Using ecological methodologies to sample anomalies in LPIS
First results and LPIS quality perspectives

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FRAMEWORK

Since the latest 2003 "*Fischler*" reform, I [st] pillar CAP supports are decoupled from the production and calculated from the eligible area of a parcel. A parcel is eligible *inter alia* when the area declared by the farmer is equal or lower to the reference parcel area contained within the Land Parcel Identification System (LPIS). Excessive declared area induces supplementary controls and potential subsidies withdrawal when irregularity is found. Generally, reference parcel areas are computer-assisted photo-interpreted (CAPI) from satellite imagery. Whatever the progresses made to have accurate images at one's disposal, effective CAPI methods and standardized procedures, it would be utopia to consider reference areas in LPIS as true. So, CAP supports allocation could be regarded as doubtful until quality assessment of LPIS is not undertaken.

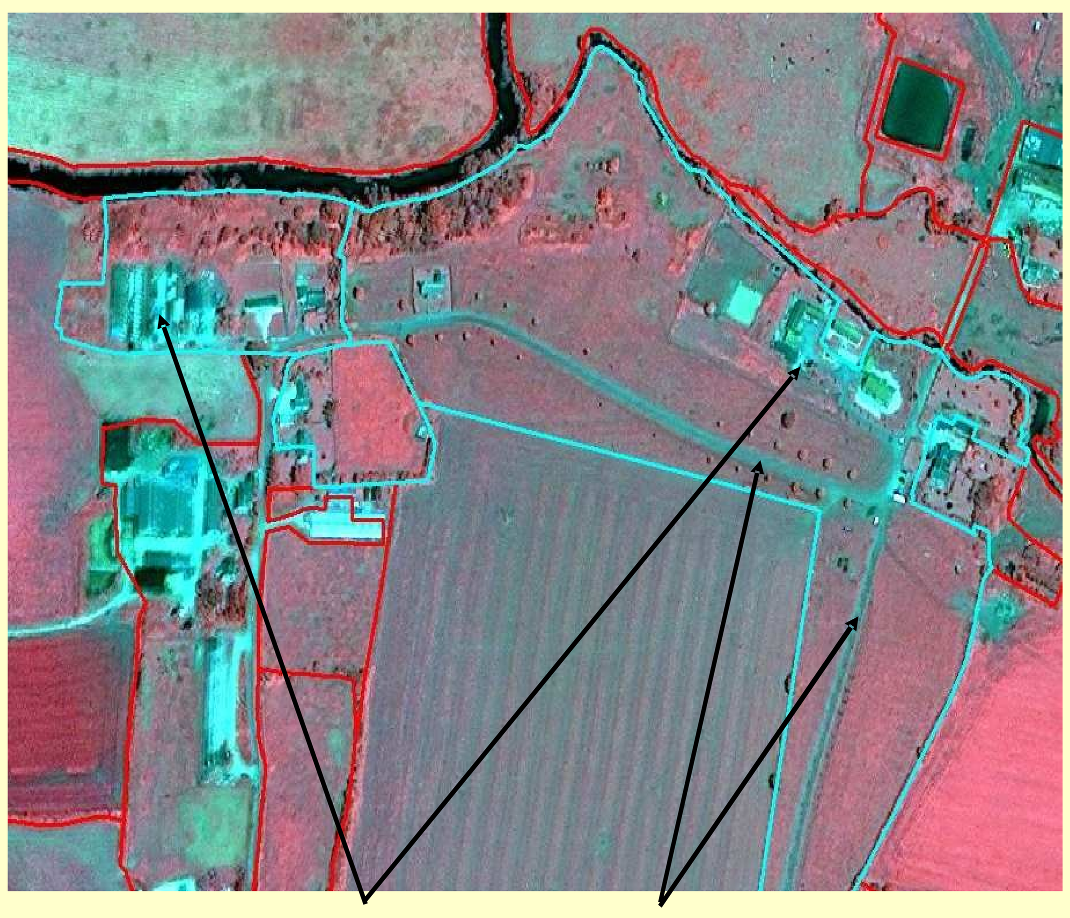
OBJECTIVE

The aim of this work is to provide to European Member States, national payment agencies and the EC, a robust and replicable method to assess the **LPIS quality**. As a geo-database, LPIS contains reference parcels more or less updated and orthophotos considered as the reality; the comparison of the two components should identify area differences i.e. LPIS anomalies and decide of the *in situ* quality of the LPIS. For that, control of all reference parcels being unrealistic, LPIS quality assessment needs a **LPIS anomalies sampling method** adapted to the **constraints** of the functioning of the LPIS.

METHODS

Sampling and quality assessment methods applied were based on **ecological methodologies** used when measuring biological species diversity to decide of the similarity of a set of ecosystems. Here, ecosystems corresponded to national LPIS when species corresponded to LPIS anomalies. Anomalies were sampled from twelve satellite images (50*50km, Ikonos/Quickbird, RGB, 1m resolution) used in eleven different European Member States during the 2005 CwRS campaign. The range of images corresponded to the european diversity of LPIS: "Agricultural parcel LPIS" (**AP**), "cadastral parcel LPIS" (**CP**), "farmer block LPIS" (**FB**) and "physical block LPIS" (**PB**). Twelve images allowed us to have three repetitions for each LPIS type. An ex-ante **typology** of the anomalies susceptible to be observed within LPIS (4 categories, 17 types) was tested. Anomalies corresponded to non eligible landscape features included inside reference parcel from which should be excluded or to a bad delineation of the reference parcel boundaries to be corrected. Only anomalies higher than 0.01 ha were counted.
On one particular zone (FB2), **calibration** of the LPIS anomalies sampling method was independently performed: sampling design, sample size and sampling unit size were decided. Then, application of the calibrated sampling method to all the zones was done and sampling method was **validated**. In a second step, similarity of the anomalies assemblages obtained from each zone was performed to decide of the potential effect of the LPIS type. Finally, single anomalies have been weighted and ranked to provide to LPIS users a picture of the **diversity** of the anomalies in LPIS and of the whole quality of the LPIS across Europe. Detailed information are available inside the dedicated JRC official report(*).

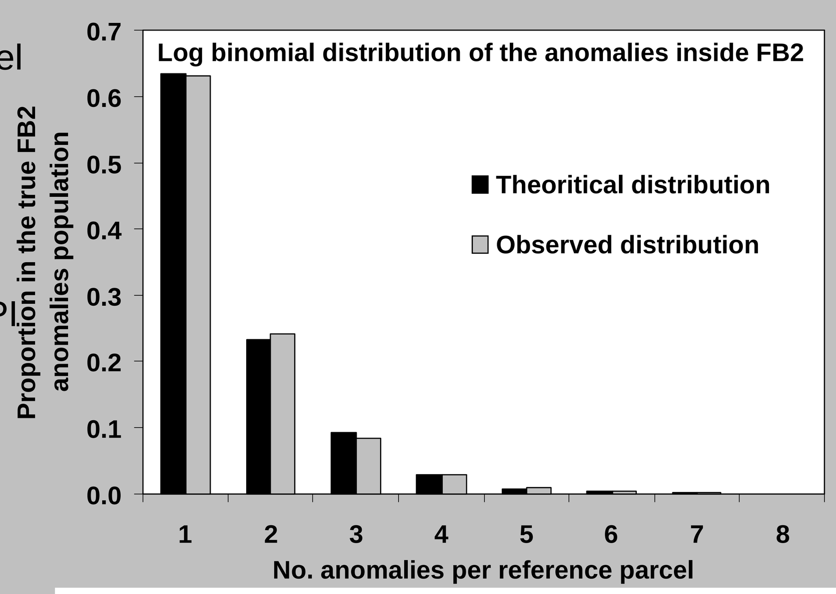
IN SITU EXAMPLES of LPIS ANOMALIES



Non eligible land use of the reference area (golf court)

CALIBRATION of the SAMPLING METHOD

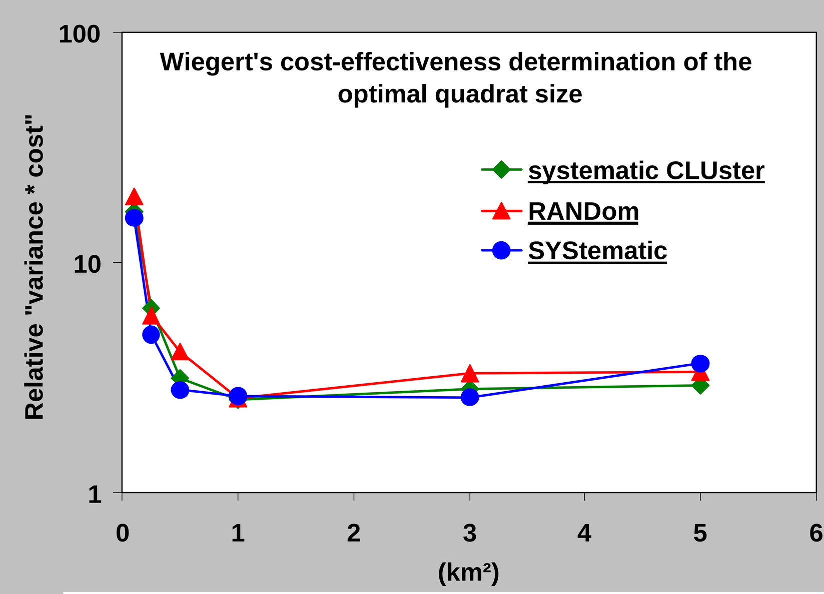
Anomalies spatial distribution



Spatial distribution of anomalies in FB2 was tested to identify which sampling design would be optimum: anomalies spatial pattern was clumped (khi2 = 2.67<9.49 ddl=4):

cluster sampling methods should be preferred to sample anomalies in LPIS

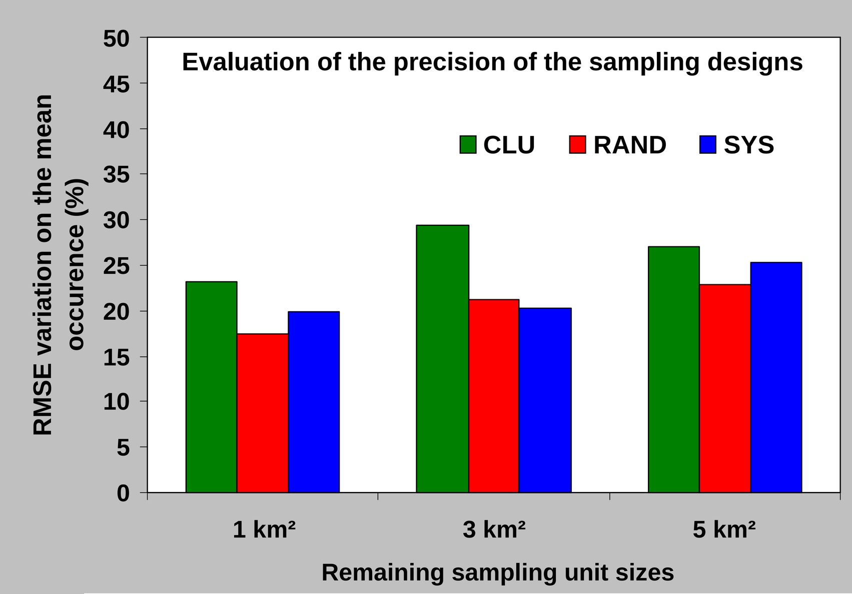
Sampling unit size



Wiegert's method allowed us to determine which size of the sampling unit (from 0.25 km² to 5 km²) was the most cost-effective:

≥ 1 km² square quadrat should be used when sampling anomalies in LPIS

Sampling design



Relative bias and imprecision (RMSE) allowed us to decide of the best design to apply when sampling anomalies in LPIS:

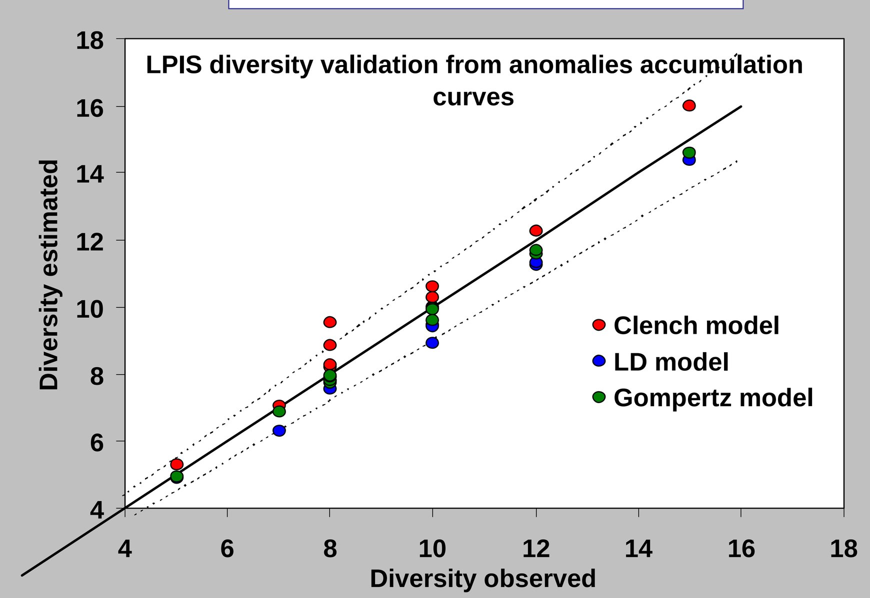
Even if slightly less accurate, systematic cluster (CLU) was retained

From calibration step, the sampling method applied was "systematic cluster design" of 45 km² sample size (results not shown) by using square quadrat of 1km² size

This sampling method was relevant to accept the two main LPIS constraints : (i) to consider the clumped spatial pattern of anomalies and (ii) to make cost-effective the consecutive on-the-spot checks of LPIS anomalies by auditors

VALIDATION of the SAMPLING METHOD

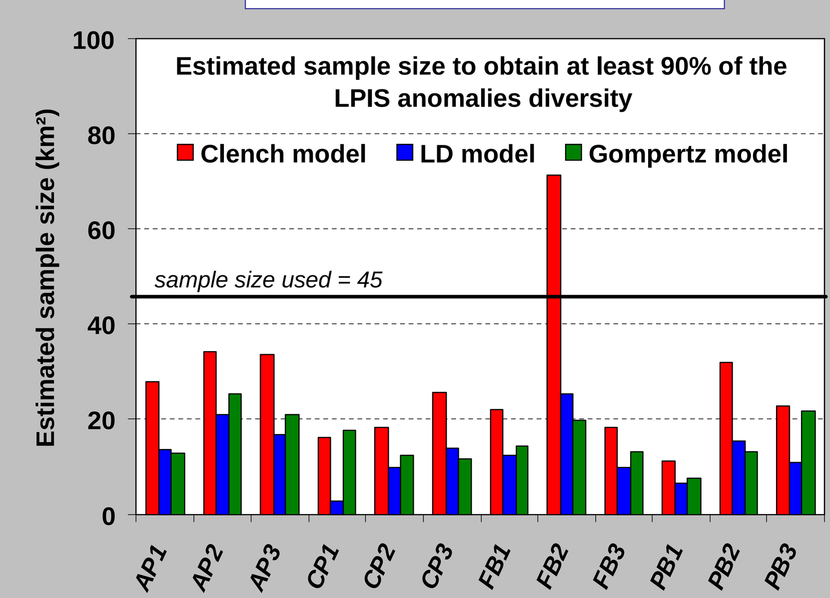
Estimated true diversity



Estimated true diversity of the LPIS anomalies per zone was modelled and confronted to the diversity sampled (observed richness):

Sampled diversity was for almost all zones and models ≥ 90% of the true diversity

Estimated sample size

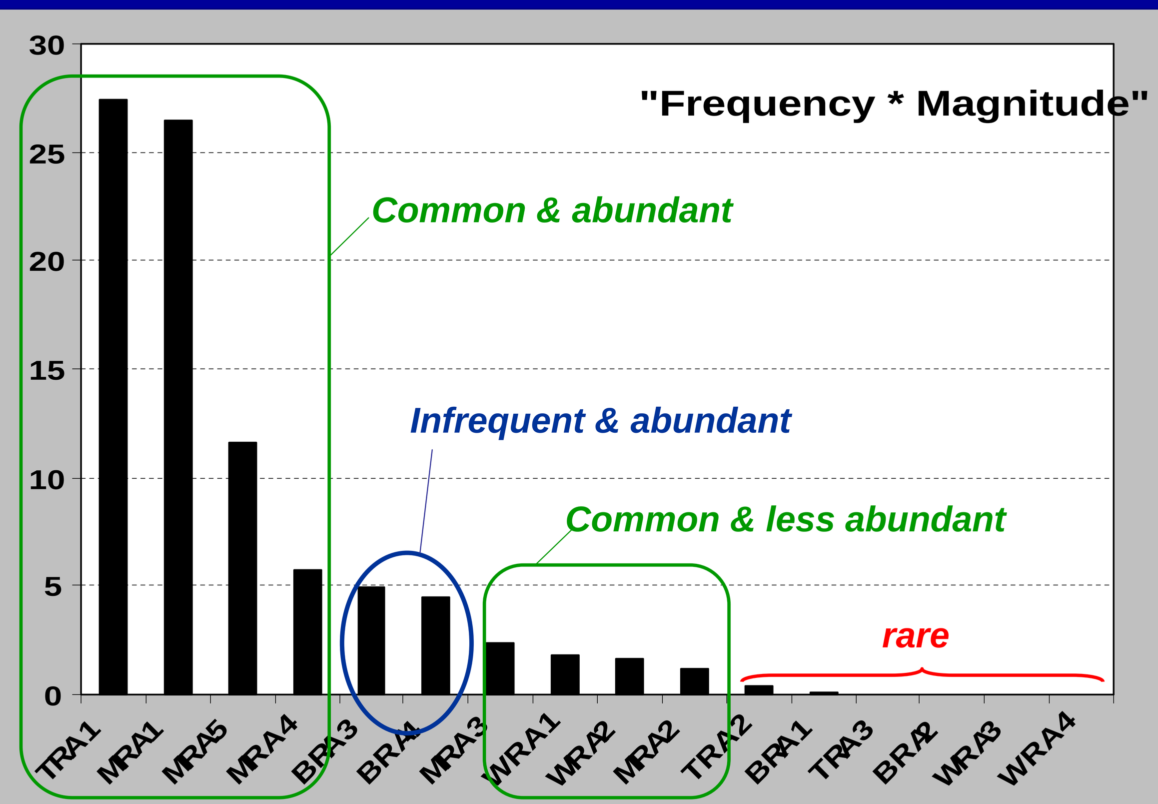


We also verified that 45 km² sample size was sufficient to obtain at least 90% of the estimated true diversity:

45 km² sample size was adequate in almost all situations
(Clench model suggested under-sampling for FB2)

From validation step, 45 km² sample size was sufficient to obtain at least 90% of the anomalies diversity
So, the sampling method was as robust and replicable as expected, this, independently of the type of LPIS !!

LPIS ANOMALIES DOMINANCE



Main anomalies observed were:

- **"Tree-related" TRA 1**: *patch(es) of trees in the reference parcel*
- **"Man-made related" MRA1**: *residential or production buildings in the reference parcel*
- **"Man-made related" MRA5**: *farmland not used for agriculture production in the reference parcel*
- **"Man-made related" MRA4**: *>2m width asphalt road in the reference parcel*
- **"Boundaries related" BRA3** (*Boundary not following stable land features*) and **BRA4** (*significant overlaps with another parcel*) were infrequent but abundant
- "Water-related" anomalies (WRA…) were observed in almost all zones but in limited proportions

WHOLE QUALITY of LPIS

LPIS types	Zones	No parcels sampled	No anomalous parcels	Anomalous parcels (%)	No anomalies	No anomalies per anomalous parcel
AP	AP1	866	237	27.37	460	1.94
	AP2	1321	167	12.64	223	1.34
	AP3	879	232	16.39	614	2.65
CP	CP1	6233	1762	28.27	3061	1.74
	CP2	2547	121	4.75	170	1.40
	CP3	6243	504	8.07	623	1.24
FB	FB1	619	237	38.29	525	2.22
	FB2	573	48	8.38	60	1.25
	FB3	788	434	55.08	1143	2.63
PB	PB1	547	271	49.54	578	2.13
	PB2	922	101	10.95	186	1.84
	PB3	154	103	66.88	1662	16.14
Average / Total		21692	4217	27.22 (±19.98)	9305	3.04 (±3.98)

All LPIS types considered, **more than 27% of the reference parcels appeared as anomalous** and anomalous parcels contained **more than 3 anomalies each**. But anomaly frequency was very variable between zones (from 4.5% up to 66%) suggesting very different LPIS status and effort to be consented if LPIS updating is envisaged. However, because area discrepancies ≥ 0.01 ha were considered, the results cannot be interpreted as irregularities – despite high anomaly frequencies observed, the LPIS in vigour could comply to current regulatory quality requirements.

Between zones, the anomalies assemblages sampled were very different (results not shown) suggesting that the type of LPIS was not a factor influencing significantly diversity and abundance of the anomalies. Other factors could explain the dissimilarity observed between zones: landscape composition and fragmentation, ownership impacts on parcels and landscape features management is another.

Altogether, results from this work provided to everyone in charge of LPIS or using it an effective method to sample anomalous reference parcels and to describe the corresponding anomalies assemblages. It also provided for the very first time, a description of the nature of the anomalies met in LPIS and at a certain extent, the level of validity at which LPIS can be considered as valid to checked areas declared by farmers.
Consequently, we encourage everyone expecting to use LPIS to conduct a preliminary assessment of the quality of the LPIS prior to use it agricultural or environmental purposes. Finally, we also suggest to persons responsible for the LPIS up-dating to have recourse to this sampling method to follow over time the whole quality of the LPIS produced.

Design: D. Grandgirard