Global Strategy
IMPROVING AG-STATISTICS

DEVELOPING MORE EFFICIENT AND ACCURATE METHODS FOR USING REMOTE SENSING

R. BENEDETTI, UNIVERSITÀ DI CHIETI-PESCARA

BRIEF DESCRIPTION OF THE RESEARCH TOPIC

1. New technologies of remote sensing
2. Methods for using remote sensing data at the design level
3. Extension of the regression or calibration estimators
4. Robustness of the estimators adopted for producing agricultural and rural statistics
5. Comparison of regression and calibration estimators with small area estimators
6. Statistical methods for quality assessment of land use/land cover databases

LITERATURE REVIEW (1)

Table 2.1: Main characteristics of some operational satellite sensors

	Spatial resolution	Channels	Swath at nadir (km)	Revisit days at nadir	Off-nadir pointing
NOAA -AVHRR/3	1.09 km	6	2900	1	No
Landsat 7 ETM+ (multispectral) **Landsat 7 ETM+ (thermal)** **Landsat 7 ETM+ (panchromatic)**	30 m 60 m 15 m	6 1 1	185	16	No
Landsat 8 OLI (multispectral) **Landsat 8 OLI (panchromatic)**	30 m 15 m	8 1	185	16	Yes
Landsat 8 TIRS (thermal)	100 m	2	185	16	Yes
SPOT 5 (multispectral) **SPOT 5 (panchromatic)**	10 -20 m 2.5 m	4 1	60 60	26 (2-3 off-nadir)	Yes
SPOT 6 (multispectral) **SPOT 6 (panchromatic)**	8 m 1.5 m	4 1	60	26 (1-3 off-nadir)	Yes
IKONOS (multispectral) **IKONOS (panchromatic)**	3.2 m 0.82 m	4 1	11.3	≃141	Yes
QuickBird (multispectral) **QuickBird (panchromatic)**	2.44 m 61 cm	4 1	16.8	≃2.4 (40°N Lat)	Yes Yes
WorldView-1 (panchromatic)	50 cm	1	17.7	≃1.7 (40°N Lat)	Yes
WorldView-2 (multispectral) **WorldView-2 (panchromatic)**	1.85 m 46 cm	8 1	16.4	≃1.1 (40°N Lat	Yes Yes
MODIS	250 m (bands 1-2) 500 m (bands 3-7) 1 km (bands 8-36)	36	2330	1	No
Proba-V	100 m	4	2250	1-2	Yes

LITERATURE REVIEW (1)

Table 2.2: Main characteristics of some near future satellite sensors

	Spatial resolution	Channels	Swath (km)	Revisit days at nadir	Off-nadir pointing
WorldView-3 (multisp.) [2014]	1.24 m	8	13.1	<1	Yes
WorldView-3 (panchromatic)	31 cm	1		(40°N Lat)	
WorldView-3 (SWIR)	3.70 m	8			
WorldView-3 (CAVIS)	30 m	12			
Sentinel -1 (IW) [2013]	5x20 m	1 mode	250	12 (with 1	Yes
Sentinel -1 (WV)	5x5m	1 mode	20	satellite)	
Sentinel -1 (SM)	5x5 m	1 mode	80	6 (with 2	
Sentinel -1 (EW)	20x40 m	1 mode	400	satellites)	
Sentinel -2 [2014]	10 m	4	290	<5 at equator	Yes
	20 m	6			
	60 m	3			
Sentinel -3 (SLSTR) [2014]	500 m - 1 km	9 + 2 for fire monit.	1420	<1 at equator	Yes
Sentinel -3 (OLCI)	300 m	21	1270	<2 at equator	Yes
Sentinel -3 (SRAL)	300 m	2 modes	>2	27	No
VENµS -VM1 [2014]	5.3 m	12	27.5	2	Yes
HyspIRI (VSWIR)	60 m	220	145	19	Yes
HyspIRI (TIR)	60 m	8	600	5	No

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LITERATURE REVIEW (2)

- The units to be observed are often randomly selected from a finite population whose main feature is to be geo-referenced. Thus, its spatial distribution has been widely used as crucial information in designing the sample.

- The geographical position in many agricultural surveys is an intrinsic characteristic of the unit and, given the particular nature of this information, its efficient use in sample design often requires methods that cannot be adapted from those used when dealing with classical auxiliary variables.

LITERATURE REVIEW (2)

In sampling theory the large concentration of the population with respect to surveyed variables constitutes a problem that is difficult to handle without:

- The use of selection probabilities proportional to a size measure

Multivariate auxiliaries in πps sampling

- The use of a stratification or partition tool

Optimal stratification

LITERATURE REVIEW

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LITERATURE REVIEW (3)

- The class of calibration estimators is an instance of very general and practical approach to incorporating auxiliary information, represented by remote sensed data, into the estimation.
- The technique of estimation by calibration was introduced by Deville and Särndal (1992). The idea behind is to use auxiliary information to obtain new sampling weights, called calibration weights that make the estimates agree with known totals. The estimates are generally design consistent and with smaller variance than the HT estimator.
- The estimators are obtained through a minimization of an appropriate distance function.

LITERATURE REVIEW (3)

- However, statisticians are educated to think in terms of models, and they feel obligated to always have a statistical procedure that state the associated relationship of y to x.

- The idea of model calibration is proposed in Wu and Sitter (2001), Wu (2003) and Montanari and Ranalli (2005). The motivating factor is that, when the auxiliary information xk is known for all the population units, this should be used in a more effective way than what it is possible in model free calibration, where a known total is sufficient.

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LITERATURE REVIEW (4)

- Many different estimators can be applied in different practical circumstances.
- A very important research question is represented by the choice of the more appropriate estimator for the particular case of study under investigation.
- These different estimators should be compared.
- This issue is not largely analyzed in the specialist literature.
- We will only provide some ideas and contributes that can be applied to this context.

LITERATURE REVIEW (5)

- It is worth noticing that different estimation methods, such as calibration, regression and SAE estimators, can lead different results both in the magnitudes of coefficients estimates and in the values of the related estimated standard error.
- The appropriate use of estimators primarily depends on the available data and on the objective of the analysis. For example, according to the availability of auxiliary information (i.e. remote sensed images), it can be used an approach rather than another. Furthermore, the researcher should pay attention to the definition of the used methods in order to compare statistical properties.
- Note that calibration and regression estimators are model-assisted methods, and the properties have to be assessed in terms of design. These estimators are design-unbiased. On the other hand, SAE are model-based techniques, and so the statistical properties should be analyzed with reference to the model. So, the analysts should interpret the comparisons with caution.

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LITERATURE REVIEW (6)

Accuracy assessment should be performed during any phase of the data production process, involving the quality of the classification, as well as the validation of the resulting map, that is the assessment of the degree to which the map agrees with reality (Lunetta et al 1991, Carfagna and Marzialetti 2009).

Stehman and Czaplewski (1998) identified three major components of land cover/ land use map accuracy assessment:

- the sampling design that identifies the protocol by which the reference units (i.e. the units upon which is based the map accuracy assessment) are selected;
- the response design that identifies the protocol by which the reference classification for the sample units is determined (i.e. the identification of support region and the assignment of labels to the sample units)
- the estimation and analysis protocol (the estimate of accuracy measures is based on confusion matrix. Specific guidelines to implement consistent estimators for accuracy parameters are also given by Strahler et al (2006).

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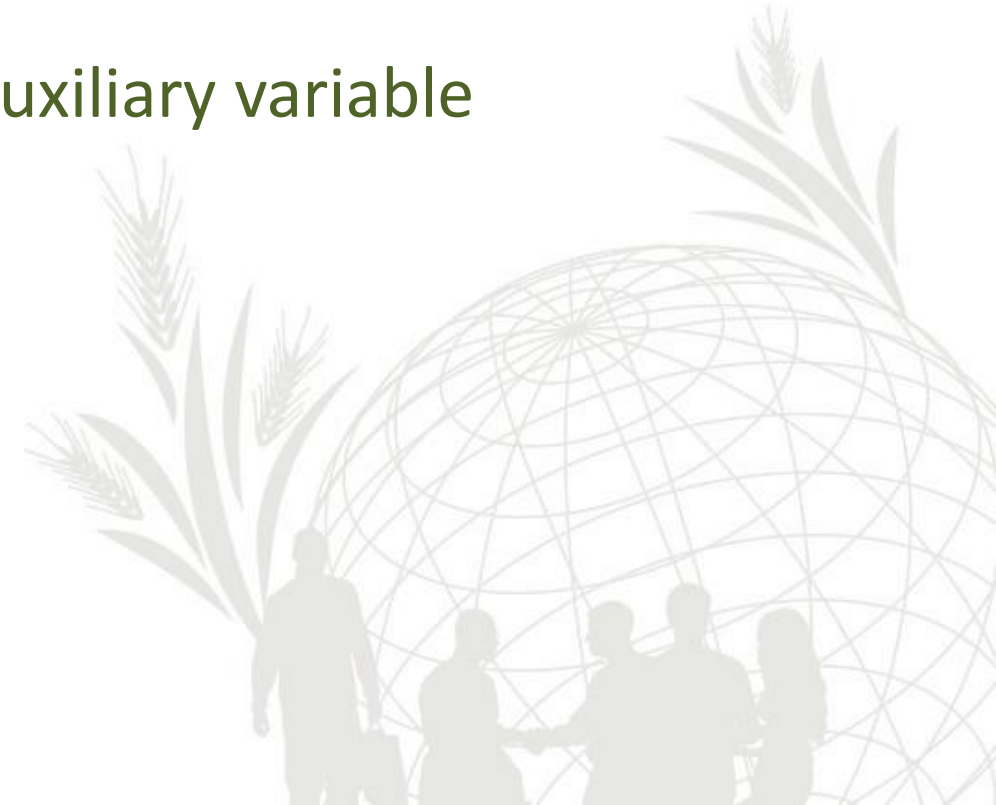
SUB-TOPICS REQUIRING FURTHER RESEARCH (1)

- Sample selection with probability proportional to the size when a size measure is multivariate
- Optimal stratification with multivariate continuous auxiliary variables
- Sampling design that are well spread over a study region
- Model that link the survey variable with some auxiliary to design the sample (sample size, sample allocation etc)

SUB-TOPICS REQUIRING FURTHER RESEARCH (2)

- Models for space varying coefficients. Optimal stratification with multivariate continuous auxiliary variables
- Missing values in the auxiliary variable



THANK YOU

(R. Benedetti, benedett@unich.it)