Appendix 2. Individual and group mental models methods and results

MENTAL MODELS ELICITATION INTERVIEWS

Interviews took place at farmers' house. They lasted on average 1 hour and a half (+/- 38 min). Before starting, the area of study was presented on a map with only rivers and main cities and the methodology was explained with an example. The overarching question was: "how would you describe the functioning of the local agricultural landscape?" It was then split into three specific sub-questions to help the respondents formalize the representation of their individual mental models: (1) who are the main stakeholders that have an impact on the local agricultural landscape? (2) What are the main biophysical components of the local agricultural landscape? (3) What are the main processes and drivers of change that changed or that you foresee are likely to change the local agricultural landscape within a decade timeframe? Each of these questions led the respondent to create three lists of items that were written as they cited them. Farmers were free to cite any concepts they liked within the frame described above, no predefined categories or examples related to the subject of the interview were given. However, in order for them to familiarize with the elicitation method a simple model representing the interviewer's mental model of the "interview system" was showed and explained beforehand. The next step consisted in iteratively drawing a network by linking the previously cited item. The instructions for this drawing step were: describe how do these concepts interacts for you. How do stakeholders interact with each other and with the landscape components, how are components interrelated and how do they impact stakeholders, how do drivers of change influence the system?

The respondents gave instructions to the interviewer on how to link the concepts by indicating concepts to be linked, link direction) and named the links through an action verb. This fourth step was completed using a laptop and the Cmap Tool software (Florida Institute for Human and Machine Cognition (IHMC) http://cmap.ihmc.us/). It allowed building and amending the concept map in front of the interviewee who was able to control directly that his words were correctly understood. Respondents could select concepts from the list they had established beforehand with no obligation of selecting all of the items and they were allowed to add some if they felt it necessary.

Below is an example of results from an interview (in French):

(1) Who are the main stakeholders that have an impact on the local agricultural landscape?
  – Agriculteurs
  – Europe
(2) What are the main biophysical components of the local agricultural landscape?
  – Forêt
  – Forme des terrains (relief)
  – Rivières
  – Talus
  – Champs
  – Faune et flore sauvage
(3) What are the main processes and drivers of change that changed or that you foresee are likely to change the local agricultural landscape within a decade timeframe?
  – Manque de main d'œuvre agricole
  – Plus de céréales
  – Moins d'élevage
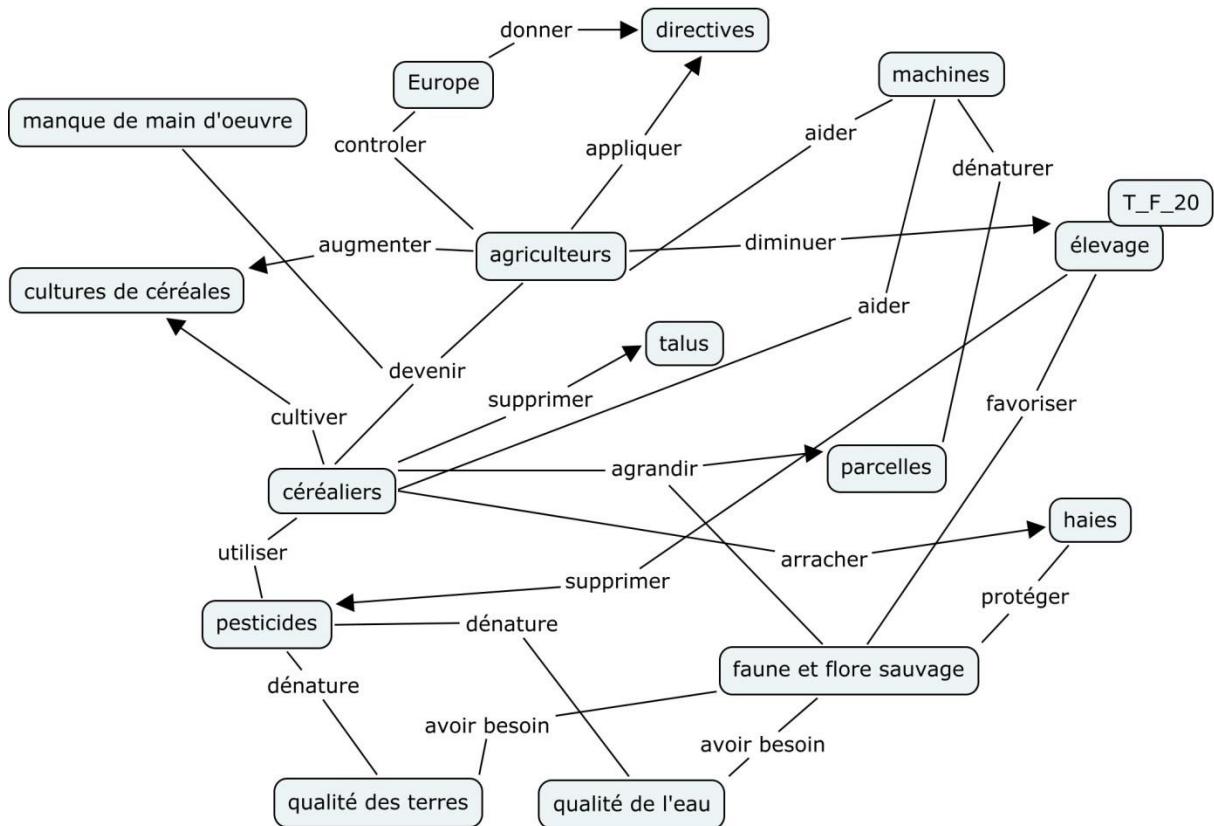
– Plus de pollution (produits chimiques)

Figure A2.1 Example of an original ICM

CONCEPTS CATEGORIZATION

During the IMMS elicitation interviews, farmers were free to cite, select and add any concept they liked to their conceptual map and link them in their own way. This led to a great variety of concepts and links included in the ICMs. As we were interested in similarities between ICMs, we condensed concepts that had a close meaning into a broader combined category using qualitative aggregation (Özesmi and Özesmi 2003). Following Carley's and Palmquist's (1992) idea that, within an IMM, the meaning of a concept is embedded in its links to other concepts, we ensured the reliability of the categorization process by systematically referring to ICMs to check whether the meaning of the category was consistent with the links flowing through the concepts. We then consolidated the categories by cross checking them with three different researchers (CV, AG, RM) until an agreement was reached. Below are some examples of aggregated categories (Table A2.1).

Table A2.1. Examples of the qualitative aggregation process: for each broader category, the original words uttered by farmers we included in this broader category are indicated (in French)

BROADER CATEGORY	ORIGINAL CONCEPTS (in French)
farmers	agriculteurs; agriculteurs et éleveurs ; anciens agriculteurs ; céréaliers ; éleveurs ; jeunes agriculteurs ; paysans ; polyculture élevage
local authorities	CG ; collectivités ; communautés de communes ; communes ; conseil général ; conseil municipal ; employés de la voirie ; maire ; mairies ; politiques
agricultural marketing cooperatives	techniciens coop ; coopératives
Europe and CAP	Bruxelles ; Europe ; PAC
local population	citadins ; citoyens ; habitants ; habitants locaux ; néoruraux ; nouveaux arrivants ; promeneurs ; retraités ; familles des villages ; gens de l'extérieur ; villages
livestock	animaux ; animaux d'élevage ; bovins lait ; bovins viande ; élevage ; moutons ; troupeaux ; vaches ; animaux domestiques ; bovins ; vaches à lait ; vaches à viande ; vaches et moutons
grass strips	bandes enherbées
agricultural buildings	bâtiments agricoles ; bâtiments d'élevage ; construction neuves ; constructions agricoles ; constructions agricoles photovoltaïques ; hangar photovoltaïque ; stabulation
woods and forests	bois ; forêts
paths and roads	chemins communaux ; routes ; routes et abords des routes ; voirie
annual crops	blé ; céréales ; céréales d'hiver ; colza ; cultures ; cultures de céréales ; cultures sèches ; maïs ; céréales à paille ; céréales de printemps ; maïs tournesol ; récoltes de printemps (maïs, soja) ; soja ; surfaces en cultures ; tournesol
agricultural holdings	exploitations agricoles ; petites exploitations
wild fauna	abeilles ; abeilles (petite noire) ; chevreuil et lièvre ; faune sauvage ; gibier ; insectes ; lapins ; lièvres ; blaireaux ; chevreuil ; limaces ; palombes ; perdreaux ; poissons ; ragondins ; sangliers
hedgerows	arbres ; haies ; haies pérennes ; talus
chemical inputs	chimie ; désherbants ; engrais ; engrais minéraux ; pesticides ; phyto ; produits ; produits phyto
agricultural machines	engins agricoles ; machines agricoles ; matériel agricole ; tracteurs
cultivated plots	champs ; grandes parcelles bien parallèles ; parcelles ; terre cultivées ; terres agricoles
grasslands	cultures en herbe ; enherbement ; herbe ; prairies ; prairies artificielles ; prairies naturelles ; prairies temporaires ; prairies permanentes ; prés verts
slopes	coteaux ; fortes pentes ; parcelles difficiles d'accès ; pentes ; relief ; terre accidentée ; terre difficiles à travailler ; terres en coteaux plus de 20% ; topographie ; vallons très pentus

world market prices	adaptation aux marchés ; augmentation du prix des céréales ; cours du marché de la viande ; cours du marché des céréales ; marchés ; prix ; prix de vente ; prix des céréales ; baisse des prix de vente ; contexte financier ; prix du marché
water quality	qualité de l'eau
soil quality	bonne terre ; couleur du sol ; qualité des terres ; matière organique ; vie du sol
production costs	augmentation du prix du pétrole ; couts de production ; couts de revient ; couts de transport ; prix du gazole
problems in farms transmission	départs à la retraite ; départs à la retraite sans successeur ; diminution du nombre d'exploitations ; installations ; reprise par les petits ; transmission des exploitations ; vieillissement des agriculteurs ; départs des agriculteurs ; difficulté à s'installer pour les jeunes
upgrading of farm equipment	grossissement du matériel ; mécanisation ; modernisation du matériel

COMPARISON OF ICM STRUCTURES

For each typology, we looked at differences between groups in terms of ICM structure, using graph theory indicators (Vanwindekens et al. 2014). We used indicators such as concept centrality (total number of links going from or going to a concept), indegree (total number of links going to a concept) and outdegree (total number of links going from a concept) and compared the distribution of these indicators between groups using a Kruskal-Wallis rank sum test. We found no statistically significant differences in terms of concept centrality, indegree and outdegree after controlling for false positive and false negative detection rates using Benjamini-Hochberg p-value adjustment technique.

LITERATURE CITED

Özesmi, U., and S. Özesmi. 2003. A participatory approach to ecosystem conservation: fuzzy cognitive maps and stakeholder group analysis in Uluabat Lake, Turkey. *Environmental management* 31(4):518–531.

Vanwindekens, F. M., P. V. Baret, and D. Stilmant. 2014. A new approach for comparing and categorizing farmers' systems of practice based on cognitive mapping and graph theory indicators. *Ecological Modelling* 274:1–11.