Towards the creation of a multidisciplinary and multi-institution research platform / Consortium in the EA Highlands :

Concept note

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The objective of this document is to provide some background and the framework for the scientific project of the proposed Research Platform (or Consortium) in East Africa, and determine its contours. This platform is dedicated to the management of functional diversity of landscapes in the context of the High Plateaus of East Africa (HPEA) for enhancing agricultural production and adaptation of rural communities to changes. This document reflects the discussions and comments made by participants at the seminar held in Nairobi in November 2011 “Management of functional diversity of landscapes in the context of the High Plateaus of East Africa”

1. Context

Kenya, Uganda, Ethiopia, Tanzania, Burundi and Ruanda share most of the high plateaus of East Africa (>1000m asl) that concentrate a large part of the rural population of these countries. Biophysical features are extremely variable according to this altitudinal stratification, and these plateaus are thus characterized by a high level of natural and agro-ecological diversity, resulting in very diverse landscapes at both local and regionalscales. From the agricultural point of view, topography generates a very high spatial diversity in terms of climate and hence agricultural potentials with two rainy seasons and high rainfall regimes in some humid zones to one rainy season with erratic rainfall pattern in more arid areas. Along with this biophysical diversity, the HPEA are also characterized by a high ethnic and linguistic diversity, with for example approximately 70 languages spoken in Kenya. The presence of both family and industrial farming systems that interact in a number of major production areas (tea, coffee, sugar cane, banana, horticulture and flower production, …) also adds to this diversity.
Despite their high agricultural potential, HPEA are characterized by a high level of poverty due to the fact that this region has among the highest population density in the rural world (farm ≤ 1ha). Increasing population pressure is leading to the degradation of natural resources. This is particularly true of forests and natural biodiversity, water, related to a massive deforestation of arable areas, or the fertility of cultivated soils. Due to landscape saturation, expansion of agricultural activity is not possible and rural development relies essentially on production intensification (Pender et al., 2006). In relation with the diversity of farming systems, two strategies for intensifying co-exist according to (i) specialized low diversity (SLD) model on large scale farms and nucleus, and (ii) highly diversified model by smallholders.

The scarcity of water, fertilizers and energy, combined with the increasing cost of fossil fuel, render the SLD model less financially attractive for large farm systems and out of reach for most smallholders. In light of this analysis, Matson et al. (1997), Cassman (1999), Altieri (1999) and Doré et al. (2011) advocated for an ‘ecological intensification’, based on the consideration of ecological processes, traditional knowledge of farmers in addition to academic knowledge in genetics and plant sciences. In

landscapes where smallholders' agriculture is predominant, high diversification of activities is intentionally maintained as (i) a strategy to avoid relying on a single crop in case of failure, (ii) a mean to reduce the incidence of pests and diseases and (iii) a way to spread out labour demand over time (Netting and Stone, 1996 ; Conelly et Chaiken, 2000). Yet, despite a long agricultural tradition and a sophistication of their practices with respect to diversification and exploitation of spatial and temporal biodiversity, rural societies are increasingly exposed to risks with regard to food security in the context of climate change (Mati, 2000).
High plateau ecosystems are most affected by global change, both by the direct effect of global warming and by changes in agricultural and pastoral practices (Hill et al., 2002). Moreover globalization of markets and practices is a threat to biodiversity and local knowledge associated, either in terms of variety of local species whose use (food, medicine, energy ...) is lost, and traditions in ecosystem management.

2. Target of the platform/consortium

We propose a platform for (i) assembling multi-disciplinary academic knowledge and local knowledge, in order to (ii) improve the management and the mobilization of the functional diversity of landscapes in the context of HPEA, to serve agricultural production and the adaptation of rural societies facing changes.
The proposal consists in studying fluxes (organisms, material and energy), natural, induced or performed by farmers: (i) At the interface of ecosystems, intra-community (topography, natural, lake …) and/or inter-community (urban vicinity, industrial crop, Highland periphery …), in respect to production, ecological and social sustainability, (ii) For the provision of ecosystem services, with a particular focus on regulation (pest, disease, water), (iii) In order to mitigating anthropic perturbations (dominant practice / maize, GMO …) in respect to biodiversity and resilience.

Challenge is to combine the 'top-down' approach of scholars in ecology, economy, … to serve public policies in terms of land use, ecosystem services and valuation, and the 'bottom-up' approach of agronomic disciplines, to inform farmer decisions (individual action) and those of rural communities (collective action). This challenge refers to the pressing call by Fischer and Lindenmayer (2007) or Ostrom (2009) for a multi-disciplinary approach to rural development and sustainability of social-ecological systems as echoed by Chevassus au Louis (2006) as "a global agronomy" based on a triple alliance of agronomic, social and ecological sciences.

3. Assumptions

Technical innovation at field and farm organization levels is required but not sufficient in order to improve the well-being of rural societies through enhanced capacities to adapt to global changes. A coordination of actions at higher levels of organization, both social and ecological, is thus required
Landscape is the appropriate level to study with a holistic approach the resource uses by stakeholders resulting in sustainable productions and environment. Agricultural landscapes are heterogeneous due to (i) ecological heterogeneity in relation to environmental characteristics (climate, soil, topography, vegetation …) and (ii) social heterogeneity in relation to socio-economic environment (culture, techniques, market, rights, physical access to resource ...). This heterogeneity is key to many processes involved in the provision of services by ecosystems. Although most of these services are relevant to agricultural

production, other services are also affected (e.g. biodiversity conservation attracting tourism). The viability of multifunctional landscapes is thus essential for well being of rural populations.

HPAE landscapes exhibit a high level of heterogeneity due to complex social processes and a diversity of bio-physical properties. Such situation provides an ideal laboratory for observation (i) to capture local knowledge about ecological processes, (ii) to disentangle social and ecological mechanisms involved in 'in situ' conservation. Moreover, these systems provide thermal gradients and ecological adaptations that enable the study of existing species and communities (flora and fauna), and their responses to change (Becker et al., 2007).

4. Conceptual framework

The proposed conceptual framework is based on the concept of 'Ecological intensification', adapted to HPEA context in regard to (i) the small size of fields and farms (fine landscape grain) and its consequences on smallholders wellbeing and the provision of ecosystem services (ii) the plurality of socio-professional organizations interacting in the production process, and (iii) a limited access to resources socially and spatially distributed.

Level of analysis

The Social-Ecological System" (SES) is defined by the Resilience Alliance (http://www.resalliance.org) as a set of dynamic interacting biological and social factors between populations, societies and the environment (figure 1). The system resilience relies on the sustainability of the resource together with that of the social group managing this resource. This supposes that the social group has the adaptation capacity to buffer the exposition of the ecosystem or regulate its sensitivity to changes, especially climatic ones. To the extent that both concepts of ecosystem and society are dimensionless, this SES representation is as well applicable to farmers in the area of the field and farm as to other types of organization, i.e. local communities, agricultural chain supply or groups formed for the provision of environmental services, respectively on spaces corresponding to the village, the production basin or a watershed for instance.

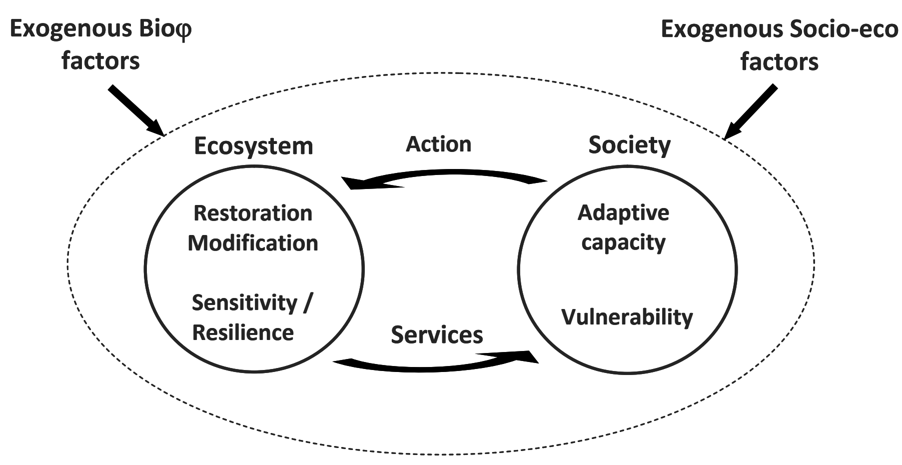

Figure 1: The Social-Ecological-System associates a society with an ecosystem on which it acts to obtain services in a environment fluctuating biophysically such as with climatic changes or socially such as with market fluctuations or public policy (adapted from Locatelli et al., 2008).

Ecological complexity

To take into account the phenomena involved in the ecosystem functions, ecology has developed a representation of ecosystems that relies on spatial heterogeneity and the existence of fluxes between patches over time and space (Haila, 2002 ; Vandermeer and Perfecto 2007).
This representation applies notably to the study of fluxes of organisms, matter and energy as well as their regulation within the framework of spatial ecology, according to the three dimensions of bio-complexity, i.e. spatial heterogeneity, organizational connectivity, and temporal contingencies (Pickett et Cadenasso, 1995 ; Cadenasso et al., 2006).

Dealing with socio-ecological complexity

Ecological complexity is superimposed on the social complexity induced by multiple organizations interacting in a given space, each responsible for particular resource management, and according to a specific mode of governance (local communities, project of rural development, commodity chain, etc.). To study the sustainability of interconnected SES in its social and ecological performance, Ostrom (2009) proposes an analytical framework, based on the interaction between (i) Resource system, (ii) Resource units, (iii) Governance system, and (iv) Users. In this framework, knowledge is considered as a subcomponent of the Users (knowledge of SES, mental representations,) and the Governance system (rules of collective choice, …). In terms of analysis, these four components of SESs are involved in the evaluation of society ability to self-organize in response to a perturbation or changes.

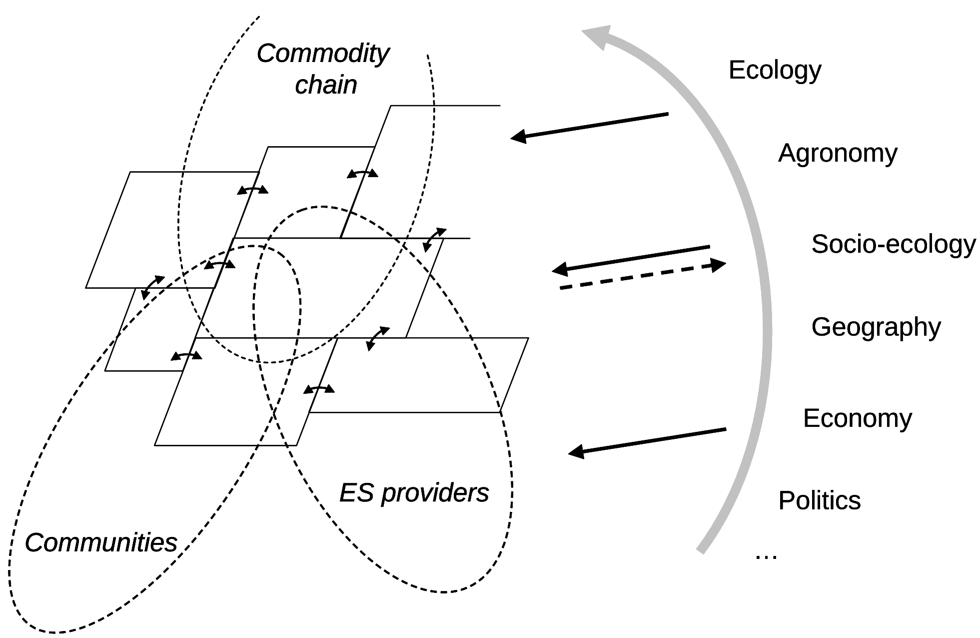

Figure 2: The Social-Ecological System (SES) according to the two levels of ecological (functional patch dynamics: insect fluxes vs. crop mosaic for instance) and social complexity (linked SESs), all interacting with Research through academic (solid line) and profane (dotted line) knowledge.

Each organization operates on the basis of knowledge, traditional, technical and academic, whose composition forms a system of knowledge mobilized for action. In light of the proposed objectives, the ambition of the platform is to contribute to (i) the emergence of a knowledge system (bottom-up) and (ii) the proposition of economical and political incentive (top-down) to promote the self-organization of rural societies exposed to changes. The composition of the two ways of impacting SES, bottom-up and top-down, leads us to propose the block diagram shown in Figure 2.

5. Hypothesis

- The diversity of biophysical, ecological and social/institutional features allow access to diversified resources and livelihood options which should enhance the capacity of HPEA socio-ecological systems to adapt to external perturbations (market, climate changes …).
- Most farmers remain 'out of reach' of official extension services (invisible farmers). These populations represent a pool of knowledge in the management of the agro-ecosystem at the field, farm and community levels.
- Despite a high level of diversity of species at farm level, the example of fruit trees shows that only 3% of the existing biodiversity is used as official commodities. 'Informal' markets are thus acting, assuring the commercialization of 'active' and 'passive' production by farmers. These so-called informal markets and underlying organizations are actively involved in the biodiversity of agro-ecosystems.
- Because of changes already being experimented by farmers (e.g. ongoing transformation of coffee to vegetable based cropping systems because of climate change), research can observe the processes underlying adaptation to change.
- Through a better understanding of the processes underlying adaptations of HPEA SES to changes, research can significantly contribute to improved well-being of farmers and sustainability of agro-ecological systems

6. Contours and case study

During the workshop in Nairobi, participants (Appendix I and II) have agreed to define the area of study based on an altitude level. Highlands are between 1000 - 2300 m. However, in addition to adaptation issues facing the people of the Highlands, we will consider also the interactions of highland agricultural systems with the upper boundary (= forest) but also the impact of these highland systems on the lowlands.

In reference to the framework proposed by Ostrom (2009), the table 1 shows the different case studies discussed during the workshop. This list is not exhaustive; the aim here is merely to illustrate the spectrum of work covered by the participants.

Resource system	Resource units	Governance syst.	Users	Outcomes
Agro-ecosystem	Genetic biodiversity of food crops	Ethnic rules	Farmers, linguistic groups, …	In-situ conservation
Agro-ecosystem	Specific biodiversity / local species	Network structure	Farmers, traders, consumers	Nutrition, diversification, biodiversity
Tree-coffee-food crop systems	Ecosystem biodiversity	Operating rules	Farmers, formal and informal chain supply	Efficiency, sustainability, resilience
Coffee system and boundaries	Interactions among resource units	Operational rules	Farmers, cooperatives	Sustainability
Sugar cane-food crop-livestock systems	Interactions among resource units (water, input, biomass, …)	Technology used, location	Smallholders, large farms, nucleus	Efficiency, sustainability
Functional HPEA landscape	Landscape composition and structure	Collective-choice rules	Farmers / communities	Pest regulation, resilience
Lake / ponds) x cultivated area	Interactions among resource units	Technology used, location	Farmers, community, chain supply	Biodiversity, sustainability
Forest x cultivated area interaction	Water, biomass, widelife	Operational and constitutional rules	Farmers, park manager	Conservation, sustainability
High x Low-land interaction	Habitat, trophic chain,	Operational rules	Farmers, community, politics	Pest regulation, externalities to other SESs
High - Low land interaction	Water, soil	Operational rules	Communities, History of use	Equity, sustainability, externality to other SESs
…				

Table 1: case studies presented or discussed during the workshop in Nairobi: "Management of functional diversity of landscapes in the context of the High Plateaus of East Africa: Towards the development of a Research Platform…" in November 22 and 23, 2011. The column headings correspond to the subsystems proposed by Ostrom (2009) for analyzing the sustainability of social-ecological systems.

7. Research groups

The term « perspective » is proposed to emphasize the need for further interactions between working groups tackling the various objects and research topics listed below.

Perspective 1: Mechanisms

This research group will focus on the study of the mechanisms involved in the shaping of functional landscapes, in relation to (i) biophysical properties vs. the lateral fluxes (organisms, matter & energy) and (ii) human organization, dealing with biodiversity and landscape structure.

Questions of research!
- Landscape organization vs. lateral fluxes and regulation / academic knowledge?
- What boundaries (area / social organization) vs. the management of ecosystem services?
- Adaptation to changes and ‘perturbations’, Maize generalization, GMO?
- Local landraces vs genetic biodiversity, risk mitigation?
- Integrating ponds and landscape?
- Difference in gender behavior?
- Multitrophic interaction soil-disease? Water availability, properties?

Perspective 2: Management of knowledge:

This working group focuses on the development of methods to (i) formalize local knowledge, (ii) develop multi-disciplinary scientific knowledge (databases,..), and (iii) combine local and scientific knowledge. The methodology implemented mobilizes techniques revolving around ‘knowledge management’.

Questions of research!
- Local knowledge vs. individual vs. collective action: hierarchy, trade-off?
- Network approach of knowledge systems: how improve the understanding of the drivers?
- IPM, why by farmers?, what benefit? => requires understanding the socio-technical drivers
- What methodology for extension in regard to heterogeneity and multifunctional landscapes?

Perspective 3: Functional organization of landscape

This working group is dedicated to implementing novel approaches of complexity and principles developed above, within the framework of participatory projects.

Questions of research!
- Governance vs landscape functional organization, social equity?
- How to incentivize adoption by resource-poor households of beneficial, sustainable yet profitable practices?
- How vulnerability interact with practices? => requires land use practices better understanding
- Adaptation to climate change / the role of toposequence?
- Typology of landscapes: main commodities, resilience to external drivers.

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Appendix I : 'Management of functional diversity of landscapes in the context of the High Plateaus of East Africa: Towards the development of a Research Platform', Nairobi 22 et 23 Novembre 2012 : **workshop participants**.

Organisme	Pays	Détachement	Noms
CIRAD	France		P. Bonnet (ES) ; P. Clouvel, P. Martin (Persyst)
	Kenya		J. Lançon (DRE)
		ICRAF	P. Vaast (Persyst)
		ICIPE	F. Pinard (Bios)
			C. Mwongera (Bios)
	Zimbabwe		M. de Garine (RP-PCP)
	Uganda	ASARECA	J. Lazard (DRE)
IRD	Kenya		J. Albergel (Représentant)
		ICIPE	P. Calatayud
		ICRAF	D. Wiliamson
INRA	France		J. Baudry
KARI	Kenya		F. Makini (Dr adjoint / partenariat), P.T. Kamoni
KESREF	Kenya		B. Mulianga
ICRAF	Kenya		F. Sinclair (Dr / Production Ecology), J. Oduol, Miyuki Iiyama
ICIPE	Kenya		T. Johansson, J. Jamarillo, B. Nyambo
IITA	Ouganda		Piet van Asten, L. Jassogne
ICRISAT	Kenya		D. Harris, L. Claessens
BIOVERSITY	Kenya		Y. Morimoto
CIMMYT	Ethiopie		F. Baudron
SCAC	Kenya		S. Fogel

Appendix II : Personal / Institution interest

- ICRISAT has a mandate for research into many of the crops mentioned during Caroline Mwongera's presentation and my research interest (Dr Dave Harris) lies in the linkages between individual household decisions and the aggregate effects on the landscape. I would thus propose a major research theme on this issue – how to incentivize adoption by resource-poor households of beneficial, sustainable yet profitable practices.
- Dr P.T. Kamoni (KARI): soil scientist Interest: land degradation, rehabilitatioon, sustainable management of land resources and sociologic aspects that influence management practices. Contribution: sustainable land management, environmental conservation. Proper management of ecosystem requires proper management of natural resources. Water conservation downstream.
- Dr L. Jassogne (IITA) definition of the research area: humid tropics. The broad research question to me would be to understand the complexity of smallholder agricultural systems. Understanding there drivers at all levels and also the diversity of innovations they put through their systems. One thing though I would really find an added value (and this is related to the experience of the CIALCA project) is involving stakeholders along the value chain (farmer groups, ngo's, decision makers etc.), to not only create a horizontal knowledge base, but also getting this knowledge through to vertical chain.
- IITA (Dr Piet van Asten) : from IITA side, it was particularly interesting to learn about the crop and landscape analyses along East African altitude/climate gradients in the (semi-)humid highlands. The issues related to crop, farm, and land-use management and trade-offs across scales in the coffee growing areas was of particular interest and I understood from Laurence that this first exchange already lead to agreed visits from Philippe and Fergus to Uganda… when the opportunity arises. So, as you can see, the platform idea already starts to bear fruit. The topic of biophysical and socio-economic trade-offs across scales (plant – plot – farm – village - region) in the coffee-growing regions certainly has our strong interest and of several colleagues that were present. Hence, this is certainly a thematic area where we would love to contribute and participate.
- CIMMYT (Ethiopia): Dr F. Baudrons's interest: interactions between crop management - e.g. keeping residues as soil cover in CA systems vs. ploughing them in, landscape matrix and population dynamics of stalk borer.
- ICIPE : Dr Paul Calatayud : Noctuid Stem Borers Biodiversity in Africa (NSBB): A Joint IRD (France)-ICIPE Program. The NSBB team is part of an IRD Research Unit, which is part of the recently established French Institute for the Diversity, Ecology and Evolution of the Living World (IDEEV) that brings together scientists from French institutions (IRD, CNRS and INRA) and a French University (Paris XI-Orsay University). The team is working with ICIPE since 2001 and the overall research program focuses on the response of tropical insects to global changes and on biodiversity and evolution of insects.

Tropical insects, like those of other parts of the world, respond to global change, which can be the result of direct anthropic effects on tropical ecosystems (wild habitat fragmentation and destruction) or of indirect consequences of human activities (global warming and increased atmospheric CO_2 concentration). Our research program aims at characterizing and quantifying these responses to allow for estimating their ecological consequences on entomological communities, habitats, landscapes and agro-ecosystems. In this context, the main research activities of the NSBB team at ICIPE encompass: 1) the characterization of global changes in two main regions (Africa and South America) where drivers gradients have been established, 2) to study the effect of these factors on insects at the level of individuals, populations and communities, and 3) to integrate these results into predictive models.

ASARECA: The Association for Strengthening Agricultural Research in Eastern and Central Africa is a non-political organization of the National Agricultural Research Systems (NARS) of ten countries: Burundi, D. R. Congo, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Sudan, Tanzania and Uganda. It aims at increasing the efficiency of agricultural research in the region so as to facilitate economic growth, food security and export competitiveness through productive and sustainable agriculture. Its mission is to enhance regional collective action in agricultural research for development, extension and agricultural training and education to promote economic growth, fight poverty, eradicate hunger and enhance sustainable use of resources in Eastern and Central Africa (ECA). A large area of the countries concerned by ASARECA investigations is located in "High Plateaus of East Africa" and are concerned by the proposed platform. Moreover, all the research programmes of ASARECA may be concerned and involved: staple crops, non-staple crops, agro-biodiversity and biotechnology, livestock and fisheries, natural resource management and forestry, policy analysis and advocacy.

- KESREF (Kenya Sugar Research Foundation) is mandated to develop and disseminate appropriate technologies for enhanced productivity, value-addition and competitiveness of the sub-sector. It is interested in functional landscape heterogeneity focusing on diversity, interactions between small scale and large scale farming systems, crop intensification and environmental services (Betty Mulianga)..