Integrating geo-referenced multiscale and multidisciplinary data for the management of biodiversity in livestock genetic resources

GIS-based breeding sustainability assessment

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OUTLINE

Introduction

- FAO Global Plan of Action and **need for AnGR monitoring**
- **GIS** as a key tool for the monitoring of AnGR

Case study on Swiss Original Braunvieh

- Two components for the monitoring of AnGR
  - a) Georeferenced herdbook data (diversity index)
  - b) Multicriteria Local Sustainability Index
- Combining the 2 indices for decision-making

Conclusions

AnGR MONITORING REQUIRED

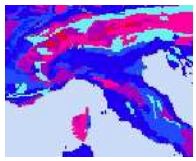
- **All over the World**, animal genetic resources have essential roles and values for food and agriculture (food security)
- **We presently face loss and erosion of FAnGR**
- **There is a need to** establishing a sustainable way to use, develop and **conserve animal genetic resources** for food and agriculture
- In the **Global plan of action** for animal genetic resources (FAO 2007), **Strategic Priority 1** is **to characterize** AnGR, **monitor** trends and risks and establish **early-warning and response systems**
- Geographic Information Systems (**GIS**) **constitute a key tool** to contribute to **FAnGR monitoring** and to support related prioritization decision-making

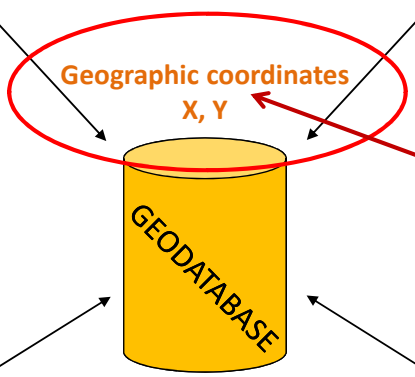
KEY FUNCTION: **GIS** PERMIT TO INTEGRATE DIFFERENT TYPES OF DATA

Elements to be included in AnGR monitoring tasks (Bruford et al. 2005)

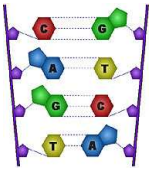
Administrative boundaries
Socio-Economic data
Socio-demographic data

Environmental data:
topography, climate,
soil, etc.





Common information between all data sets



Sampling
Genetic data
Herdbook data

GIS

Questionnaires
Husbandry pratices

TWO COMPLEMENTARY COMPONENTS FOR THE MONITORING OF ANGR

1. GIS-based monitoring of AnGR
   Early Warning System (Alderson 2009) – Herdbook-based
   Inbreeding coefficient

2. GIS-based monitoring of the local environment where a given breed is reared (socio-economic & demographic, natural environment data)
   Multicriteria Local Sustainability Index *(LMSI)*

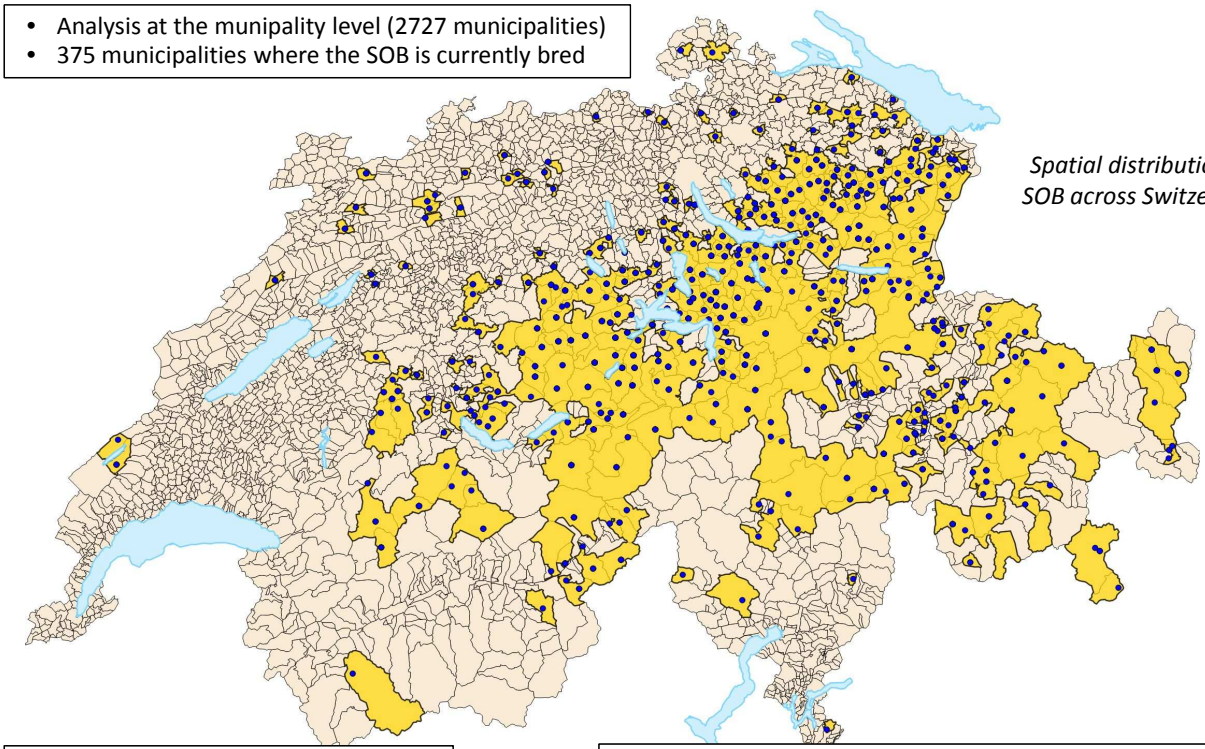
→ Combination of these two information layers: **Resultant**

- Assess breeding activity sustainability and compare it to the information produced by the EWS
- Highlight regions of Switzerland where the most sustainable conditions are met to favour breeding activities

Approach applied to the **Swiss Original Braunvieh** (SOB) with the support of Christine Flury (SHL) and Beat Bapst (SBZ)

7'079 ANIMALS BORN IN 2007 GEOCODED (PLZ)

- Analysis at the munipality level (2727 municipalities)
- 375 municipalities where the SOB is currently bred



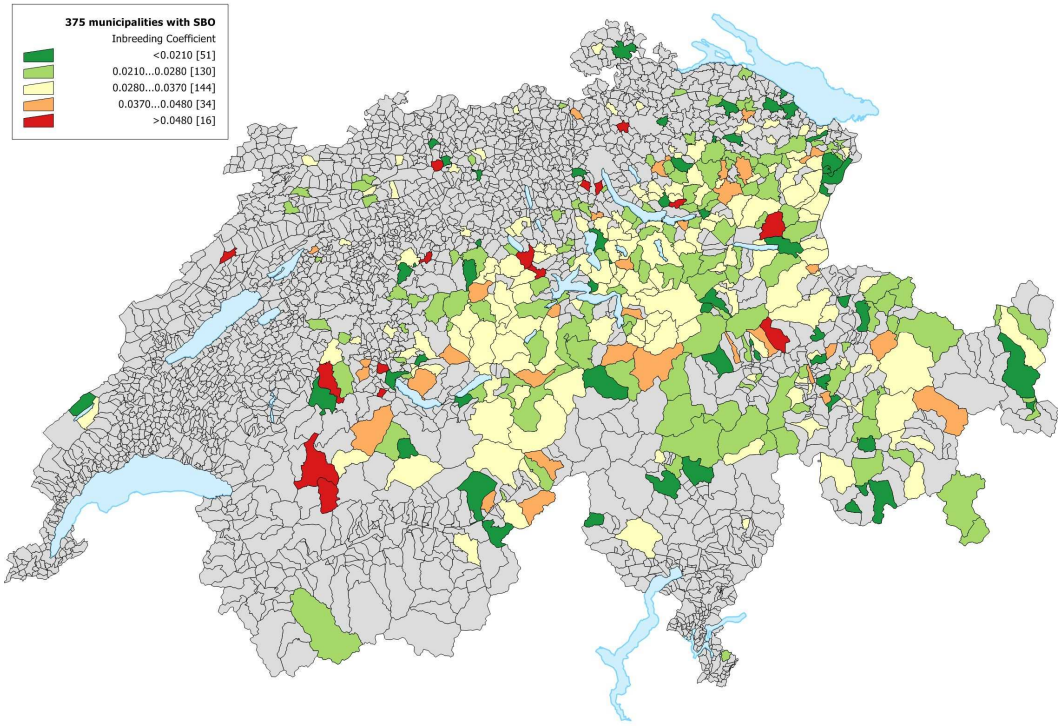
Spatial distribution of SOB across Switzerland

Blue = location of SOB farms ●
Yellow = limit of areas where SOB is reared

Municipality = **geographic unit of reference**, many socio-economic and socio-demographic variables available (Federal Office for Statistics BFS)

1. Inbreeding coefficient & Diversity index

Derivation of individual inbreeding coefficients from pedigree data



Diversity index

- We transformed the inbreeding coefficient into a diversity index so that a high value is positive
- As we need to combine the genetic index with the LMSI, both indices have to be comparable (a low value is “bad” and a high value is “good”)
- Diversity index : $\frac{1}{\frac{Inbreeding\ coefficient}{100}}$

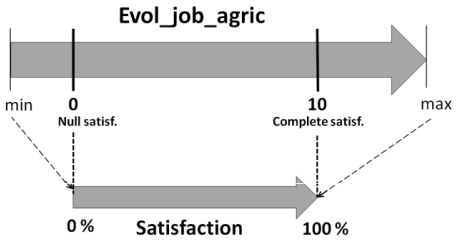
2. Local multicriteria sustainability index

- Integrating natural, social, economic and demographic data
- **Additive multicriteria aggregation method** (Joerin 2009; Munda & Nardo 2003) to create LMSI characterizing municipalities where SOB is bred
- We selected 7 variables related to the breeding activity or providing information to characterize the dynamics of municipalities:
    - Demographic balance (1980-2005)
    - Median available income (2005)
    - Unemployment rate (2005)
    - Proportion of farmers (2005)
    - Number of hectares with cattle breeding activities (2000)
    - Proportion of grazing surfaces (1997)
    - Evolution of the number of jobs in agriculture (2001-2005)

Satisfaction thresholds

- On the basis of these 7 variables, we built a composite multicriteria index
- Method requires **2 thresholds** (T1 and T2) for each variable
- T1 = value of the variable, for which we reach **no satisfaction** at all
- T2 = value of the variable, for which we reach **complete satisfaction**

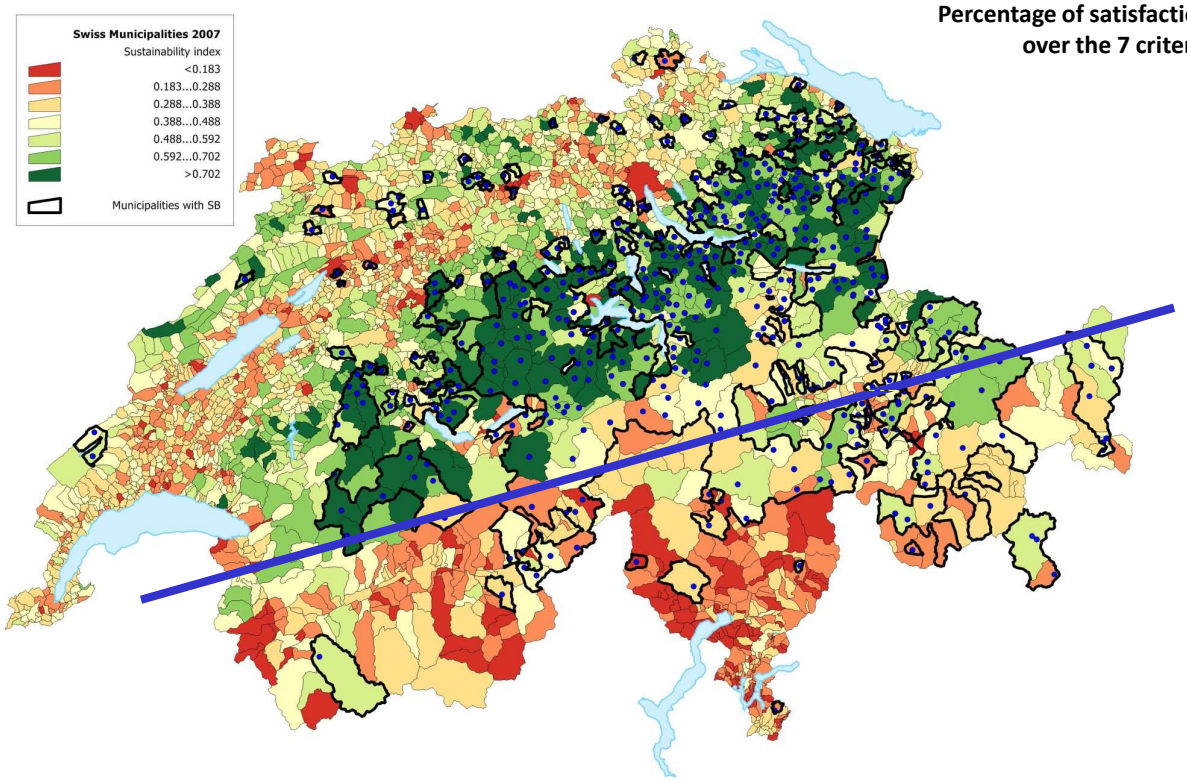
- Then we scale the range of remaining values between 0 and 1 (0% to 100% satisfaction)
- Attenuation of extreme values



- Calculation of a weighted sum (with weights w_j) of the J satisfaction scores s_j
- We obtain a global multicriteria satisfaction index S for each municipality

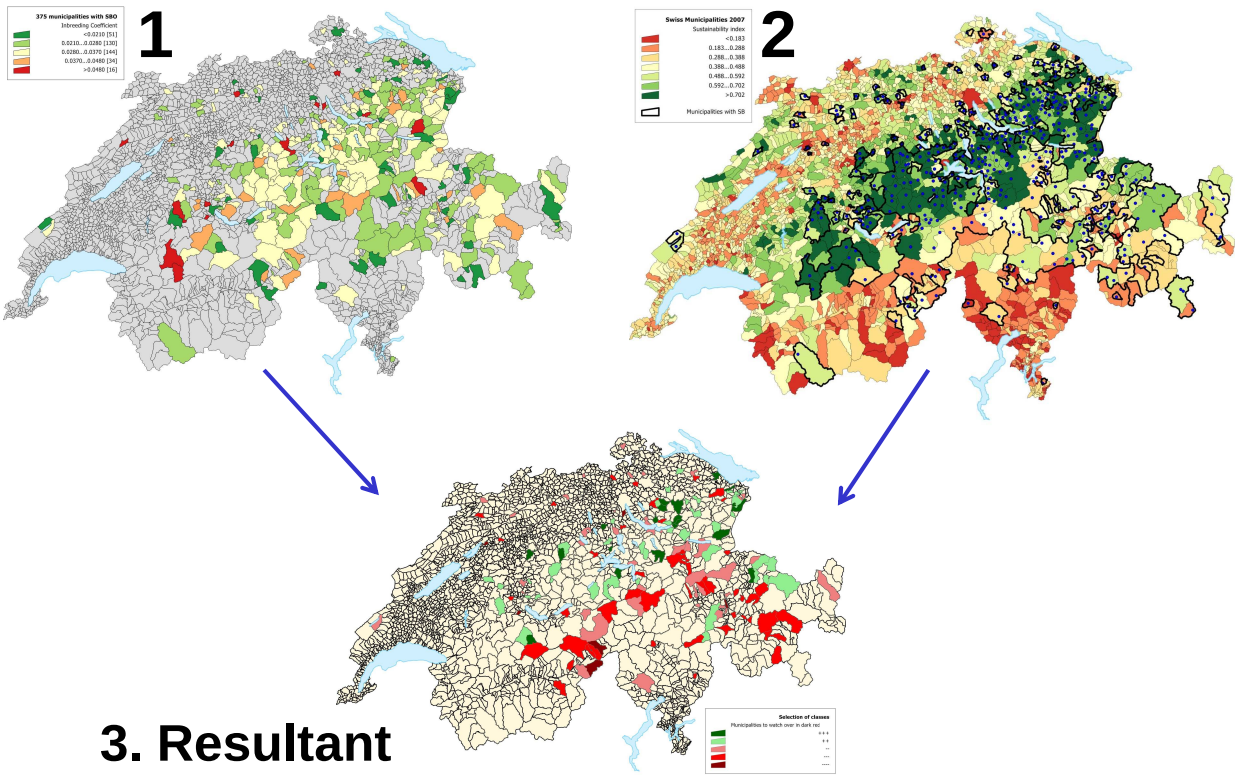
$$S = \sum_{j=1}^{J} s_j \cdot w_j$$

SUSTAINABILITY INDEX OBTAINED

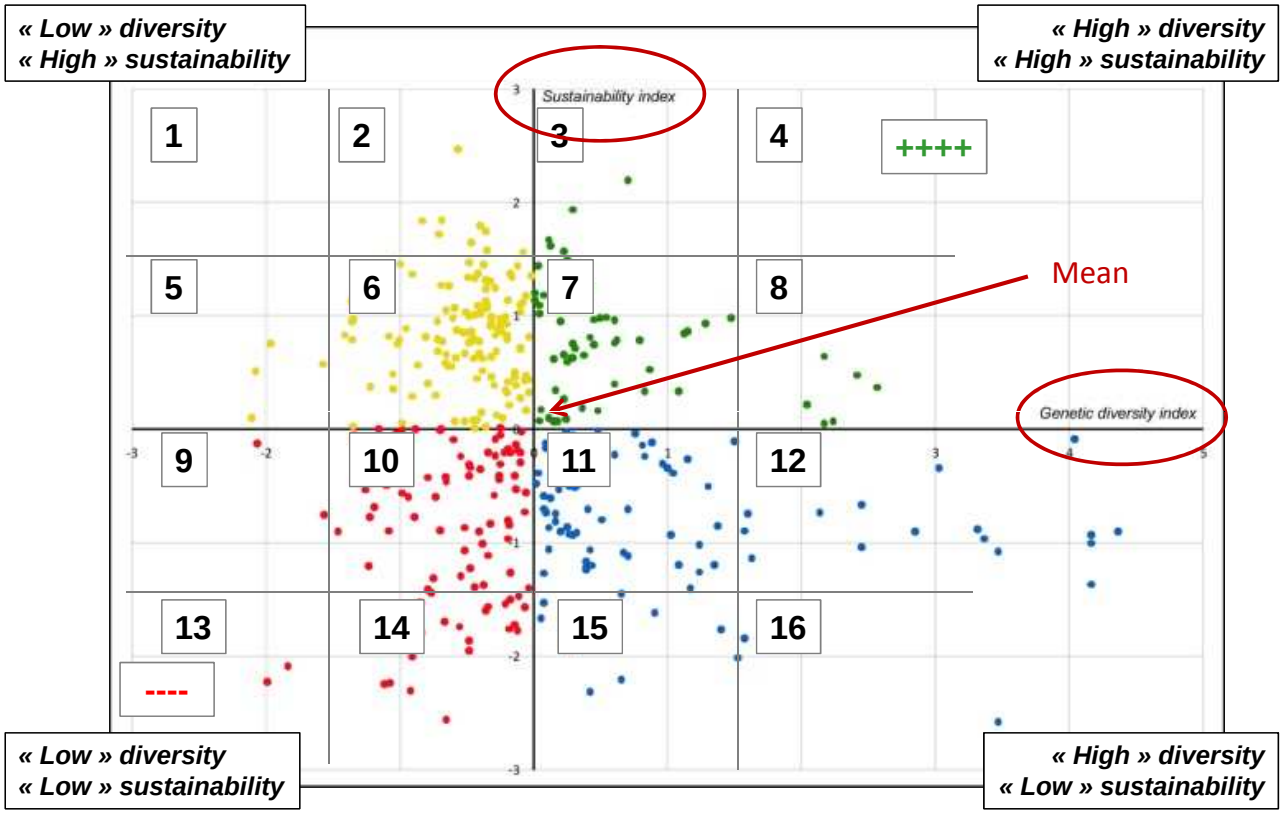


Percentage of satisfaction over the 7 criteria

COMBINING THE 2 INDICES

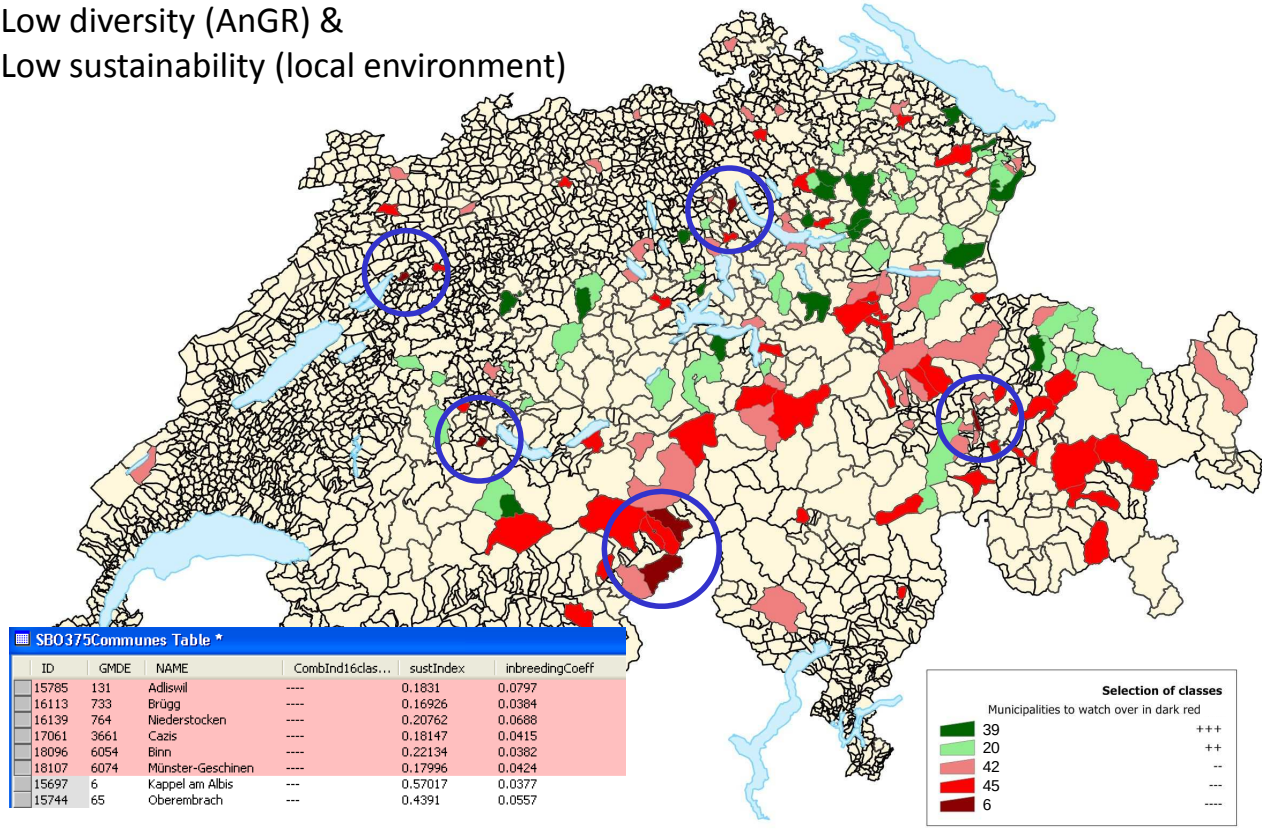


TYPOLOGY IN 16 CLASSES BASED ON **STANDARD DEVIATION**



Highlighting municipalities with problems

- Low diversity (AnGR) &
- Low sustainability (local environment)



CONCLUSION

- The **joining** of **GIS** and **multicriteria analysis** constitutes a very helpful **diagnostic** tool to assess the local sustainability of breeding conditions
- Applicable to all species and breeds (a "standard" local sustainability index could be defined for livestock species)
- The approach requires the **participation of experts** to define thresholds T1 and T2 and to select relevant variables :
  - Time consuming at the beginning, but
  - Permits decisions to be better accepted and implemented
- The **coupling with an Early Warning System** (see in particular the UK EWS including geographic criteria, Alderson 2009) is essential
- This complementarity provides robust support for monitoring and decision-making tasks related to AnGR conservation

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THANK YOU FOR YOUR ATTENTION !

Picture: Swiss Brown Cattle Breeders' Federation