., Le Houérou H.N.). Cirad, Montpellier, France, 729-733
- Boutaud A., Brodhag C., 2006. Le développement durable, du global au local. Une analyse des outils d'évaluation des acteurs publics locaux. *Nat. Sci. Soc.*, **14** : 154-162
- Brunet R., Ferras R., Théry H., 1992. Les mots de la géographie. Dictionnaire critique. Reclus - La documentation française, Paris, France, 518 p.

5. Evaluation de la durabilité pour l'accompagnement des ménages agricoles

6. Evaluation de la durabilité des systèmes aquacoles

7. Marco para la evaluación de sistemas de manejo de recursos naturales incorporando indicadores de sustentabilidad

- Cantoni C., Lallau B., 2010. La résilience des Turkana. Une communauté de pasteurs kenyans à l'épreuve des incertitudes climatiques et politiques. *Dév. Durable Territ.*, **1** (2) : 2-19
- Chia E., Rey-Valette H., Lazard J., Clément O., Mathé S., 2009. Evaluer la durabilité des systèmes et des territoires aquacoles : proposition méthodologique. *Cah. Agric.*, **18** (2-3) : 211-219
- Daget P., Godron M., 1995. Pastoralisme : troupeaux, espaces et sociétés. Hatier Aupelf-Uref, Paris, France, 510 p.
- Darnhofer I., Bellon S., Dedieu B., Milestad R., 2010. Adaptiveness to enhance the sustainability of farming systems. A review. *Agron. Sustain. Dev.*, **30**: 545-555
- Davies J., 2008. Turning the tide: Enabling sustainable development for Africa's mobile pastoralists. *Nat. Res. Forum*, **32**: 175-184
- Décamps H., 2007. La vulnérabilité des systèmes socioécologiques aux événements extrêmes : exposition, sensibilité, résilience. *Nat. Sci. Soc.*, **15** : 48-52
- De Wit J., Oldenbroek J.K., van Keulen H., Zwart D., 1995. Criteria for sustainable livestock production: a proposal for implementation. *Agric. Ecosyst. Environ.*, **53**: 219-229
- FAO, 2001. Pastoralism in the New Millennium. FAO, Rome Italy. (Anim. Prod. Health Paper No 150) www.fao.org/docrep/005/y2647e/y2647e02.htm#P0_0
- FAO, 2011. World Livestock 2011. Livestock in food security. FAO, Rome, Italy.
- Fratkin E., Mearns R., 2003. Sustainability and pastoral livelihoods: lessons from East African Maasai and Mongolia. *Hum. Organ.*, **62**: 112-122
- Gallopin G.C., 2006. Linkages between vulnerability, resilience, and adaptive capacity. *Global Environ. Change*, **16**: 293-303
- Goodland R., 1995. The concept of environmental sustainability. *Annu. Rev. Ecol. Systematics*, **26**: 1-24
- Guillaumin A., Dockes A.C., Palazon R., 2009. La contribution des exploitations d'élevage au développement durable : état des lieux des méthodes d'évaluation et résultats. *Rencontres Rech. Rumin.*, **16** : 85-92
- Hesse C., Thébaud B., 2006. Will pastoral legislation disempower pastoralists in the Sahel? *Indigenous Aff.*, **1**: 14-23
- Homewood K., 2008. Ecology of African pastoralist societies. James Currey, Oxford, UK, 392 p.
- Hopwood B., Mellor M., O'Brien G., 2005. Sustainable development: mapping different approaches. *Sustain. Dev.*, **13**: 38-52
- Köchy M., Mathaj M., Jeltsch F., Malkinson D., 2008. Resilience of stocking capacity to changing climate in arid Mediterranean landscapes. *Reg. Environ. Change*, **8**: 73-87
- Lopez-Ridaura S., Masera O., Astier M., 2002. Evaluating the sustainability of complex socio-environmental systems. The MESMIS framework. *Ecol. Indic.*, **2**: 135-148
- Manoli C., Ickowicz A., Dedieu B., 2010. Livestock farming systems and local development: a review of the multiple dimensions of "Territory" in livestock science. Ninth European IFSA Symposium, Vienna, Austria, 4-7 July 2010
- Maxwell S., Frankenberger T.R., 1992. Household food security: Concepts, indicators, measurements. A technical review. UNICEF, New York, USA
- McKenzie S., 2004. Social sustainability: towards some definitions. Hawke Research Institute, University of South Australia, Magill, Australia, 31 p.
- Mosnier C., Ridier A., Képhaliacos C., Carpy-Goulard F., 2009. Economic and environmental impact of the CAP mid-term review on arable crop farming in South-Western France. *Ecol. Econ.*, **68**: 1408-1416
- Payraudeau S., van de Werf H.M.G., 2005. Environmental impact assessment for a farming region: a review of methods. *Agric. Ecosyst. Environ.*, **107**: 1-19
- Piorr H.P., 2003. Environmental policy, agri-environmental indicators and landscape indicators. *Agric. Ecosyst. Environ.*, **98**: 17-33
- Ripoll-Bosch R., Díez-Unquera B., Villalba D., Molina E., Joy M., Olaizola A., Bernués A., 2012. An integrated sustainability assessment of Mediterranean sheep farms with different degrees of intensification. *Agric. Syst.*, **105**: 46-56
- Scoones I., 1998. Sustainable rural livelihoods. A framework for analysis. *IDS Work. Paper*, **72**: 22 p.
- Sen A., 1983. Poor, relatively speaking. *Oxford Econ. Papers*, **35**: 153-169
- Smit B., Wandel J., 2006. Adaptation, adaptive capacity and vulnerability. *Global Environ. Change*, **16**: 282-292
- Terrier M., Gasselin P., Leblanc J., 2010. Assessing the sustainability of activity systems to support agricultural households' projects. Ninth European IFSA Symposium, Vienna, Austria, 4-7 July 2010
- Thébaud B., Batterbury S., 2001. Sahel pastoralists: opportunism, struggle, conflict and negotiation. A case study from Eastern Niger. *Global Environ. Change*, **11**: 69-78
- Thompson P.B., 1997. Sustainability as a norm. *Soc. Philos. Technol.*, **2** (2): 75-94
- Thompson P.B., Nardone A., 1999. Sustainable livestock production: methodological and ethical challenges. *Livest. Prod. Sci.*, **61**: 111-119
- Van der Werf H.M.G., Petit J., 2002. Evaluation of the environmental impact of agriculture at the farm level: a comparison and analysis of twelve indicator-based methods. *Agric., Ecosyst. Environ.*, **93** (3): 131-145
- Von Wehrden H., Hanspach J., Kaczensky P., Fischer J., Wesche K., 2012. Global assessment of the non-equilibrium concept in rangelands. *Ecol. Appl.*, **22** (2): 393-399
- Wiese M., Yosko I., Donnat M., 2008. Contribution à une approche intégrée du pastoralisme. Pauvreté, vulnérabilité et déséquilibre écologique. *Sécheresse*, **19** (4) : 237-243
- Zahm F., Viaux P., Vilain L., Girardin P., Mouchet C., 2008. Assessing farm sustainability with the IDEA method – from the concept of agriculture sustainability to case studies on farms. *Sustain. Dev.*, **16**: 271-281
- Zhang W., Ricketts T.H., Kremen C., Carney K., Swinton S.M., 2007. Ecosystem services and dis-services to agriculture. *Ecol. Econ.*, **64**: 253-260

Résumé

Lambert-Derkimba A., Aubron C., Ickowicz A., Touré I., Moulin C.-H. Méthode innovante pour évaluer la durabilité des systèmes pastoraux dans leurs territoires (PSSAF)

L'avenir des systèmes pastoraux et leurs interactions avec les territoires sont au cœur de débats majeurs dans la littérature scientifique et sont encore insuffisamment documentés. Évaluer la durabilité de ces systèmes pastoraux et leurs interactions avec la durabilité des territoires est donc une tâche complexe. Nous proposons dans cette étude une méthode pour évaluer la durabilité des systèmes pastoraux dans leurs territoires. Suite à un travail de synthèse bibliographique, nous avons conduit des entretiens auprès d'experts du pastoralisme en France et en Afrique sur le sujet de la durabilité de manière générale et de celle des systèmes pastoraux en particulier. Nous avons conçu une grille sur la base de l'approche principes-critères-indicateurs, en incluant 10 principes autour de trois thèmes majeurs que sont la disponibilité des ressources dans le territoire, les propriétés des systèmes, et la durabilité étendue. La compréhension des stratégies utilisées dans le cadre de l'activité pastorale nous a permis de proposer un jeu de critères spécifiques par principe. Enfin, nous discutons de cette nouvelle méthode au regard d'autres méthodes utilisées pour évaluer la durabilité.

Mots-clés : pastoralisme, territoire, durabilité, évaluation

Resumen

Lambert-Derkimba A., Aubron C., Ickowicz A., Touré I., Moulin C.-H. Método innovador para asesorar la sustentabilidad de los sistemas pastoriles en sus territorios (PSSAF)

El futuro de los sistemas pastoriles y sus interacciones con territorios son el foco de un debate considerable en la literatura científica y se encuentran aún insuficientemente documentados. Asesorar la sustentabilidad de los sistemas pastoriles y sus interacciones con la sustentabilidad de los territorios es por lo tanto una tarea compleja. Proponemos en este estudio un método para asesorar la sustentabilidad de los sistemas pastoriles dentro de sus territorios. Después de revisar la literatura, condujimos entrevistas con expertos en pastoreo en Francia y África sobre el tema de la sustentabilidad en general y en sistemas pastoriles en particular. Diseñamos nuestra cuadrícula según un enfoque en los principios-criterios-indicadores e incluimos 10 principios agrupados en tres campos mayores: la disponibilidad de los recursos en el territorio, las propiedades del sistema y la sustentabilidad duradera. Comprender las estrategias utilizadas en los sistemas pastoriles nos permitió proponer un set de criterios específicos por principio. Finalmente comparamos nuestra cuadrícula con otros métodos utilizados para asesorar la sustentabilidad.

Palabras clave: pastoralismo, territorio, sostenibilidad, evaluación